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80micro 12/83

SPECIAL ANNIVERSARY ISSUE

80micro

A WAYNE GREEN PUBLICATION

the magazine for TRS-80* users

SPECIAL ANNIVERSARY ISSUE



Special 13th Issue:

Over 70 NEW Articles, Including Programming Techniques Utilities Tutorials Games 2 3-D Stereoscopic Programs Disk Utility Pack for Tape Users Bill Barden's Assembly-Language Primer 200 User Groups Listed PLUS a Complete 80 Micro Annotated Index with Debugs

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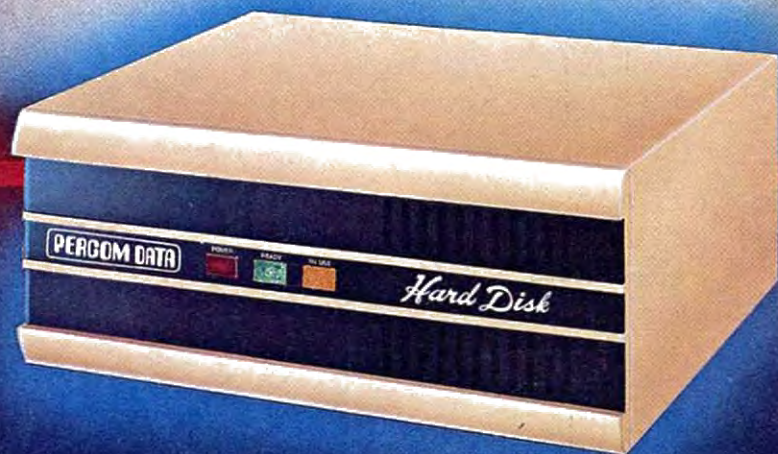
MicroTerm retails for \$79.95, but registered DOSPLUS owners can purchase it for only \$59.95. \$20.00 off the retail price! MicroTerm comes complete with the terminal program, the direct file transfer program, some standard translation tables, and documentation.

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Happy, Happy Birthday 80

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Bill Barden, Jr.
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Word processors ease the task of producing letters and manuscripts, but you must find one that fits your

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


Cover by Ray Maher

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system and your needs.
Dan Robinson

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Thomas Quindry
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David S. Peckett
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Ron Balewski
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Robert Jacobs
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 A unique application for your microcomputer, this menu-driven, Basic package will help amateur astronomers and other stargazers.
Joey Robichaux
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Dennis Ridgway
176. **Pick a Card...**
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Norman Efroymsen
178. **AND...OR...NOT**
Boolean logic is a powerful programming tool. Here's how it works and what it's used for.
Jeffrey Myers


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Avoid cluttering your work space with wires and cables and install this internal sound mod.

Richard C. McGarvey

190. Android Picture Gallery

 Here's a new game for you! It seems that there are no humanoids left on the planet Rehabul. Who will take over dusting the art gallery?

Mike Cook

196. Using DEFFN

The DEFFN statement lets you create your own functions. Using it simplifies programming and saves memory.

Ralph Rideout

200. Categories

Categories is playable without a computer, but this program adds new dimensions to the game.

Glenn Collura

208. Number Your Program Listings

It's much easier to handle those long, long program listings when they are numbered.

Joe Edwards

213. Brainstorm

This game challenges you with number sequences, just like the IQ tests you took in school.

Richard Ramella

216. More Memory for Peanuts

Adding memory to your Model III is not as hard as it seems, so don't be intimidated. But remember, you may void your warranty.


James Schaefer

220. Fast Tape Operating System

FTOS lets you use disk commands to increase the speed of storage time in your cassette system.


Michael Pollard

228. The Glamour of Grammar

 So your students don't appreciate the finer points of grammar? This program will let them learn the rules and have fun at the same time.

George Stone

238. Avoid the Danger of Dirty Disks

 Keeping a disk system clean has never been easy.


Dave Grimes

240. Making Labels

Producing custom labels has never been easier. Written in Basic, the program can easily be modified to work with just about any printer.


William Nelson

244. Two-Person Space Bomber

 In Space Bomber, one player defends his planet from bombs being dropped by his opponent.


Dale Chermak

253. Dual-Voice Music Synthesizer

 Those of you who are bored with your computer playing only one note at a time can learn how to get multiple notes through software.

Lee Morgenstern

264. Flexcat, Your Basic DBM

 Wouldn't it be nice to use one database manager for all your filing and retrieval needs? Flexcat fits the bill.

Lawrence A. Terre

274. Math Hangman

Math Hangman is a game that entertains you as it helps you develop your mathematical skills.

Tim Knight

278. Smartcat

The Lynx modem and Emterm software make an impressive communications package. Smartcat makes this combination even more powerful.

Irwin Rappaport

284. Long, Long Division

Teach your kids (or yourself) long division. Your Model I makes a good, patient tutor.

David Cecil

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Winston Llamas

298. Rapid Random Access

Find specific records quickly, even if your files contain 5,000 or even 10,000 records.

Karl Townsend

300. Auto Dial/Auto Answer

This addition to your modem will make your computer answer and dial your phone automatically.


Alan Moyer

306. Fly Like an Eagle

This simulation of a sailplane race can show you the excitement of being at the controls.

Ian Coffin

316. Catalog Your Files

 You need not hassle with filespecs any longer. Instead, install this cataloging routine in programs that maintain sequential filespecs.

Jane Goodale

320. Directory Information, Please

No disk directory can suit everyone's needs. But this one, written for LDOS, has enough flexibility to be adapted with relative ease.

Charles Knight

326. Tiger Graphics

The IDS Paper Tiger is an excellent graphics printer. Here are some graphics techniques in Assembly language, Basic, and Pascal.

Dan Robinson

366. Cobol on Your 80

Learning a new computer language can be a long tedious process, but this article leads you painlessly into the confusing world of Cobol.

Sam Perry

392. Disk Tiny Pascal

Did you have to abandon all your cassette-based Tiny Pascal programs when you upgraded to a disk system? David's got the answer.

David M. Silver

398. Reload 80

A primer on how to use this shortcut to getting the most out of this issue of *80 Micro*.

Art Huston

Color Computer

408. Teach Your CC New Words

Add commands, statements, and functions to Color Basic and gain more computing power.

Allen Curtis

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Tear the viewer from the mount carefully

80micro

Do not damage the colored lenses.

RIGHT



3-D

LEFT



416. Games in Color

These games for the Color Computer will test you, amuse you, and frustrate your friends!
Robert Toscani

427. 3-D for Real

Until now, 3-D has been a misnomer for CC graphics. Our CC expert has done the groundwork for real 3-D. It'll come out and grab you!
Dennis Bathory Kitz

436. Something-or-Other 3-D

With great perseverance, Jake Commander has come up with this stereoscopic 3-D program that features a rotating cube in two colors.
Jake Commander

440. Solitary Maneuvers

In this follow-up to Colorful Maneuvers, the computer is the opponent.
James Wood

442. Colorful Language Instruction

The Color Computer can be a useful tool in language instruction. Here's a graphic depiction of how the mouth makes certain sounds.
Alan F. Lacy and David Gordon

469. High-Res Alphanumerics for the Color Computer

Make up your own character sets in high resolution on a TRS-80 Color Computer with 16K.
Scott Norman

472. Teach Your Computer to Talk

What will your Color Computer's first words be? Here's a step-by-step method in Assembly language to get you and your CC speaking.
Richard Seymour

478. Five Games for 4K

Don't despair if your Color Computer has only 4K of memory; you can still play graphics games.
James Wood

482. Reconcile with Color

Organize your checkbook and reconcile bank statements with this Color Computer program.
David Dacus

486. Expanded Color Capabilities

The Color Computer can now display green, blue, red, and black on the screen at one time.
James Wood

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488. 80 Index, 1980-1982

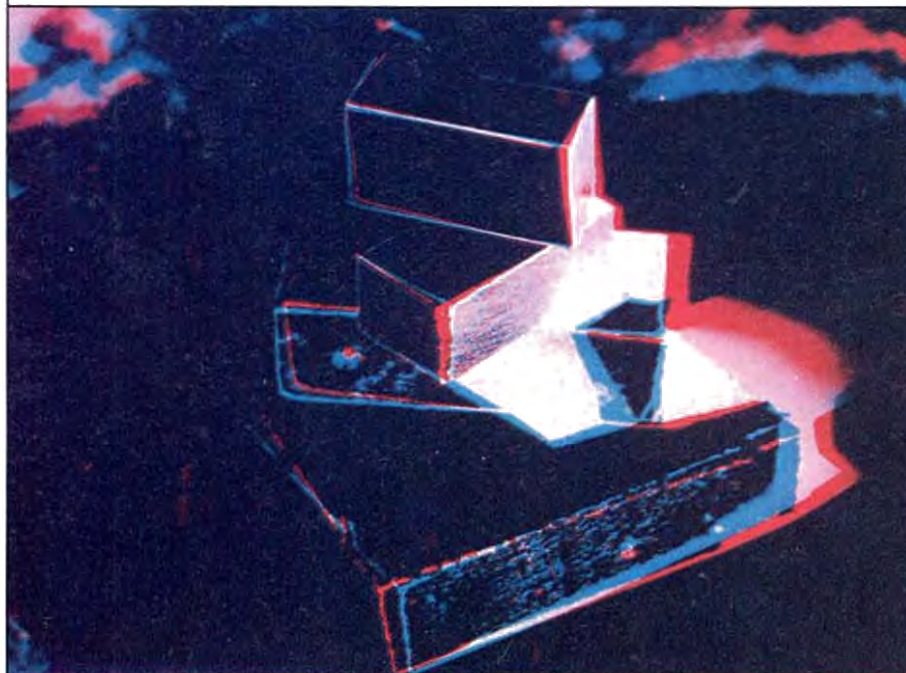
80 Micro has published hundreds of articles and reviews in the past three years. Here's a list of them.

400. Load 80 Index

Here's a handy list of all programs on Load 80.

526. User Groups

Want to find the clubs in your area? Check this out.

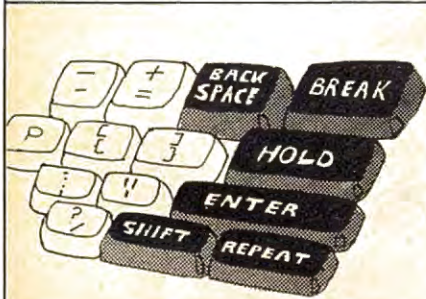


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530. The Art of Encoding and Decoding
If you would like to keep private correspondence private, this program is for you.
Karl Andreassen

536. BRKSEL
What could be worse than accidentally pressing the break key when running a Basic program on your Model II? Worry no more by disabling break using Debug.
Jim Barbarello



538. Model II Business Bar Graphs
Your Model II can produce bar graphs like those the Models I and III generate.
Richard Harkness

546. Mod II Disk Index
Indexing your Model II disks will eliminate confusion the next time you look for a program.
Charles R. Perelman

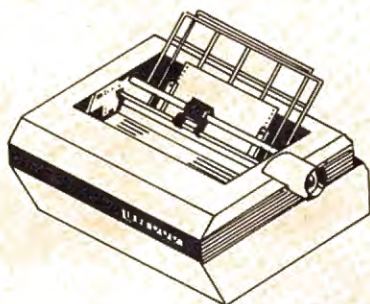
554. Compress, Mod II Style
Are your Model II programs too long? This program takes out spaces and remarks.
Charles R. Wood

558. Take a Letter
Draw large block letters using regular size letters, any printer, and a Model II.
James Barbarello

564. Investment Advisor
Determine the profit margin of an investment by computing its internal rate of return.
Charles R. Perelman

Peripherals

572. How to Buy a Printer
Epson, IDS, Okidata, NEC—which do you choose? Jim Hansen is an industry insider who can give you good advice when printer shopping.
Jim Hansen



578. Suppress Those Demon Transients
Transients, surges, power outages, and the like can destroy data and damage your hardware.
G. Michael Vose

582. Into the 232
Ever wonder about the RS-232 port on the back of your micro? Just how does it receive and send data? Stay tuned. Howard's got the scoop.
Howard Miller

586. Ribbon Rewind
Save money by rewinding multi-strike carbon ribbons for your daisy-wheel printer.
Dan Keen and Dave Dischert

588. Homebrew Green Screen
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James Conroy

590. Coping with Cassettes
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Richard Whitney

592. Ultimate Joystick Interface
This joystick interface is not only cheap, it is easy to build and program for.
Donald E. Michel and Art May

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80 formats its program listings to run 64-characters wide, the way they look on your video screen. This accounts for the occasional wrap-around you will notice in our program listings. Don't let it throw you, particularly when entering assembly listings.

Article submissions from our readers are welcomed and encouraged. Inquiries should be addressed to: Submissions Editor, 80 Pine Street, Peterborough, NH 03458. Include an SASE for a copy of our writers' guidelines. Payment for accepted articles is made at a rate of approximately \$50 per printed page; all rights are purchased. Authors of reviews should contact the Review Editor, 80 Pine Street, Peterborough, NH 03458.

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The editors look at the issues

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Here we are, three years later and 400 pages bigger. It looks like *80 Micro* is a success. This Third-Anniversary Issue celebrates that success.

Regular readers can expect the same great utilities, programming tips, tutorials, games, and construction projects they get in every issue. First-time readers are in for a treat.

If you just bought your TRS-80, you'll find valuable articles on topics such as shopping for a printer, choosing a word processor, how a disk stores information, care and feeding of cassette systems, and why a voltage suppressor is a good idea.

We also asked David Lien, who was one of the people responsible for developing the TRS-80, to write a short piece for us. He talks about the early days and how the industry is beginning to realize the need for user-understandable documentation. We hope you find it interesting.

Oh yes—our surprise. When we were sitting around last spring trying to think of ideas for this Anniversary Issue, someone suggested writing a stereoscopic 3-D program for the Color Computer and binding in the 3-D glasses. Of course, we all laughed... and then looked at each other and said, "Why not?" We think you'll find the technique interesting enough to try it yourself.

In This Issue

Though most of the articles were from our files, we solicited several especially for this Anniversary Issue. These include "NODOS 80" by Thomas L. Quindry, the piece on shopping for a printer by Jim Hansen, Mike Vose's article on voltage suppressors, and, of course, the two 3-D pieces by Dennis Kitz and Jake Commander.

NODOS 80 seemed like a good idea: Put a few of the better disk-based utilities published in past issues of *80 Micro* into one program for cassette users. Some of the utilities Tom included are not found in many commercial DOSes. Owners of cassette-based systems should find this article a real prize.

There's no end in sight

Jim Hansen is an engineer who designs printers for microcomputers, so when he tells you what to look for in a printer, you know he knows what he's talking about. After reading his advice, you'll feel confident when dealing with printer salesmen and reassured that you'll make a good choice.

The need for voltage suppressors is often overlooked by micro users. It takes only one good electrical surge to zap a disk, or only one lightning strike to burn out your computer. This inexpensive peripheral could be one of the best investments you'll make.

When we asked Dennis Kitz to write a stereoscopic 3-D program for the Color Computer, his eyes lit up. Dennis has long touted the Color Computer as a technical marvel, and he jumped at the chance to do something new with it. Even if you don't own a Color Computer, you will find his explanation of how 3-D works interesting. In fact, we've published two sets of photos that you can see in 3-D even without using the special glasses.

Jake Commander, our own technical wiz, was also eager to try his hand at 3-D. But Jake, having a reputation to uphold, had to break new ground. Even without the 3-D, Jake's program is interesting for its rotating-cube graphics techniques. It turned out to be more work than he expected, but you should find his efforts worthwhile.

The Future

Someday, *80 Micro's* growth will level off—it's inevitable. But at the moment, there's no end in sight.

Not only will we be publishing more articles each month, but the quality of those articles will be better. We've been impressed with the submissions of late, and to give you an idea of what to expect in the near future, here is a sample

THE SWITCH



SWITCH TO 5⁷/₈" DOUBLE DENSITY

LNDoubler 5/8

FEATURES

- 5- and 8-inch* disk drives
- Single- & double-density
- Any size and density in any mix
- Read Model I, II* and III disks
- 5- or 8-inch* system disk
- Single & double sided disk drives
- DOS+ 3.3.9 included, with Disk BASIC.
- 6 month warranty
- Up to 3.75 megabytes online
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- Precision write precompensation
- Regulated power supply
- Guaranteed operation at 4MHz
- All contacts gold plated
- Solder masked & silk screened
- Runs under DOS+ 3.3.9, TRSDOS 2.3, NEWDOS 2.1, NEWDOS/80 1.0, LDOS, NEWDOS/80 2.0, and ULTRADOS
- Reads 40- and 35-track disks on 80-track drives
- FD1791 controller + your FD1771
- Fits Model I expansion interfaces
- Fits LNW expansion interfaces
- Track configurations to 80-tracks
- 5 inch disk storage increased to:
 - 161,280 bytes - 35-track SS/DD
 - 322,560 bytes - 35-track DS/DD
 - 184,320 bytes - 40-track SS/DD
 - 368,640 bytes - 40-track DS/DD
 - 368,640 bytes - 80-track SS/DD
 - 737,280 bytes - 80-track DS/DD
- 8 inch disk storage increased to:

591,360 bytes - 77-track SS/DD
1,182,720 bytes - 77-track DS/DD
SS: single-sided DS: double-sided
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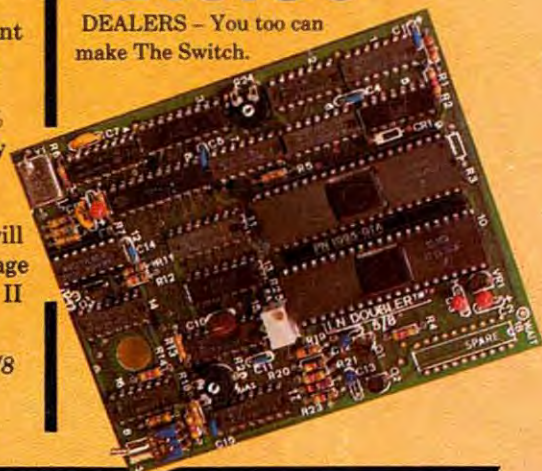
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The 80 Micro staff gets ready for 3-D.

of articles we've recently bought:

- A build-your-own hi-res color monitor for the Model III for \$150.
- A \$5 CP/M mod.

- A great tutorial on the FLEX operating system for the Color Computer from the man who adapted it from the IBM system.

- A new column by Hardin Brothers on using Assembly-language subroutines in Basic programs.

- A series on using a micro in cryptanalysis by Karl Andreassen, the first of which appears in this Anniversary Issue.

- How to copyright and market your software.

- Many well-written tutorials on Basic programming that will appeal to the beginning to intermediate programmer.

We'll also be publishing timely reviews written by users and a new-product listing. And your favorite columns will continue: Feedback Loop, a question-and-answer forum; MONEY DOS a financial-investment advisor; Medical Opinion, advice for MDs; and 80 Applications, a hardware hacker's haven by Dennis Kitsz.

We think we've put together a pretty good collection of articles in this Anniversary Issue; there should be enough of everything to satisfy everyone. And if there isn't, let us know and we'll try to include it in the next one. ■

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A Look Back

Through Level II Basic, tutorial-style documentation, and persistence, the TRS-80 Model I was born a user-friendly computer.

Ed. note: Dr. David Lien is one of the people who made the TRS-80 possible. He continues to support the Radio Shack computers by publishing books on Basic programming on the TRS-80—several of which are considered standards. Following are Dr. Lien's reflections on his role in the development of the Model I and the need for quality documentation.

It was 1976—only 6 years ago. Fort Worth was hot and humid.

I sat in the shabby old Radio Shack headquarters building discussing the possibility of a “personal computer.” President Lou Kornfeld was justifiably skeptical.

“If I gave one of these to my wife for Christmas, she’d think I was some sort of nut,” he said, clutching a prototype of the original Model I. Worded that way, the project didn’t seem to make much sense.

“What can I really use it for?” others asked.

My answer: “Its use is limited only by your imagination.”

That answer sounds as inadequate today as it did then.

At that time there was only Tiny Basic. No Level II Basic. No VisiCalc. No Scripsit. No Profile. No nothin! Just a game of Blackjack on an audio cassette.

I was retained to create a critical new interface between the engineers and the customers—a *tutorial-style* user’s manual. It was to be a complete correspondence course on how to run a computer—without the correspondence! No one had ever heard of a “user’s manual” for a computer written for beginners,

and no one (including me) was completely sure it could be done.

I promised Radio Shack only one thing—I would “*take away the fear.*” They got the Model I user’s manual for Level I Basic. The rest is history.

At the Creation

Don French, Steve Leininger, and I sat around a large old oak table, located in an entry where everyone bumped into it. The project was now well under way and it had a problem.

Don was the marketing genius who conceived the TRS-80, and who sensed the need for the engineer-consumer interface. He had asked me to solve that problem. There was just one additional little problem. No one at Radio Shack seemed to know much about the Basic language. I did, and agreed to help.

We sat all day at that big round table. I went through an exhaustive list of Basic words and explained their capabilities. Only 4K of ROM was available, and we had to decide which words to include in a Basic interpreter. It seemed like an impossible job, but at the end of the day Level I Basic was a reality.

The Breakthrough

The complete story of the TRS-80 has never been told. It is fascinating, but perhaps of interest mostly to historians.

From my perspective, the important breakthrough was recognition of the need for *premium-quality* “documentation” to accompany a highly technical product destined for a consumer market. Most important, that need was recognized and acted upon before the product was even designed. Radio Shack and Epson both had such vision.

Count their profits!

It’s amazing how few hardware and software manufacturers appreciate the importance of communicating with we end users in “end-user talk.” Fewer still actually do it without insulting our intelligence. How many failures of good products can be attributed to not understanding the marketing value of correctly interfacing the product with the end user?

Let Engineering Do It?

“Documentation,” “manuals,” “books,” or “instructions,” by any name are usually an afterthought, remembered only when the product finally works and engineering turns it over to marketing. Marketing realizes that something has to be stuffed in the shipping box along with the widget, so they tell engineering, “You guys know more about this thing than anyone else, so you write the instructions.” Engineering gathers up notes scribbled on the back of used computer printouts and does what it hates most—and does worst. The results are usually awful!

Since the products are usually well engineered, what can we do to get our money’s worth? Not many are sold in sufficient volume to attract good supplemental documentation written by noncompany authors.

Friends, user groups, and local computer stores can sometimes help, but the best information source usually comes each month in the mail. Magazines like *80 Micro* with their specific product emphasis promote the free exchange of information and ideas, encouraging experimentation and learning. If you can’t understand the manual, try a good magazine.

Specific articles like those that follow in this special Anniversary Edition help bridge the gap between the “official documentation” and *your* imagination.

*Dr. David A. Lien
San Diego—1982*



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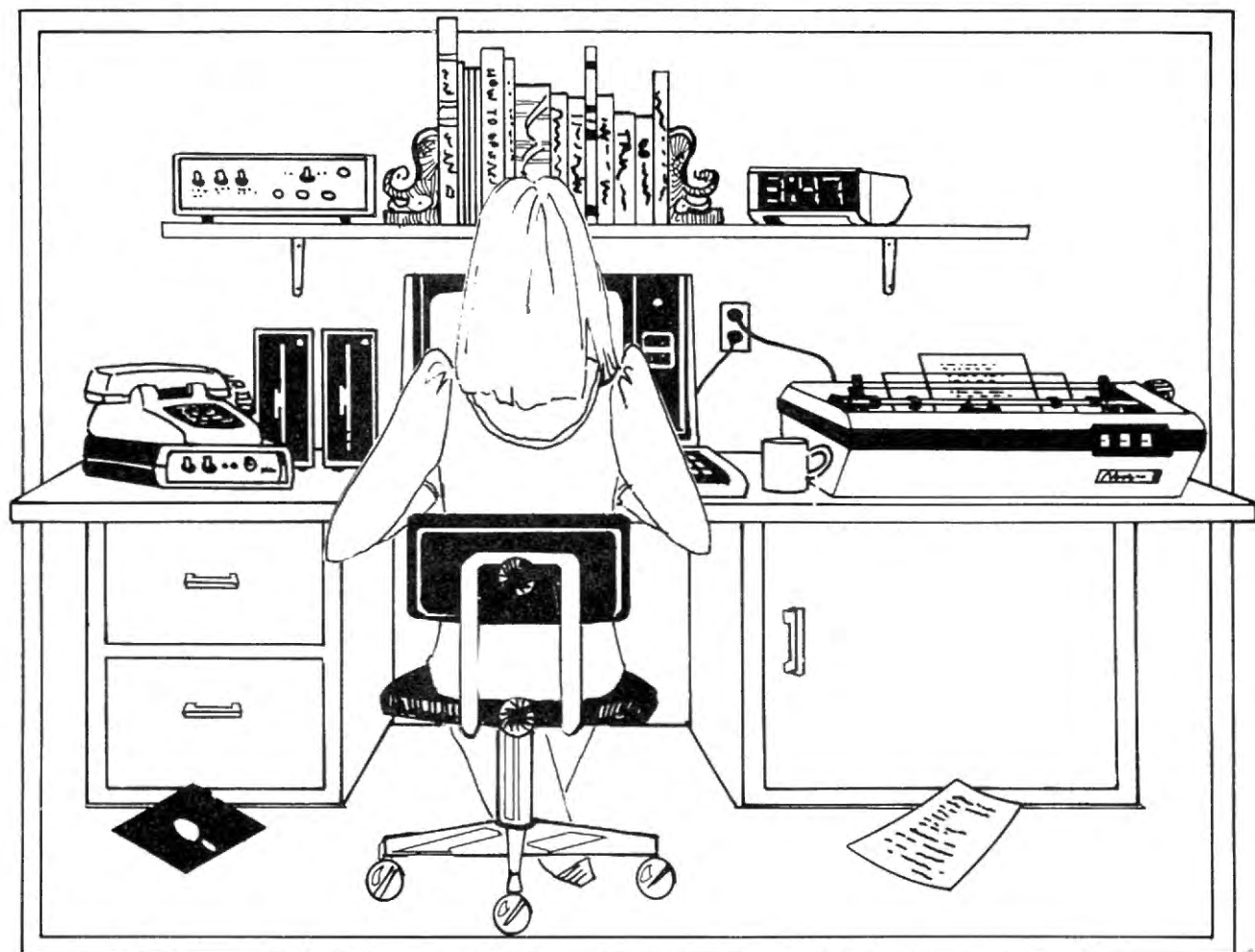
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Part I.
KNOW
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SYSTEM



Assembly Language Primer

by Bill Barden, Jr.

Bored by Basic, but unsure of taking the plunge to Assembly language? Bill Barden may give you just the encouragement you need.

Want a convincing demonstration that Assembly language is better than double density on the Model I, a 68000 in the Model II, a hard disk for the Model III, or lowercase for the Color Computer? Enter Program Listing 1 for your Model I/III (protect mem-

ory from &H7F00 on) or Program Listing 2 for your CoCo (CLEAR 200,&H3EFF) and run it.

Each program is a simple bubble sort of random characters on the first half of your video screen. You'll see the characters rearrange themselves in alphabetical order. Time how long it takes to sort the data. Now enter the version shown in Program Listing 3 or 4 and run it. Time it. Incredible, eh? The first version took about 20 minutes while the second version took about 10 seconds!

As you might have guessed, the second version is in Assembly language. Assembly language is the difference between stuffing a TV chicken dinner into the microwave and preparing Coq au Vin from scratch. The results are similar, but one is convenient and adequate while the other is handcrafted and a gourmet delight.

In this article we'll look at what Assembly language is, how it differs from Basic and other higher-level languages, the advantages and disadvantages of Assembly language, assembler programs, and finally, give you a bibliography of materials to help you learn Assembly language.

Which Came First, Basic or Assembly Language?

Basic has special commands related to useful functions, such as addition, multiplication, exponentiation, processing of alphabetic text strings, printing and display of results, and arrays

of data. The Basic commands are meant to be general-purpose functions that when strung together in a program accomplish useful results.

It is virtually impossible to build an electronic device that implements these commands directly. It's hard to conceive of being able to build a machine that would perform such diverse functions as finding the nth left characters of a string (LEFT\$), printing a line of numeric and alphabetic characters in special format, and finding the SIN of an angle. There are just too many functions and in too many combinations to be able to build such a computer.

How do we implement Basic or other applications problems, such as spread sheets, word processing, or control of the Acme No-Cal Cheesecake production line? It's done on a microprocessor, a machine that performs rudimentary arithmetic and control functions. These low-level functions, when properly combined in a program, can implement the Basic commands, word processing searches, and rejection of cheesecakes that contain too many calories.

As a matter of fact, we've been looking at the whole topic in reverse. First came machine and Assembly language, and then came Basic. Computers were originally developed from the need to rapidly perform simple operations such as addition, subtraction, multiplication, and division. The first computers were high-speed calculators that evolved into machines capable of performing other functions, such as making decisions and comparisons. The current evolutionary state of computing machines uses Basic and applications programs.

Instruction Sets

Let's get down to the actual instruc-

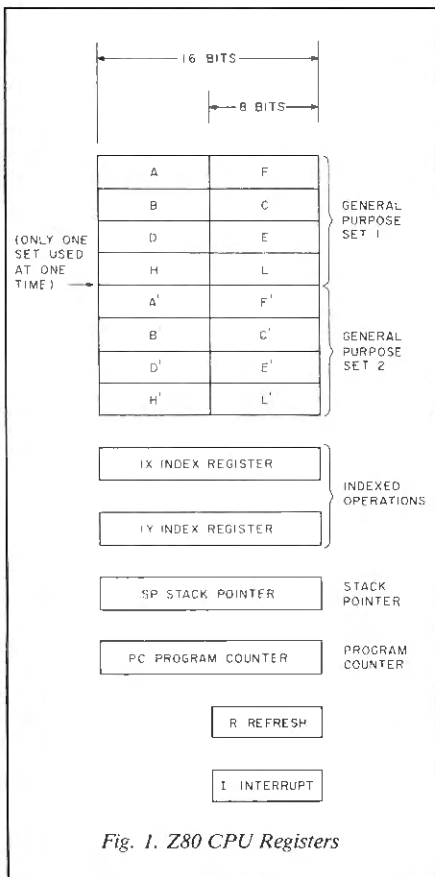


Fig. 1. Z80 CPU Registers

tions that microprocessors can perform. There aren't very many. We'll look at the Z80 microprocessor used in the Model I, II, and III, and the 6809E microprocessor used in the CoCo. In spite of chauvinists, these microprocessors are roughly the same in power and capability.

Addition and Subtraction: Both the Z80 and 6809E have a number of instructions to add and subtract numbers, as you might expect. However, only smaller numbers can be processed—numbers that are 16 binary digits (bits) in length, maximum. These are binary numbers that are 0000000000000000-1111111111111111, representing decimal equivalents of 0-65,535, or (in another format) -32,768 to +32,767.

Any size of numbers *can* be processed by combining multiple adds and subtracts in a sequence of instructions, but the Z80 and 6809E instructions only operate on 8 or 16-bit numbers.

Multiplies and Divides: The Z80 has no multiplication or divide instructions; the 6809E has a multiply only. Believe it or not, microprocessor instructions are that rudimentary! Multiplies and divides must be done by stringing together adds and subtracts, along with other instructions, in a 20 or 30-instruction program to implement multiplies and divides.

Decision-Making Instructions: The Z80 and 6809E have instructions to make decisions. These instructions alter the flow of the program and are used continually. These *conditional jump* or *conditional branch* instructions jump to a new sequence of instructions *if* a condition is met. The condition tested is usually the result of some previous add, subtract, or comparison, and represents conditions such as *zero result*, *negative result*, *positive result*, *not equal*, *equal*, and others.

An *unconditional jump* also alters the sequence of instructions to be executed, and is always (unconditionally) done.

Logical and Bit-Manipulation Instructions: Basic generally operates on entire numeric quantities. However, the instructions of the Z80 and 6809E provide a *bit-manipulation* capability. ANDs and ORs provide logical functions on a binary-digit level, and *shifts* provide the ability to realign data on a bit basis. These instruction types are important to the microprocessor as they allow multiplies and divides to be implemented in programs, permit efficient storage of data, and provide control of input/output devices.

Subroutine Instructions: Subroutines are sets of instructions, ranging from several to thousands of instructions, that perform certain functions, ranging from comparing two numbers to sorting data into an alphabetized list. Rather than repeating the instructions every time they are required, they are stored in one set of locations in memory and *called* by different parts of the program. This saves a great deal of memory space. Both the Z80 and 6809E have instructions that allow subroutines to be called and for returns to the calling point.

Memory-Reference Instructions: Assembly-language programs are stored in memory (ROM or RAM), along with operands for the program. The operands are temporary results or constants for the program. The Z80 and 6809E have a large number of *memory-reference* instructions that pass 8 and 16-bit operands between memory and *CPU registers*, which are high-speed memory locations located within the Z80 or 6809E CPU (central-processing unit) itself. We'll look at the CPU registers shortly.

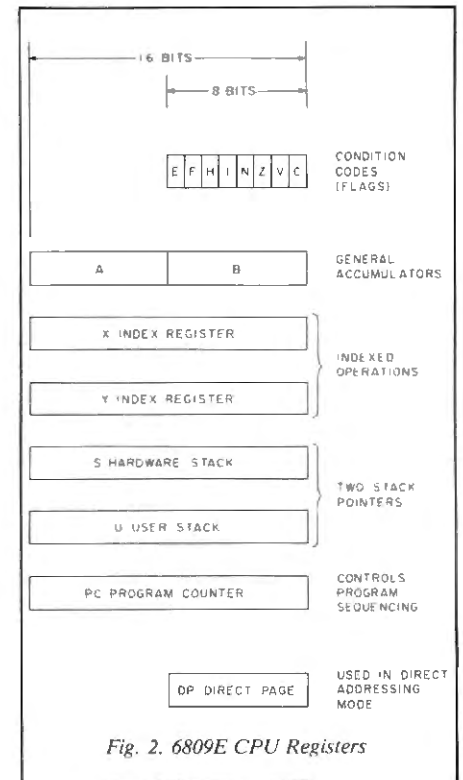
Input/Output Instructions: The Z80 has a few important instructions that allow 8 bits of data to be passed between the microprocessor CPU and the outside world—input/output devices such as printers, disk drives, and cassette recorders or their *I/O controllers*. (The 6809E handles I/O devices by *memory mapping* them as locations in memory.)

Chip Architecture

Before we look at the detailed instruction sets of the Z80 and 6809E, let's first look at the *architecture* of the microprocessors. This is just a fancy word for defining the internal structure of the microprocessor.

Each microprocessor contains tens of thousands of transistor equivalents. Many of these are related to the timing and control of the microprocessor, along with interpretation of the instruction set. The most important parts of the microprocessors from an Assembly-language standpoint, however, are the CPU registers, shown in Figs. 1 and 2.

The CPU registers are memory locations, but fast-access memory locations located within the microprocessor chip itself, and not addressed as part of external ROM or RAM. For this reason, they are called *registers*.



```

100 * BUBBLE SORT DEMO FOR MODEL I/III
110 CLS:P=0
120 FOR I=15360 TO 15615
130 A=RND(127):IF A<32 THEN GOTO 130
140 POKE I,A
150 NEXT I
160 S=0
170 FOR I=15360 TO 15614
180 A=PEEK(I):B=PEEK(I+1):IF A<B THEN GOTO 200
190 S=S+1:POKEI,A:B:POKE I+1,A
200 NEXT I
210 P=P+1:PRINT @ 530,"* SWAPS=";S;"PASS=";P
220 IF S<>0 THEN GOTO 160 ELSE GOTO 220

```

Program Listing 1. Basic Bubble Sort for Model I/III

```

100 * BUBBLE SORT DEMO FOR COCO
110 CLS:P=0
120 FOR I=1024 TO 1024+255
130 A=RND(127):IF A<64 THEN GOTO 130
140 POKE I,A
150 NEXT I
160 S=0
170 FOR I=1024 TO 1278
180 A=PEEK(I):B=PEEK(I+1):IF A<B THEN GOTO 200
190 S=S+1:POKEI,A:B:POKE I+1,A
200 NEXT I
210 P=P+1:PRINT @ 260,"* SWAPS=";S;"PASS=";P
220 IF S<>0 THEN GOTO 160 ELSE GOTO 220

```

Program Listing 2. Basic Bubble Sort for CoCo

Some of the registers hold intermediate results of arithmetic and other processing operations. Other registers are devoted to program control—the proper sequencing of instructions.

The A and B registers in the 6809E are general *accumulator* registers that hold temporary results. The Z80 A, B, C, D, E, H, and L registers (two sets) are the general-purpose accumulators in that chip.

Both microprocessors have *index registers* that allow the program to easily access sequential data. Both also have *stack pointers* that control access

to a special part of external memory called the *stack*, which is used to hold the return points for subroutine calls, and temporary results.

Both chips also have a set of eight *flags*, collectively called the F register in the Z80 and the CC (condition codes) in the 6809E. Condition codes is probably a better term, because this special-purpose storage holds the results of adds, subtracts, comparisons, and other operations that can be tested for conditional branching.

The main program sequence register in both microprocessors is called the

PC, or program counter. The PC points to the current *byte* of the program instruction. The instructions in the microprocessors are generally 1–4 bytes in length. A 400-instruction program, for example, would probably require about 800 bytes of RAM memory storage.

The PC register points to the next instruction in sequence. Branches change the contents of the program counter to allow different sets of instructions to be executed.

Data, or *operands*, can be interspersed with program instructions, or

Table 1. Z80 Instruction Set

ADC HL,ss	HL + ss + CY to HL	EX DE,HL	Exchange DE and HL
ADC A,r	A + r + CY to A	EXX	Set prime B-L active
ADC A,n	A + n + CY to A	HALT	Halt
ADC A,(HL)	A + (HL) + CY to A	IM 0	Set interrupt mode 0
ADC A,(IX + d)	A + (IX + d) + CY to A	IM 1	Set interrupt mode 1
ADC A,(IY + d)	A + (IY + d) + CY to A	IM 2	Set interrupt mode 2
ADD A,n	A + n to A	IN A,(n)	Load A with input from n
ADD A,r	A + r to A	IN r,(C)	Load r with input from (C)
ADD A,(HL)	A + (HL) to A	INC r	Increment r by one
ADD A,(IX + d)	A + (IX + d) to A	INC (HL)	Increment (HL) by one
ADD A,(IY + d)	A + (IY + d) to A	INC (IX + d)	Increment (IX + d) by one
ADD HL,ss	HL + ss to HL	INC (IY + d)	Increment (IY + d) by one
ADD IX,pp	IX + pp to IX	INC IX	Increment IX by one
ADD IY,rr	IY + rr to IY	INC IY	Increment IY by one
AND r	A AND r to A	INC ss	Increment register pair
AND n	A AND n to A	IND	Block I/O input from (C)
AND (HL)	A AND (HL) to A	INDR	Block I/O input, repeat
AND (IX + d)	A AND (IX + d) to A	INI	Block I/O input from (C)
AND (IY + d)	A AND (IY + d) to A	INIR	Block I/O input, repeat
BIT b,r	Test bit b of r	JP (HL)	Unconditional jump to (HL)
BIT b,(HL)	Test bit b of (HL)	JP (IX)	Unconditional jump to (IX)
BIT b,(IX + d)	Test bit b of (IX + d)	JP (IY)	Unconditional jump to (IY)
BIT b,(IY + d)	Test bit b of (IY + d)	JP cc,nn	Jump to nn if cc
CALL cc,nn	CALL subroutine at nn if cc	JP nn	Unconditional jump to nn
CALL nn	Unconditionally CALL nn	JR C,e	Jump relative if carry
CCF	Complement carry flag	JR e	Unconditional jump relative
CP r	Compare A:r	JR NC,e	Jump relative if no carry
CP n	Compare A:n	JR NZ,e	Jump relative if non-zero
CP (HL)	Compare A:(HL)	JR Z,e	Jump relative if zero
CP (IX + d)	Compare A:(IX + d)	LD A,(BC)	Load A with (BC)
CP (IY + d)	Compare A:(IY + d)	LD A,(DE)	Load A with (DE)
CPD	Block Compare, no repeat	LD A,I	Load A with I
CPDR	Block Compare, repeat	LD A,(nn)	Load A with location nn
CPI	Block Compare, no repeat	LD A,R	Load A with R
CPIR	Block Compare, repeat	LD (BC),A	Store A to (BC)
CPL	Complement A (one's complement)	LD (DE),A	Store A to (DE)
DAA	Decimal Adjust A	LD (HL),n	Store n to (HL)
DEC r	Decrement r by one	LD dd,nn	Load register pair with nn
DEC (HL)	Decrement (HL) by one	LD dd,(nn)	Load register pair with location nn
DEC (IX + d)	Decrement (IX + d) by one	LD HL,(nn)	Load HL with location nn
DEC (IY + d)	Decrement (IY + d) by one	LD (HL),r	Store r to (HL)
DEC IX	Decrement IX by one	LD I,A	Load I with A
DEC IY	Decrement IY by one	LD IX,(nn)	Load IX with nn
DEC ss	Decrement register pair	LD IX,nn	Load IX with location nn
DI	Disable interrupts	LD (IX + d),n	Store n to (IX + d)
DJNZ e	Decrement B and JR if B≠0	LD (IX + d),r	Store r to (IX + d)
EI	Enable Interrupts	LD IY,nn	Load IY with nn
EX (SP),HL	Exchange (SP) and HL	LD IY,(nn)	Load IY with location nn
EX (SP),IX	Exchange (SP) and IX	LD (IY + d),n	Store n to (IY + d)
EX (SP),IY	Exchange (SP) and IY		
EX AF, AF'	Set prime AF active		

Table 1 continues

can be kept in a separate area. The program itself must be set up to *jump/branch* over the data areas and to keep the flow of instructions in proper order.

Generally, the instruction steps are located in sequential order. Instruction execution consists of two parts, the *fetch cycle*, which fetches the 1, 2, 3, or 4 bytes of the instruction from memory and decodes it into the proper instruction, and the *execute cycle*, which may access memory again in different locations to read in or write out memory operands. This process is

```

100 ' BUBBLE SORT DEMO WITH AL SORT
101 DATA 14,0,221,33,0,60,6,254,221,126,0
102 DATA 221,86,1,186,40,10,56,8,14,1,221,114,0
103 DATA 221,119,1,221,35,16,233,203,65,32
104 DATA 221,201
105 FOR I=32512 TO 32547
106 READ A
107 POKE I,A
108 NEXT I
109 DEFUSR0=32512
110 CLS
120 FOR I=15360 TO 15615
130 A=RND(127):IF A<32 THEN GOTO 130
140 POKE I,A
150 NEXT I
160 A=USR0(0)
170 GOTO 170

```

Program Listing 3. Basic/Assembly-language Bubble Sort for Model I/III

Table 1 continued

LD (Y + d),r	Store r to (Y + d)
LD (nn),A	Store A to location nn
LD(nn),dd	Store register pair to location nn
LD (nn),HL	Store HL to location nn
LD (nn),IX	Store IX to location nn
LD (nn),IY	Store IY to location nn
LD R,A	Load R with A
LD r,r'	Load r with r'
LD r,n	Load r with n
LD r,(HL)	Load r with (HL)
LD r,(IX + d)	Load r with (IX + d)
LD r,(IY + d)	Load r with (IY + d)
LD SP,HL	Load SP with HL
LD SP,IX	Load SP with IX
LD SP,IY	Load SP with IY
LDD	Block load, f'ward, no repeat
LDDR	Block load, f'ward, repeat
LDI	Block load, b'ward, no repeat
LDIR	Block load, b'ward, repeat
NEG	Negate A (two's complement)
NOP	No operation
OR r	A OR r to A
OR n	A OR n to A
OR (HL)	A OR (HL) to A
OR (IX + d)	A OR (IX + d) to A
OR (IY + d)	A OR (IY + d) to A
OTDR	Block output, b'ward, repeat
OTIR	Block output, f'ward, repeat
OUT (C),r	Output r to (C)
OUT (n),A	Output A to port n
OUTD	Block output, b'ward, no rpt
OUTI	Block output, f'ward, no rpt
POP IX	Pop IX from stack
POP IY	Pop IY from stack
POP qq	Pop qq from stack
PUSH IX	Push IX onto stack
PUSH IY	Push IY onto stack
PUSH qq	Push qq onto stack
RES b,r	Reset bit b of r
RES b,(HL)	Reset bit b of (HL)
RES b,(IX + d)	Reset bit b of (IX + d)
RES b,(IY + d)	Reset bit b of (IY + d)
RET	Return from subroutine
RET cc	Return from subroutine if cc
RETI	Return from interrupt
RETN	Return from non-maskable int
RL r	Rotate left thru carry r
RL (HL)	Rotate left thru carry (HL)
RL (IX + d)	Rotate left thru carry (IX + d)
RL (IY + d)	Rotate left thru carry (IY + d)

RLA	Rotate A left thru carry
RLC r	Rotate left circular r
RLC (HL)	Rotate left circular (HL)
RLC (IX + d)	Rotate left circular (IX + d)
RLC (IY + d)	Rotate left circular (IY + d)
RLCA	Rotate left circular A
RLD	Rotate bcd digit left (HL)
RR r	Rotate right thru carry r
RR (HL)	Rotate right thru carry (HL)
RR (IX + d)	Rotate right thru cy (IX + d)
RR (IY + d)	Rotate left thru cy (IY + d)
RRA	Rotate A right thru carry
RRC r	Rotate r right circular
RRC (HL)	Rotate (HL) right circular
RRC (IX + d)	Rotate (IX + d) right circular
RRC (IY + d)	Rotate (IY + d) right circular
RRCA	Rotate A right circular
RRD	Rotate bcd digit right (HL)
RST p	Restart to location p
SBC A,r	A-r-CY to A
SBC A,n	A-n-CY to A
SBC A,(HL)	A-(HL)-CY to A
SBC A,(IX + d)	A-(IX + d)-CY to A
SBC A,(IY + d)	A-(IY + d)-CY to A
SBC HL,ss	HL-ss-CY to HL
SCF	Set carry flag
SET b,(HL)	Set bit b of (HL)
SET b,(IX + d)	Set bit b of (IX + d)
SET b,(IY + d)	Set bit b of (IY + d)
SET b,r	Set bit b of r
SLA r	Shift r left arithmetic
SLA (HL)	Shift (HL) left arithmetic
SLA (IX + d)	Shift (IX + d) left arithmetic
SLA (IY + d)	Shift (IY + d) left arithmetic
SRA r	Shift r right arithmetic
SRA (HL)	Shift (HL) right arithmetic
SRA (IX + d)	Shift (IX + d) right arithmetic
SRA (IY + d)	Shift (IY + d) right arithmetic
SRL r	Shift r right logical
SRL (HL)	Shift (HL) right logical
SRL (IX + d)	Shift (IX + d) right logical
SRL (IY + d)	Shift (IY + d) right logical
SUB r	A-r to A
SUB n	A-n to A
SUB (HL)	A-(HL) to A
SUB (IX + d)	A-(IX + d) to A
SUB (IY + d)	A-(IY + d) to A
XOR r	A EXCLUSIVE OR r to A
XOR n	A EXCLUSIVE OR n to A
XOR (HL)	A EXCLUSIVE OR (HL) to A
XOR (IX + d)	A EXCLUSIVE OR (IX + d) to A
XOR (IY + d)	A EXCLUSIVE OR (IY + d) to A

shown in Fig. 3.

Each instruction takes about 2-12 microseconds or more to be performed—that's 2-12 millionths of a second. Although very fast (in comparison to Basic's hundreds of statements per second), don't forget that we're doing very rudimentary operations, and that it sometimes takes a large number of these instructions in sequence to accomplish the same thing that can be done in one Basic statement.

Addressing Modes

We're getting to the instruction set. Before we do, though, we should discuss instruction addressing modes.

Some microprocessor instructions are very simple. The Z80 SCF instruction, for example, sets the Carry flag to a 1; the 6809E CLRA clears the A register to zeros.

Other instructions are more complex. About the most complex Z80 instruction, the LDIR, moves a block of memory from one location to another; the 6809E MUL multiplies two numbers in the A and B registers and puts the product back into A and B.

To save memory space, the Z80 and 6809E have varying types of *addressing modes* for the instructions. In general, the instruction is made as short (as few bytes) as possible. However, the instruction length is a function of the instruction action.

An example: If an instruction adds a number from memory to the contents of a CPU register, it probably requires that the address of the memory operand must be in the instruction itself,

and that takes 16 bits, or 2 bytes, as the operand may be located at any memory location from 0-65,535. Add another byte for an *operation code* to denote the type of instruction, and you have a 3-byte instruction. The STF and CLRA discussed above, though, can be made 1 byte long, as they require no memory address for an operand.

The Z80 and 6809E have a large

number of addressing modes to provide efficient instruction storage and flexibility. Some of the modes are *implied*, where the instruction function is simple with no external operands; *immediate*, where the operand is part of the instruction itself (rather than holding a constant somewhere else in memory); *direct*, where the operand is addressed with a 2-byte operand address;

```

100 ' BUBBLE SORT DEMO FOR COCO WITH AL
101 DATA 16,142,0,0,142,4,0,166,132,230,1
102 DATA 161,1,35,8,16,142,0,1,231,132
103 DATA 167,1,48,1,140,4,255,38,233
104 DATA 16,140,0,0,38,220,57
105 FOR I=&H3F00 TO &H3F24
106 READ A: POKE I,A
107 NEXT I
108 DEFUSR0=&H3F00
110 CLS
120 FOR I=1024 TO 1024+255
130 A=RND(127):IF A<64 THEN GOTO 130
140 POKE I,A
150 NEXT I
160 A=USR0(0)
170 GOTO 170
    
```

Program Listing 4. Basic/Assembly-language Bubble Sort for CoCo

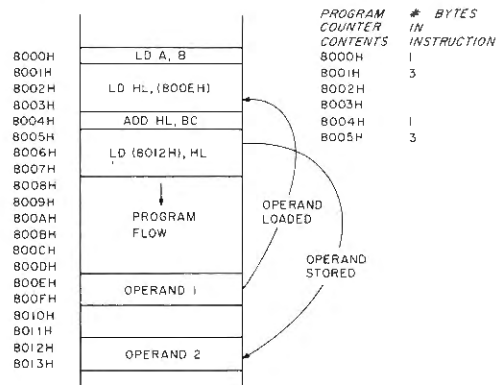


Fig. 3. Program Flow

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LOC	CONTENTS	INSTRUCTION	
8000	21-00-00	LD HL,0	
3	01-64-00	LD BC,100	
6	09	ADD HL,BC	THIS VALUE IS AN "ABSOLUTE" LOCATION
7	0B	DEC BC	
8	78	LD A,B	
9	B1	OR C	
A	C2-06-80	JP NZ, 8006	
D	C9	RET	

"OPCODE" IN FIRST BYTE MAY BE 1-3 ADDITIONAL BYTES FOR ADDRESS OR OTHER OPERANDS

H = HEX#

Fig. 4. Hand Assembly, Z80

and indexed, where the index registers point to the operand or the starting location of sequential data.

Having a large number of addressing modes has one drawback: It makes it confusing for the beginner. He not only has to learn the *instruction set* of the microprocessor, he has to learn the addressing modes and for what instructions they are used, as well.

Instruction Sets

Well, we finally made it to the in-

struction sets of the Z80 and 6809E. The instruction sets for both microprocessors such as the 6800, 6502 (used in the Apple and Commodore), and 8088 (IBM PC). They are shown in Tables 1 and 2 in *mnemonic* form. The mnemonics are simply shorthand ways of representing the instructions—it's much easier to say, "LDA," than to say, "Load the contents of the A accumulator with an 8-bit memory location value."

Table 2. 6809E Instruction Set

Mnemonic(s)	Operation	Addressing Modes									
		Implied	Immediate	Direct	Extended	Extended Indirect	Indexed	Indexed Indirect	Relative	Relative Indirect	
ADCA, ADCB	Add memory to accumulator with carry	—	x	x	x	x	x	x	x	x	x
ADDA, ADDB	Add memory to accumulator	—	x	x	x	x	x	x	x	x	x
ANDA, ANDB	And memory with accumulator	—	x	x	x	x	x	x	x	x	x
ASL	Arithmetic shift left memory location	—	—	x	x	x	x	x	x	x	x
ASLA, ASLB	Arithmetic shift left accumulator	x	—	—	—	—	—	—	—	—	—
ASR	Arithmetic shift right memory location	—	—	x	x	x	x	x	x	x	x
ASRA, ASRB	Arithmetic shift right accumulator	x	—	—	—	—	—	—	—	—	—
BITA, BITB	Bit test memory with accumulator	—	x	x	x	x	x	x	x	x	x
CLR	Clear memory location	—	—	x	x	x	x	x	x	x	x
CLRA, CLRB	Clear accumulator	x	—	—	—	—	—	—	—	—	—
CMPA, CMPB	Compare memory with accumulator	—	x	x	x	x	x	x	x	x	x
COM	Complement memory location	—	—	x	x	x	x	x	x	x	x
COMA, COMB	Complement accumulator	x	—	—	—	—	—	—	—	—	—
DAA	Decimal adjust A-accumulator	x	—	—	—	—	—	—	—	—	—
DEC	Decrement memory location	—	—	x	x	x	x	x	x	x	x
DECA, DECB	Decrement accumulator	x	—	—	—	—	—	—	—	—	—
EORA, EORB	Exclusive or memory with accumulator	—	x	x	x	x	x	x	x	x	x
EXG R1, R2	Exchange R1 with R2 (R1, R2 = A, B, CC, DP)	x	—	—	—	—	—	—	—	—	—
INC	Increment memory location	—	—	x	x	x	x	x	x	x	x
INCA, INCB	Increment accumulator	x	—	—	—	—	—	—	—	—	—
LDA, LDB	Load accumulator from memory	—	x	x	x	x	x	x	x	x	x
LSL	Logical shift left memory location	—	—	x	x	x	x	x	x	x	x
LSLA, LSLB	Logical shift left accumulator	x	—	—	—	—	—	—	—	—	—
LSR	Logical shift right memory location	—	—	x	x	x	x	x	x	x	x
LSRA, LSRB	Logical shift right accumulator	x	—	—	—	—	—	—	—	—	—
MUL	Unsigned multiply (AXB→D)	x	—	—	—	—	—	—	—	—	—
NEG	Negate memory location	—	—	x	x	x	x	x	x	x	x
NEGA, NEGB	Negate accumulator	x	—	—	—	—	—	—	—	—	—
ORA, ORB	Or memory with accumulator	—	x	x	x	x	x	x	x	x	x
ROL	Rotate memory location left	—	—	x	x	x	x	x	x	x	x
ROLA, ROLB	Rotate accumulator left	x	—	—	—	—	—	—	—	—	—
ROR	Rotate memory location right	—	—	x	x	x	x	x	x	x	x
RORA, RORB	Rotate accumulator right	x	—	—	—	—	—	—	—	—	—
SBCA, SBCB	Subtract memory from accumulator with borrow	—	x	x	x	x	x	x	x	x	x
STA, STB	Store accumulator to memory	—	—	x	x	x	x	x	x	x	x
SUBA, SUBB	Subtract memory from accumulator	—	x	x	x	x	x	x	x	x	x
TST	Test memory location	—	—	x	x	x	x	x	x	x	x
TSTA, TSTB	Test accumulator	x	—	—	—	—	—	—	—	—	—
TFR,R1,R2	Transfer R1 to R2 (R1, R2 = A, B, CC, DP)	x	—	—	—	—	—	—	—	—	—

NOTE: A and B may be pushed to (pulled from) either stack with PSHS, PSHU (PULS, PULU) instructions.

Table 2 continues

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Machine Language

We've been discussing the instruction sets (or instruction repertoire) of both the Z80 and 6809E, but haven't described how we enter them into the system. The most rudimentary way to do this is by *machine language*.

We could sit down and write a program to add the numbers 1-100 by using the instruction-set mnemonics from Table 1. We've done that in Figs. 4 and 5, for both the Z80 and 6809E.

The next step is to translate the mnemonics into the proper machine-language binary data values. This involves looking up the proper code from a table. The table values are given in hexadecimal, a shorthand form of binary. (Four binary digits equal one hexadecimal digit: 0000-1001 become hex 0-9, while 1010, 1011, 1100, 1101, 1110, and 1111 become hex A-F.)

The first byte in the instruction is usually an *opcode*, while remaining bytes are memory addresses or intermediate addressing values; some knowledge of the instruction length is required to properly *hand assemble* the code.

The hand-assembled code shown in Figs. 4 and 5 works and this is one way to generate the machine-language code. Early programmers had to do this for the very first machines. However, hand-assembly is very tedious, and it's extremely easy to make errors. Also, if more instructions are added, or if instructions are deleted, then the process has to be repeated for the entire program.

Why Not Let The Computer Do It?

Early in the computer game, programmers, being a shiftless lot at best, decided to let the computer do all the work. The result was an *assembler*, a computer program that automatically assembles the mnemonics into the proper machine-language code.

You can see how assemblers are implemented. The assembler looks at a mnemonic representing the opcode and at the operands for each instruction. It then looks up the proper machine-language code in a table and constructs an instruction of the proper length and operand addresses.

About the only subtlety in the assembly operation is the question of location *references*. In a hand assembly, the programmer must fill in the addresses of operands on a *second pass*

after he assembles the skeleton of all the instructions and finds where in memory each instruction or constant is located. He can't put in the address of each operand or instruction beforehand, because he doesn't know how many bytes will be present before the operand or instruction appears. (If he wants to jump to a further point in the program, for example, he doesn't know what location that jump point will be at until after assembly.)

The assembler program solves the

problem by letting the programmer refer to locations by symbols, rather than absolute memory locations. You might, for example, jump ahead to NEXT instead of location 8000 hexadecimal (32768 decimal in RAM).

This symbolic form of the two programs is shown in Listings 5 and 6, assembled this time by Z80 and 6809E assembler programs. Note that the machine-language code on the left side of the listing is largely identical to the hand assembly.

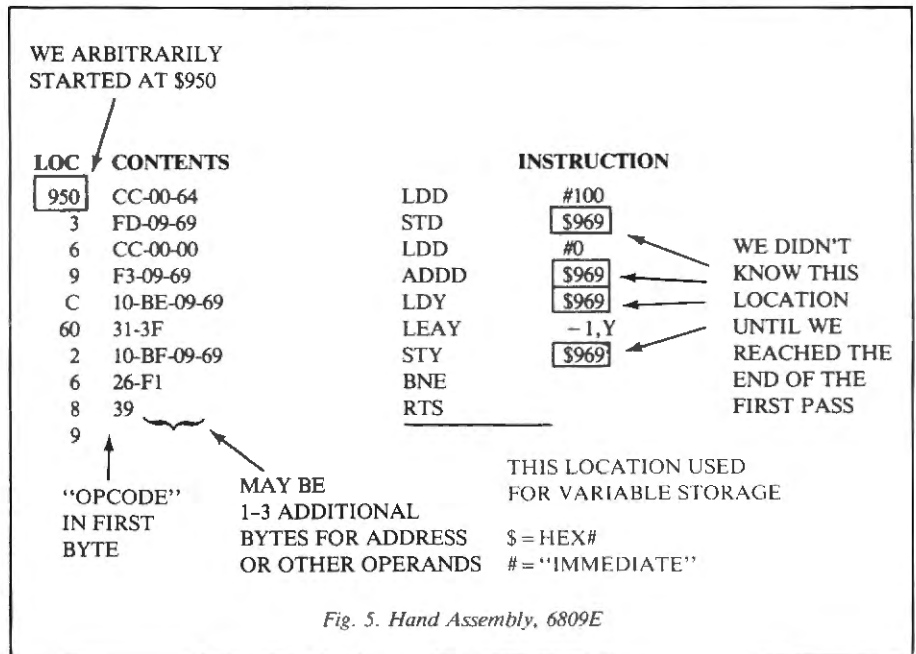


Fig. 5. Hand Assembly, 6809E

```

0000 210000 00100 ***ADD THE NUMBERS FROM 1 TO 100 - MODEL I/III***
0003 016400 00110 ADDNUM LD HL,0 :ZERO TO TOTAL
0006 09 00120 LD BC,100 :INITIALIZE CURRENT #
0007 0E 00130 ADD010 ADD HL,BC :ADD IN CURRENT #
0008 78 00140 DEC BC :#-1
0009 B1 00150 LD A,B :TEST FOR 0
000A C20600 00160 OR C
000D C9 00170 JP NZ,ADD010 :GO IF NOT 0
0000 00180 RET :RETURN
0000 00190 END
0000 Total errors
    
```

Program Listing 5. Symbolic Assembly for Z80

```

* 0950 CC 0064 00100 ***ADD THE NUMBERS FROM 1 TO 100 - COCO***
0953 FD 0969 00110 ADDNUM LDD #100 ZERO TO A+B
0956 CC 0000 00120 STD LOC INITIALIZE CURRENT #
0959 F3 0969 00130 LDD #0 INITIALIZE TOTAL
095C 10BE 0969 00140 ADD010 ADD LOC ADD IN CURRENT #
0960 31 3F 00150 LDY LOC GET CURRENT #
0962 10BF 0969 00160 LEAY -1,Y #-1
0966 26 F1 00170 STY LOC STORE
0968 39 00180 BNE ADD010 GO IF # NOT 0
0969 00190 RTS RETURN
00200 LOC RMB 2 VARIABLE
00210 END

00000 TOTAL ERRORS

ADD010 0959
ADDNUM 0950
LOC 0969
    
```

Program Listing 6. Symbolic Assembly for 6809E

Assembly Language

Assembly language, then, is just a symbolic representation of machine language to make it possible for the programmer to feed in instructions to the assembler program for automatic

assembly.

Program Listings 7 and 8 show typical Assembly-language listings for the bubble-sort programs discussed in the first part of this article. The portion on the right half is the actual symbolic

Assembly language entered by the programmer; the left portion is the assembler-generated machine code, locations at which the code will go in memory, and edit line numbers. We've annotated the code heavily to give you an idea how the programs work.

The assembler translates the *source code* keyed in by the programmer into *object code*. The object code is very close to the machine-language code that the microprocessor uses, but contains other information for use in loading the program—such things as the load location, file name, constant data, and checksums. The object code is normally loaded from cassette or disk, and the source code can be written as source files on the same media.

Bells and Whistles on Assemblers

The process shown above is the most rudimentary form of automatic assembly by an assembler program. There are many more niceties that can be added to the basic assembler process.

Editing Capability: Almost all assemblers contain a built-in editor that can be used to create and modify source-code files from cassette or disk. The Radio Shack Series I Editor/Assembler and the Radio Shack

```

00100 :****BUBBLE SORT DEMO - MODEL I/III AL***
00110 :SORTS ONE-CHARACTER ENTRIES IN FIRST 256
00120 :BYTES OF SCREEN
0000 0E00      00130 BUBSRT LD C,0           :C IS "CHANGE FLAG"
0002 DD21003C  00140 LD IX,3C00H      :START OF SCREEN
0006 06FE      00150 LD B,254         :FOR 256 ENTRIES-1
0008 DD7E00    00160 BUB010 LD A,(IX)       :GET I ENTRY
000E DD5601    00170 LD D,(IX+1)   :GET I+1 ENTRY
000F BA        00180 CP D           :COMPARE A TO D
0011 280A      00190 JR Z,BUB020    :GO IF EQUAL
0013 3808      00200 JR C,BUB020    :GO IF I<I+1
0015 0E01      00210 LD C,I         :SET SWAP FLAG
0018 DD7200    00220 LD (IX),D      :SWAP ENTRIES
001B DD7701    00230 LD (IX+1),A
001D DD23      00240 BUB020 INC IX         :SCREEN ADDRESS+1
001F 10E9      00250 DJNZ BUB010   :DO FOR 254 PAIRS
0021 CB41      00260 BIT 0,C       :TEST C=0 OR 1 FOR CHANGE
0023 20DD      00270 JR NZ,BUBSRT :SWAP ANOTHER PASS
0025 C9        00280 RET          :RETURN TO BASIC
0027 0000      00290 END
00000 Total errors
    
```

Program Listing 7. Bubble-sort Demo for Models I/III

Table 2 continued

Mnemonic(s)	Operation	Addressing Modes							
		Implied	Immediate	Direct	Extended	Indirect	Indexed	Relative	Relative Indirect
16-BIT ACCUMULATOR AND MEMORY INSTRUCTIONS									
ADDD	Add memory to D accumulator	—	x	x	x	x	x	x	x
CMPD	Compare memory with D accumulator	—	x	x	x	x	x	x	x
EXG D, R	Exchange D with X, Y, S, U, or PC	x	—	—	—	—	—	—	—
LDD	Load D accumulator from memory	—	x	x	x	x	x	x	x
SEX	Sign Extend	x	—	—	—	—	—	—	—
STD	Store D accumulator to memory	—	—	x	x	x	x	x	x
SUBD	Subtract memory from D accumulator	—	x	x	x	x	x	x	x
TFR D,R	Transfer D to X, Y, S, U, or PC	x	—	—	—	—	—	—	—
TFR R, D	Transfer X, Y, S, U, or PC to D	x	—	—	—	—	—	—	—

Mnemonic(s)	Operation	Addressing Modes							
		Implied	Immediate	Direct	Extended	Indirect	Indexed	Relative	Relative Indirect
INDEX REGISTER/STACK POINTER INSTRUCTIONS									
CMPS, CMPU	Compare memory with stack pointer	—	x	x	x	x	x	x	x
CMPX, CMPY	Compare memory with index register	—	x	x	x	x	x	x	x
EXG R1, R2	Exchange D,X,Y,S,U, or PC with D,X,Y,S,U, or PC	x	—	—	—	—	—	—	—
LEAS, LEAU	Load effective address into stack pointer	—	—	—	—	x	x	x	x
LEAX, LEAY	Load effective address into index register	—	—	—	—	x	x	x	x
LDS, LDU	Load stack pointer from memory	—	x	x	x	x	x	x	x
LDX, LDY	Load index register from memory	—	x	x	x	x	x	x	x
PSHS	Push any register(s) onto hardware stack (except S)	x	—	—	—	—	—	—	—
PSHU	Push any register(s) onto user stack (except U)	x	—	—	—	—	—	—	—
PULS	Pull any register(s) from hardware stack (except S)	x	—	—	—	—	—	—	—
PULU	Pull any register(s) from user stack (except U)	x	—	—	—	—	—	—	—
STS, STU	Store stack pointer to memory	—	x	x	x	x	x	x	x
STX, STY	Store index register to memory	—	x	x	x	x	x	x	x
TFR R1, R2	Transfer D, X, U, or PC to D, X, S, U, or PC	x	—	—	—	—	—	—	—
ABX	Add B-accumulator to X (unsigned)	x	—	—	—	—	—	—	—

Table 2 continues

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EDTASM+ editors, for example, have a built-in editor that works identically to the editor in Basic, allowing line-by-line or character editing. The Misosys EDAS Editor/Assembler has quite a bit more capability, with block moves and copies.

Pseudo-ops: All assemblers have *pseudo-operations*— assembler commands that are instructions to the assembler. The pseudo-op ORG, for example, sets the location of the program. EQU equates one symbol to another. DEFB, DEFW, FCB, and FCW generate constant data in either byte or word format. DEFM and FCC generate messages, or ASCII text data. DEFS and RMB reserve

areas of memory, similar to allocating array storage in Basic. END ends the source-code statements.

The pseudo-ops described above are common for basic editor/assemblers such as the Series I for the Z80 and EDTASM+ for the CoCo.

In-Memory Assembly: We mentioned that object code could be stored on cassette and disk for later loading. This is the conventional approach carried over from olden days of computers 20 years ago. New assemblers, however, are much more interactive and allow you to load the object code directly into RAM memory for debugging. (Oh yes, most Assembly-language code will not run the

first time, or the second time, or the...) After a debugging session, the editor/assembler can be re-entered for a new assembly to clean up errors.

The Misosys EDAS and Microsoft EDTASM+ provide this in-memory capability for the Model I/III, and the Radio Shack EDTASM+ for the CoCo also gives you this option. (The CoCo EDTASM+ is a functional subset of the Microsoft EDTASM+, which is probably the ultimate editor/assembler/debug package.)

Debug Capability: The Microsoft EDTASM+ for the I/III and the CoCo EDTASM+ also include a built-in debug package called ZBUG. ZBUG provides symbolic debugging, which allows you to examine and change memory locations by their assembly-time symbolic names. In addition you can *disassemble* existing machine-language code into equivalent instruction mnemonics, a handy feature to allow you to see how a program works if the source code is not available. Other ZBUG features are too numerous to mention, but suffice it to say you can do a great deal. After your debugging, a simple one-character entry brings you back to Edit/Assemble with the source code intact, without reloading!

Macro Capability: Now we're getting esoteric. Certain assemblers, such as the Microsoft EDTASM+ for the Model I/III, allow you to enter *macros*, which are somewhat like predefined subroutines, but at a source-code level. By a simple call with a macro name you can invoke assembly of several lines to hundreds of lines of source code. This differs from a subroutine in that the code exists in many places, but does save a great deal of Assembly-language coding.

Relocatable Object Code: Certain other sophisticated assemblers, such as the Radio Shack Disk Assembler for the Model II, use a somewhat different structure in generating object code. Each set of object code is generated as a *relocatable object module*. Loading the complete program involves loading several to dozens of these object modules together in a *link-load* process. The advantage of relocatable object modules is that each programmer may create his own object modules with common entry points and external variable storage defined by special pseudo-ops; at load time all entry points and variables will be linked together automatically. Another advantage is the process permits larger As-

Table 2 continued

BRANCH INSTRUCTIONS		Addressing Modes							
		Implied	Immediate	Direct	Extended	Extended Indirect	Indexed	Indexed Indirect	Relative Indirect
Mnemonic(s)	Operation								
BCC, LBCC	Branch if carry clear	--	--	--	--	--	--	x	--
BCS, LBCS	Branch if carry set	--	--	--	--	--	--	x	--
BEQ, LBEQ	Branch if equal	--	--	--	--	--	--	x	--
BGE, LBGE	Branch if greater than or equal (signed)	--	--	--	--	--	--	x	--
BGT, LBGT	Branch if greater (signed)	--	--	--	--	--	--	x	--
BHI, LBHI	Branch if higher (unsigned)	--	--	--	--	--	--	x	--
BHS, LBHS	Branch if higher or same (unsigned)	--	--	--	--	--	--	x	--
BLE, LBLE	Branch if less than or equal (signed)	--	--	--	--	--	--	x	--
BLO, LBLO	Branch if lower (unsigned)	--	--	--	--	--	--	x	--
BLS, LBLS	Branch if lower or same (unsigned)	--	--	--	--	--	--	x	--
BLT, LBLT	Branch if less than (signed)	--	--	--	--	--	--	x	--
BMI, LBMI	Branch if minus	--	--	--	--	--	--	x	--
BNE, LBNE	Branch if not equal	--	--	--	--	--	--	x	--
BPL, LBPL	Branch if plus	--	--	--	--	--	--	x	--
BRA, LBRA	Branch always	--	--	--	--	--	--	x	--
BRN, LBRN	Branch never (3, 5 Cycle NOP)	--	--	--	--	--	--	x	--
BSR, LBSR	Branch to subroutine	--	--	--	--	--	--	x	--
BVC, LBVC	Branch if overflow clear	--	--	--	--	--	--	x	--
BVS, LBVS	Branch if overflow set	--	--	--	--	--	--	x	--

MISCELLANEOUS INSTRUCTIONS		Addressing Modes							
		Implied	Immediate	Direct	Extended	Extended Indirect	Indexed	Indexed Indirect	Relative Indirect
Mnemonic(s)	Operation								
ANDCC	AND condition code register	--	x	--	--	--	--	--	--
CWAI	AND condition code register, then wait for interrupt	--	x	--	--	--	--	--	--
NOP	No operation	x	--	--	--	--	--	--	--
ORCC	OR condition code register	--	x	--	--	--	--	--	--
JMP	Jump	--	--	x	x	x	x	x	x
JSR	Jump to subroutine	--	--	x	x	x	x	x	x
RTI	Return from interrupt	x	--	--	--	--	--	--	--
RTS	Return from subroutine	x	--	--	--	--	--	--	--
SWI, SWI2, SWI3	Software interrupt (absolute indirect)	x	--	--	--	--	--	--	--
SYNC	Synchronize with interrupt line	x	--	--	--	--	--	--	--

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sembly-language programs, as you can assemble the final program as a series of small modules that have no trouble fitting into memory with the editor/assembler/debug package.

Advantages and Disadvantages Of Assembly Language

Assembly language is extremely fast, typically dozens or hundreds of times faster than the equivalent Basic or other higher-level language. It is often more compact than a high-level language, using probably only half as

much memory in typical cases.

Seems too good to be true! Are there any disadvantages? Yes, and they're considerable.

First, Assembly language is hard to use. Even with in-memory assemble and built-in debug packages, it takes four or five or more times longer to write the same code as in Basic.

In addition, you've got to learn the Assembly language, which probably takes about 1,000 hours for your first Assembly language and 100 hours for each successive Assembly language. To

a certain extent, once you've learned one Assembly language you've learned them all, because you're also learning specialized techniques and algorithms with your first Assembly language. These techniques are built into Basic—things like conversions between ASCII and binary, printer drivers, and table searches.

Should you do Assembly-language programming? If you can afford the time to learn that first language, if you like to hack away at a bit level, and if you like glory, by all means learn Assembly language! Let me explain that last part: Most significant applications programs are written in Assembly language. You won't find many VisiCalcs or Electric Pencils in Basic!

Even if you don't plan on writing a 4K Assembly communications package, though, Assembly language might be worth your while. As you saw from the first part of the article, it's not too difficult to write simple Assembly-language programs and interface them to Basic to provide short, efficient code. Give it a try. ■

William Barden, Jr. is a computer consultant with nearly 20 years programming experience. He can be reached at 28122 Orsola, Mission Viejo, CA 92692.

```

00100 ****BUBBLE SORT DEMO - COCO***
00110 *SORTS ONE-CHARACTER ENTRIES IN FIRST 256
00120 *BYTES OF SCREEN
0000 10BE 0000 00130 BUBSRT LDY #0 Y IS "CHANGE FLAG"
0004 8E 0400 00140 LDX #$400 START OF SCREEN
0007 A6 84 00150 BUB010 LDA ,X GET I ENTRY
0009 E6 01 00160 LDB 1,X GET I+1 ENTRY
000B A1 01 00170 CMPA 1,X COMPARE I TO I+1
000D 23 08 00180 BLS BUB020 GO IF EQUAL OR LESS
000F 10BE 0001 00190 LDY #1 SET SWAP FLAG
0013 E7 84 00200 STR ,X SWAP ENTRIES
0015 A7 01 00210 STA 1,X
0017 30 01 00220 BUB020 LEAX 1,X SCREEN ADDRESS+1
0019 BC 04FF 00230 CMPX #$4FF DO FOR 254 PAIRS
001C 26 E9 00240 BNE BUB010 GO IF NOT DONE
001E 10BC 0000 00250 CMPY #0 TEST Y=0 OR 1 FOR CHANGE
0022 26 DC 00260 BNE BUBSRT SWAP, ANOTHER PASS
0024 39 00 00270 RTS RETURN TO BASIC
0000 0000 00280 END
00000 TOTAL ERRORS
BUB010 0007
BUB020 0017
BUBSRT 0000

```

Program Listing 8. Bubble-sort Demo for the Color Computer

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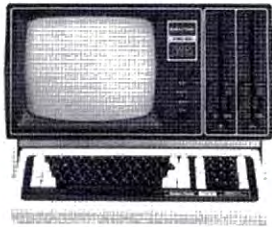
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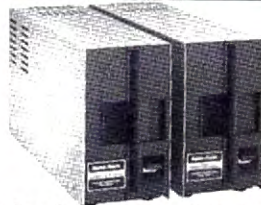
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Word Processing Guide

by Dan Robinson

Word processors ease the task of producing letters and manuscripts, but you must find one that fits your system and your needs.

The first time I heard the term "word processing," an image of words linked together like little sausages leaped to mind. In those days one could acquire a Wang for a mere \$15,000. Besides the high price tag and the standard office jokes (How's your Wang today?), early word-processing machines were about as difficult to control as Three Mile Island. They were often sold with a three-month instruction course for the operator, their features were limited, and they could do nothing more than make words into sausages.

Then about a half dozen years ago, Michael Shroyer came out with his pioneer Electric Pencil, which gave the first word-processing capability to microcomputers. Since then, programmers have engaged in an unending contest to excel one another in adding more exotic features to word-processing programs.

How many times have you wished you could change a single word to make a business proposal more effective but didn't want to take the time to retype the document? Or how many times have you found yourself typing the same letter over and over again?

A word processor differs from a typewriter in its editing and printing.

Most corrections are made by moving the cursor to the desired location and typing over the text. The cursor is usually moved by the arrow keys, although some word processors have commands that move the cursor forward or backward by word, sentence, paragraph, or to a specific character or symbol.

Since text is seldom short enough to fit on the 16 lines of the TRS-80's monitor screen, the word processor includes commands to scroll the text forward and backward into the viewing area. Some permit a quick jump to the beginning or end of the text, and some move one screen at a time.

Entire blocks of text can be deleted, duplicated, or moved to another location. Some programs accommodate several blocks at one time, allowing exchanges or a total reordering of the text.

The global-search function locates a specified string of characters. If a standard business letter has a string of NAME, the search function will find it each time it occurs. An expansion of this is the search-and-replace function that locates all occurrences of a string and replaces them with another string. Thus, NAME can be changed to Mr. Jones throughout the text.

If a word is too long to fit on the cur-

rent line, wraparound places it on the next line of the video screen. However, some programs support conditional, or soft, hyphens, so if the entire word doesn't fit on a printed line, the word is broken at the conditional hyphen location and a hyphen is printed. If the entire word fits on the line, the soft hyphen is ignored. The width of the video display can be changed so the text is seen as it appears in print. This is useful when data is presented in columnar form or when hard hyphens are used. Tabs can be set to align columnar data.

Unbreakable spaces, such as between a person's initials and his name, can be supported. If an unbreakable space is specified, the entire name appears on the next printed line if it cannot fit on the current line.

A header appears at the top of each printed page, and a footer is at the bottom. They are useful as titles and can contain such information as the report date or the department issuing the document. They often include chapter headings and page numbers. Usually, an option exists to print them on odd, even, or all pages, much as they might appear in a book. Formats can be changed in conjunction with headers or footers to adjust the margins.

Standard paragraphs can be inserted from other files to make repetitious typing unnecessary. Some programs can chain files so a large body of text, such as a technical manual, can be printed without interruption of page numbers or without continuously specifying headers, footers, or print formats.

If supported, a specified number of

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blank lines appear between paragraphs, and the new text is indented. The program can include reverse indentation that inwardly aligns a title or number with the adjacent block of text, as required in an outline. Since ending a page with the first line of a paragraph or beginning one with the last line is undesirable, some programs let you specify how many such "widow" lines are acceptable.

You can include comment lines in the text as notes or instructions to the operator, but they are not normally printed. Some programs support limited editing or input from the keyboard at print time to provide a fill-in-the-blank capability.

The program controls the appearance of the printed text, so you can specify items such as the number of lines to be printed on each page, the width of text, and single or multiple spacing. You can set left and right margins, as well as the number of blank lines at the top and bottom of each page. Most programs offer right justification, where additional spaces are added within the line to provide even margins on both sides. Some also allow an even margin on the right with

a ragged left edge, as in some poetry. Or, the text may remain unjustified to give it a personalized look. A few programs take on the ambitious task of justifying proportional font printing, and some center a line or block of text horizontally as well as vertically.

Word-processing programs always support a parallel (Centronics) printer. Some also function through the RS-232 port to operate serial printers or work with the popular Small Systems Software TRS-232 printer driver through the cassette port. Some programs support control codes that use the special abilities of certain printers, such as condensed printing, italic or double-wide fonts, bold face type, or graphic characters.

Some word processors, such as those written in Basic, are limited to a specific number of characters on each line, and you must edit one line at a time. Usually, these are tape-based programs aimed at 16K computers, and they support few features. They are good for occasional or light use, such as preparing a club newsletter.

Most programs are character-oriented with a constant stream of letters and symbols. Since a main purpose of

word processing is conserving time in written communication, most programs are written for disk systems. Some of these are displayed on the screen in a formatted presentation exactly as they will appear in print.

Radio Shack's Scripsit was one of Tandy's earliest and best efforts. Produced in both cassette and disk versions, its shortcomings have been overcome by several patch programs. One of the best is Flextext, which sends codes to smart printers to change type fonts, produces subscripts and superscripts, provides boldface headings, and so on. Qwerty, another Scripsit patch, creates an index and table of contents for lengthy documents.

Electric Pencil is probably the easiest word-processing program to use. It is inexpensive, because it offers few features in its stripped-down model; additional features can be purchased separately.

CopyArt offers all the standard features plus unique graphics capabilities that other programs can't equal.

Lazy Writer and Newsprint offer the largest range of features, as well as the highest price tags. Lazy Writer, for example, lets you delete by character,

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word, sentence, or block, or to a specified character, as well as from the cursor to the top or bottom of the file. Newsprint automatically creates an index. Both of them let you program a number of keys with a series of commands you select to invoke their many features.

All programs mentioned are well documented and provide good after-purchase support.

When selecting a word processor, consider the availability of support software. Some word processors are compatible with programs like Special Delivery, which personalizes a form letter and integrates it with a mailing list. Special Delivery sends out a "personal" letter to everyone on your list.

Other programs like Electric Webster or Hexspell check for spelling errors and automatically correct the document.

Grammatik makes writing more effective by identifying poor style in a text file. It alerts you to the repetitious use of a word, as well as capitalization and punctuation errors. You can structure Grammatik to keep your computer jargon from creeping into communications with those who don't

understand it.

As far as hardware is concerned, you need either a daisy-wheel or dot-matrix printer. Although the price of daisy-wheel printers is coming down, they still cost half again as much as dot-matrix printers, and they operate at about one-fifth the speed. The strong point of a daisy wheel is that the final text doesn't look like it comes from a computer.

With the newer model dot-matrix printers, the reader has to look closely to see that the text is a computer product, although the added quality results in reduced speed. Be certain that the printer has descenders so letters such as y and g won't appear to be pushed upwards. If you need graphics get a dot-matrix printer.

You'll need a disk drive for storage if the use of your word processor is heavy or complicated, or if labor is costly. Two drives are an advantage, since the advanced word processors load in modules to control the entry, edit, storage, and printing functions, and these modules must be present in a drive.

To save time, add a print buffer to your system. Then, your computer is

available for use while the printer is busy with the text. The computer sends the formatted text at high speed to the buffer where it is held until the slower-speed printer is able to accept it.

With a properly equipped TRS-80 and a word processor like Electric Pencil 2, you can compose and edit the text; check it for proper spelling; identify poor writing style; print the document with data inserted from the keyboard, from files, and from a data base; and use the computer for other purposes while the document is being printed.

Exotic capabilities are not for everyone. Added features mean added cost, less text memory, more complex commands, and slower operation. The word processor that can process a multi-chapter technical manual or a graduate school thesis is not necessarily useful for someone who has a large volume of one or two-page letters to produce. Tailor your choice to meet your special requirements. ■

Dan Robinson (1625 Higgins Way, Pacifica, CA 94044) is the author of 80 Micro's September 1982 special section on word processing.

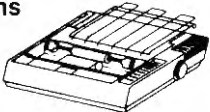
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The Data Base Explained

by Wynne Keller

Introduction to data bases—everything you need to know explained in plain, simple English

Most complex computer programs include a data-base manager. Data-base managers (DBMs) maintain a file or group of items that are related. The DBM performs clerical office functions such as add, change, delete, sort, search or print for any item or group of items in the file. It is fast and efficient, but it cannot do everything. Generally, a DBM manages a file but cannot perform massive changes. For that, you need an auxiliary program.

Data-base managers are all-purpose programs and are useful in business and home environments. To choose the right data-base manager, you need to understand DBM terms and evaluate the program's intended use.

Types of Data-base Managers

There are two types of DBMs: in memory and random access. In-memory programs hold all the filed items in computer memory at one time. They can be cassette or disk based. Random-access programs are always disk-based; they bring each item into memory as needed, so random-access files can be larger than in-memory programs that are limited to smaller files.

Some programs try to incorporate the best of both types. In-memory pro-

grams are faster, because they don't need to access the disk each time you want an item. These programs allow you to divide the file into small sections that are retained in memory and written to disk as groups, and can be merged with other groups as the need arises.

In-memory programs are best for small files; even with 48K, a typical application holds only 200 items. However, large-capacity personal computers such as the IBM increase the usefulness of in-memory programs. A 128K IBM can hold three times as many items in memory as a 48K computer, so you can accomplish large projects with an in-memory DBM.

Because in-memory programs record the whole file as a unit, any system crash affects a large number of items. A random-access program is usually safer because each item records back on disk after access.

Selecting a Program

The three most important DBM terms are file, record, and field. Files are items in the data base. The record is one item in the group.

In a data base organized for household inventory, one item might be a sofa. You can record several things about the sofa: its price, purchase date, and present value.

Each piece of information about the sofa is a field. You enter the relevant field information for each record in the data base. If this data base were a card

file, the entire box is the file, each card is a record, and on the card are three data fields about every item.

DBMs differ greatly in capability and price. Elementary versions can cost as little as \$20, while sophisticated programs are \$300 or more. The following descriptions of important features can help you choose the DBM best suited for your needs.

Capacity

Estimate the number of records in the file and the amount of information needed for each record. Every letter or number counts as one byte. In the household inventory, the name-of-item field (chair, sofa, and so on) will need perhaps 10 bytes. Round the price field to the nearest dollar, and if no item is more than \$999, three bytes would be sufficient. The date of purchase could be the last two digits of the year, using two bytes, or five bytes to write it with the month and a slash, 12/82. Adding these together shows that each record needs 18 bytes. If there are 100 items in the house, only 1,800 bytes are required, easily within the capacity of a cassette-based, in-memory DBM.

On the other hand, a business computerizing its mailing list might find they will exceed the disk's capacity. A typical mailing list requires 115 bytes per record. On a two-drive system, the program resides on one disk and the data resides on another. But, even using the whole disk for data, more than 700

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records can exceed the capacity of a Model I disk. If the program is not capable of spanning drives, it is worthless for this application.

Speed

A slow DBM is a frustrating experience and can even be unusable. Many of the program's aspects affect the speed: the method of data entry and change, the method of saving data, and the type of search and sort.

Data entry can be tedious in some programs. Ideally, a fast typist should be unable to overtype. Frequently, however, the typist must slow down and check the screen to be certain the program recognized keys that were pressed.

An important feature for increasing

data-entry speed is a field-repeat key. This allows the typist to press one (or sometimes two) special keys to repeat any field's contents from the immediately previous record. For example, if you're typing addresses and several in a row list New York as the state, New York can be re-entered with one keystroke. The key that performs this function varies from one program to another, and many data bases don't have the feature at all. It is worthwhile to look for the program that does.

The ability to change entries rapidly is also important. If you make an error when typing the record, you should be able to correct the error before moving on to the next record. A nondestructive cursor is the easiest method for chang-

ing data. Nondestructive means the cursor blinks over, but doesn't destroy the letters beneath it. The cursor can be moved to any location on screen with the arrow keys and changes are made by typing over the error, or the text can be opened for insertions.

Another method of changing entries is numbered fields. To make a change, you type the number corresponding to the field in which the error occurs. The cursor then jumps to that field and the change can be made. The slowest method places the cursor at the end of the first field whenever you specify change mode. To change any field, press the enter key repeatedly while the cursor jumps down one field at a time until it is on the field where the error occurs. This is a tedious process, especially if the field to be altered is near the bottom of the screen or many records are to be changed.

The method of saving or reading data to or from the storage medium, called I/O (input/output), also affects the speed of operation. Cassette users planning DBM applications must first consider whether the project is possible on cassette. The length of time needed to save data on cassette makes a DBM for files larger than about 100 records impractical. Model III users are often unaware that the speed of cassette dumps for data, as opposed to programs, is only 500 baud. In addition, each 256-byte segment of data has a leader on the tape, which also slows data saves. You can prevent this leader with machine code, and some cassette DBMs advertise this feature.

If the project is not worth the price of a disk drive but is too large for cassette, consider the Exatron Stringy Floppy. The ESF saves data at 7,600 baud, which means 150 records are saved in about one minute.

Disk users also should consider the speed of data I/O. With in-memory DBMs, the data loads at the beginning of a session and saves at the end. This is convenient and is the main reason for the popularity of in-memory systems. The random-access DBM loads one record at a time and then saves the record as soon as you are finished with it. Since the disk turns on for each save, there are a few seconds of idle time for the operator with each I/O. When adding records, you should not record the data until you have corrected any errors. I know of one program that does not allow error correction during input; it sends the data to the disk as soon as you finish the last field, causing double disk I/O time.

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Disk I/O for random-access programs sounds more tedious than it is in practice. When only a few records will be accessed, random access is faster than an in-memory system because you can load a few records faster than the whole file. If you start out with an in-memory system, you can stretch it to handle larger and larger files. Perhaps the entire mailing list was 200 records initially, but expanded to 400, so the file was broken into halves, then halves again. Switch to random access before the file becomes too large; it's easier than shuffling and merging files that have outgrown the program.

Searching/Sorting

The type of search and sort is vital to program speed. A fast search is more important because sorting can be performed during your absence. The slowest search is sequential; the program examines each record to see if it matches, in order through the file. A binary search divides the file in halves with each pass, and finds the needed record faster. One of the fastest is an index; an index is a separate short record number file that keeps track of the major file. A record in the index contains the location or record number of its matching record in the major file.

Because record length in the index is short, the index can be read quickly (in some programs it is kept in memory). Normally, the operator chooses the field used in the index. Some programs allow the indexing of several fields. The index increases the speed of search and sort functions. Its only disadvantage is apparent if there is a machine or power failure.

Some programs rebuild the index on command. This is a good feature, because you can repair the index if it is damaged. Other programs update the index automatically after changes have been made or after 100 records have been added to the file. This type is vulnerable; if an equipment failure occurs after adding 50 records, all 50 would be lost. Even though the records are safely on the disk, they have not yet been added to the index, and without the index they cannot be found.

An index increases sort speed. The fields to be sorted are read from the disk; when the sort is complete, the index is rebuilt to reflect the new order. The index is then written to disk, and the records accessed in sorted order, even though none of the major records have been moved from their former position on the disk.

If the sort is in machine code, the sort

speed increases, but this is not the only factor in sort speed. Disk access can be the culprit when sorts continue for hours. A number of programs sort by reading two records, comparing them, then switching their order and rewriting them to disk. The disk runs continuously, and it is not uncommon for the sort to fail because the disk became worn before the sort was finished.

Reports

Designing a report with most DBMs is time consuming, because each user wants something different, and the programs allow considerable flexibility. Once designed, a report format will be used many times. Therefore, the best programs save the report design in a file on disk, and it can be recalled and used without further effort. If a program cannot save report formats, it will be limited in report capability.

Some features to look for are:

- Choice of record numbers/no numbers
- Multiple lines per record
- Mailing-label format
- Saves report format
- User-specified subtotals and/or totals
- User-specified titles
- Wraparound suppression
- User-specified paging

It is standard on most DBMs that the user can specify which fields to print and which records to print. The way this is done is by no means standard.

If you plan to use a word processor to write form letters from a mailing list, make sure the word processor and DBM you plan to use are compatible. Some DBMs interface with any word processor file; others require a specific program.

Calculations

Many programs offer one or more formula fields, which allows you to create a formula that uses values from other fields. You could set up an inventory to calculate discounts or markup with a formula field that takes the price field and multiplies it by some other value. Some DBMs perform these calculations when the record is typed. Other DBMs show nothing on the screen during data entry, but display the computed values of formula fields later when you recall or print the record. Formula fields are vital in many business applications.

Setting Up a File

Using the above guidelines, you select a DBM. How do you put it to use?

After reading the manual, you may understand how to use the program, but not how to set up the file. Most manuals assume some familiarity with the organization of DBM files.

The first step is to write down the information categories being kept with your current manual system. If there is no current system, write down all the types of information you would like to keep. I will use inventory management as an example, as this is a fairly complex, but common application of a DBM.

The following are possible categories:

● Name of Item	20 bytes
● Supplier	25
● Supplier Address	20
● Supplier City, State, Zip	28
● Supplier Code	10
● Store Code	10
● Salesman	20
● Supplier Phone	14
● Price Item	6
● Cost Item	6
● Quantity on Hand	3
● Quantity on Order	3
● Reorder Point	3
● Reorder Date	8

Next, consider typical information you would place in these categories. Calculate the maximum number of characters that would be stored in each category. In the case of name categories, you can do this by estimating the average size of an entry and adding a few characters. Some name entries can be abbreviated later if they are too long to fit.

You must calculate the byte count for numerical and date entries with greater precision. The cost field, for example, must contain enough bytes for the greatest cost you will ever encounter. If you allow six bytes, the data entered can never exceed 999.99 (the decimal point counts as one byte). A date field is normally MM/DD/YY, or eight bytes. Typical byte counts are already indicated in the sample inventory above.

After you have a byte count for each field, add them up to determine the total number of bytes per record. The example inventory would use about 200 bytes. If the total per record is over 256 bytes, you may need to eliminate some characters, depending on the program being used; some programs don't allow a single record to exceed 256 characters.

Even if the bytes per record are within the program's limits, the number of records that will fit on the disk is seriously reduced with large records. In the sample inventory, the vendor's address is probably superfluous. The ad-

dress, phone number, and salesman's name could be kept in separate file consisting of all the addresses your company needs.

It's time to fine tune the DBM layout. The more sophisticated programs allow special types of fields. Alphanumeric fields can contain any character. Numeric fields may only have numbers and number-related characters. They may even have a fixed decimal point, if desired. Some fields can be "must fill" fields, which means the operator must enter something when typing the record. You can reverse date fields, so that on sorting they will be ordered YY/MM/DD. Fields may be protected, which means the data in them cannot be changed.

In data bases that use this searching method, choose a key field. The key field should be a field unique for every record. It would be useless to make the key field the state in an address file, because so many records will occur with the same state. Choose some type of ID-number field for the key field. In an inventory, this would be the part number.

Next, design the screen. Sophisticated programs give the user complete control over placement of fields. Even pro-

grams that do not allow this can be helped with planning at this stage, because the order in which fields are typed will be the order in which they are presented on screen. Ideally, all "must fill" fields should be first on screen, so the operator does not have to step through empty fields to reach the ones for which there is data.

In some programs, the fields aren't numbered and a change in a field near the bottom of the screen means you have to keep pressing enter to position the cursor at the proper field. This is not a problem if the cursor movement is rapid. If it is slow, positioning the cursor can be time consuming. If you use such a program, position any fields that will be changed often near the top of the screen. A few programs require fields that will be sorted consecutively to be adjacent to each other, with the major sort field first. If using either of these programs, make sure you type the fields in the correct sorting order.

Once you initialize the DBM and design the input screen, it is time to begin using the program on a trial basis. Enter perhaps 25-50 records; then make changes, sort them, and use the search function. If data entry or changes are slow, would a change in screen design help? Is the key field inappropriate? Design a few reports and print the records. Will all the fields you want on one line fit?

It is typical during this stage to find that some vital field was overlooked, or a field is too short, or too long. For example, using the inventory described earlier, trial runs might show a need for a formula field to calculate price as a percentage of cost. Remember, most DBMs do not allow any changes to a file after initialization without losing all the records. A few programs allow changes, such as adding a field, but this is difficult and time consuming. Be sure to initialize the file the way you want it, because with most programs everything must be typed in again if changes are made.

If you find the program inadequate during this stage, it is better to buy another now than to type a complete file into an unsuitable program. Changing to a better program later requires retyping the file or hiring a programmer to translate it.

Manipulating the File

Putting the file to use quickly reveals why DBMs are so popular. The sophisticated search and select capabilities are perhaps the most exciting to use.

To use selection features, you'll need an understanding of Boolean relation-

ships. Most programs understand the following relationships: equal (=), greater than (>), less than (<), not equal, greater than or equal, and less than or equal. These concepts are familiar to most people. The harder part is the connective for the search (and, or).

Suppose two search criteria were desired: price less than a dollar, and supplier name XYZ. You would choose the price field as the first search field, and specify less than (<) as the relationship and 1 as the amount. Then specify the connection to the next field. In this case, you want every item under a dollar *and* supplied by XYZ. If you said *or*, you would get every item under a dollar from every company along with every item from XYZ regardless of price. Then enter the next search field (supplier name), along with the relationship, equal, and the name being sought, XYZ.

Suppose you receive a shipment from XYZ containing five different items. You want to update the record for each item by changing the quantity-on-hand field to reflect the amount received plus the amount formerly on hand. In addition, the amount on order needs to be reset to zero. To do this, you could search for each of the five items by name or product number, and change each record. This works well for five or ten items, but if hundreds of items were received, it is too time consuming.

The limits of the all-purpose DBM have just been reached. What you need now is an auxiliary program. Such a program would, in this example, accept data such as part number and quantity received for as many items as you wish to enter. Then, the program automatically accesses the DBM file and updates every record affected by the shipment. It sounds simple, but you need a programmer to write the auxiliary program.

DBMs are a compromise. You can use a DBM program for multiple tasks, thus saving the money it would cost to buy several different specialized programs. But a DBM inventory cannot hope to have the sophistication of a specially written inventory, unless program modules are added. Adding such modules does not have to be expensive but is a factor to consider. Many applications will not need extra programming, and if the DBM can computerize more than one file for you, it will almost certainly pay for itself. ■

Wynne Keller can be reached at Downeast Digital, RD#1 Box 4130, Solon, ME 04979.

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The software is available immediately from the creators. It comes in two versions. If you want to generate separate Basic programs with all the data handling plus Calculations and Report Printing features, you want *Quikpro+Plus*. Specify to run on TRS80 Model I and Model III at only \$149; to run on TRS80 Model II at \$189.

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Insure Your Computer

by Thomas McDowell

If lightning hits your house, it can be a frightening and unsettling experience. It can also damage your computer. Last year, lightning struck my house, ruining several appliances, including my TRS-80 Model I.

When I filed the insurance claim, I learned some useful information about computers and insurance. My experience should help you if you find yourself in a similar situation.

Is It Covered?

If your computer is damaged, read your insurance policy to find out if it is covered. Your policy may not mention the computer, but it will mention lightning damage. Usually, if you have a good home-owner's policy, your computer is covered for this type of loss. If you use your computer for business, you will need a special rider for it, since a business computer is not covered under a home-owner's policy.

OK, so you think you're covered. What's next? Contact your insurance agent. Eventually, an adjuster will call you. He may want to inspect the damage, but since lightning damage is usually internal, he will probably tell you to have the computer repaired, if it is "economically repairable."

If it cannot be repaired, have the repairman make a statement to that effect. If the item can be repaired, get an estimate and report back to the adjuster. If you want the insurance company to pay for the repairs, the bill must clearly state that the item was damaged by lightning.

Economically Repairable Damage

Any item is repairable if the owner is willing to pay enough money. Insurance companies recognize this, and to limit their losses, they will limit the amount they will pay to repair an item to its present value. To compute depre-

Remember to purchase insurance for your computer; you'll need it when lightning strikes!

ciated value, my insurance company divides the age of the item by its accepted life, subtracts that value from one, and multiplies the difference by the current replacement cost of like items.

Some insurance companies may use original cost instead of replacement cost. For most items in inflationary times, the replacement cost policy is best because it reflects inflation. Unfortunately, my TRS-80 cost nearly \$200 more when I bought it than it did when lightning struck it.

The owner must establish the computer's age. If you do not have the purchase receipts, tell the insurance adjuster where and when you bought it, and he can check with the retail outlet. If you are putting in a claim for stolen equipment, especially equipment worth thousands of dollars, and you don't have receipts, you could be in trouble.

Be honest with your adjuster. He deals with people every day, and he's no fool. My adjuster believed me when I told him that I had one of the earliest serial numbered TRS-80s and had purchased it in January 1978. My credibility had been established, so he again believed me when I said that my 32K Expansion Interface was new.

Determining the expected life of my computer proved more of a problem. My adjuster asked me to get the ex-

pected life from Radio Shack. The technician at the local computer center, however, refused to give me an estimate for my computer. He told me it should last forever. Even when I told him that the insurance company would consider that unrealistic, he refused to make an estimate. (He stated that he could be liable to Radio Shack if he made policy for them, and stating an average lifetime could be construed as making policy.)

After some dickering, the adjuster and I agreed that my computer's life expectancy was at least that of a color television (10 years). He gave me a check for the depreciated value of my equipment, less the deductible, and I gave him the remains of the computer.

The adjuster told me that had my unit been stolen, I would have needed to prove ownership. The best way to do this is to have a receipt. Club registrations and owner manuals can also serve as proof.

Lessons Learned

The lightning that struck my house cost me over \$400 for equipment replacement; without insurance, it would have been more than \$2,000. To protect yourself from lightning or theft, remember three things: Unplug your equipment when an electrical storm is forecast; make sure you have insurance for your equipment; and save your sales receipts. You should also think about protecting your equipment from fire or other disasters. And what about your software? Storing back-ups off site is probably the best way to protect it. I hope you won't experience the disaster that I did, but you should take precautions, just in case! ■

Thomas McDowell is a data processor. His address is HHC 1st Support Battalion, APO New York 09137.

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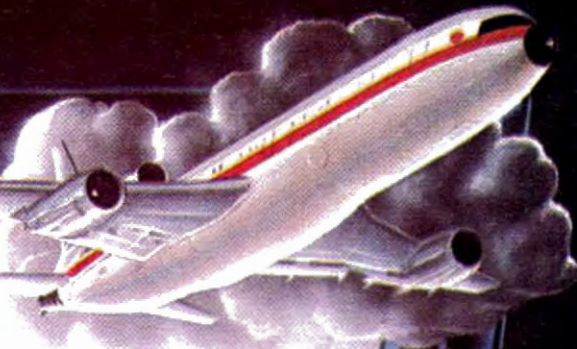
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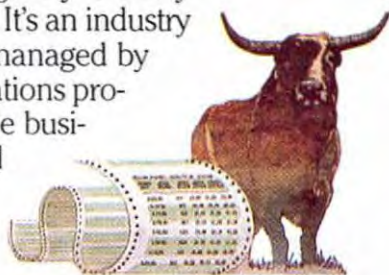
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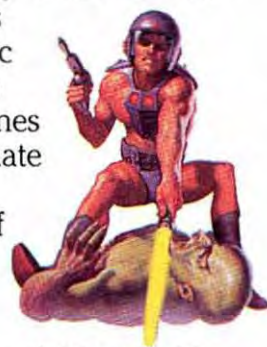
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Disk Mysteries Revealed

by Michael F. Morra

Debating on whether to upgrade to a disk system or to keep your faithful cassette player? If you have any doubts, read this article.

Are you frustrated with the trials and tribulations of the cassette, but apprehensive about taking the big step to floppy disk? Or perhaps you are a seasoned floppy-disk user who is tired of paging through a half dozen magazines, texts or operating manuals before you find a satisfactory explanation of a particular subject.

This article attempts to correlate the existing information and reintroduce it in the form of a simple, slow-paced and (hopefully) comprehensive primer on the floppy disk.

At the start, I will be on the level of the non-disk TRS-80 user who is fairly conversant with the cassette-based system. I will assume some knowledge of binary/hexadecimal number systems, cassette data storage and the basic memory structure in the TRS-80. After laying the initial groundwork, I will move into a more advanced and detailed treatise concerning the Model I floppy-disk system.

With a Little Help from My Friends

This article owes its existence to the presence of various publications and the writers. (See the Bibliography.)

These publications will undoubtedly help those readers who demand an extremely detailed treatment of a specific question. There are many other sources that were not (or could not) be consulted during the writing of this article.

Most of these publications or products are available from the many advertisers in *80 Micro*. The following addresses may also be helpful:

Shugart Associates
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Western Digital Corp.
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Irvine, CA 92714
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(For information on the FD 1771-01 chip)

Some of the Western Digital documentation has been republished in various places, including *Pathways Through the ROM*.

What Is a Floppy Disk?

A floppy disk is a form of *non-volatile* mass data storage for the TRS-80 and other microcomputers. Non-volatile storage (which also includes magnetic tape and read-only memory, or ROM) retains data without the application of external power. In contrast, random-access memory (RAM) is *volatile*—it requires power to continually refresh the stored data, and when the power is interrupted, the data is irretrievably lost.

Like cassette tape, a floppy disk is a scaled-down version of mass storage used in larger computers (minicomputers and mainframes). The granddaddy of cassette tape is the high-speed magnetic tape unit that employs open reels of wide recording tape. Large computers also utilize hard-disk storage, where data is stored on rigid metal disks coated with a magnetic material, much like the coating on recording tape. The computer industry modified disk storage to utilize flexible (floppy) disks, usually made from Mylar or similar material, with the same magnetic coating as before.

Briefly, here is a breakdown of the various components that make up a floppy-disk system:

- The *floppy disk* itself is the actual storage medium. (The disk includes both the coated disk and the protective jacket into which the disk has been sealed.)

- The *disk drive* physically manipulates the disk and, under system control, *reads* and *writes* data (“plays” and “records,” respectively).

- The *disk controller* is the interfacing circuitry between the computer and the floppy-disk system.

- The *disk operating system* is the software that coordinates and executes all data *input/output (I/O)* to the floppy disk. It actually extends and enhances the ROM routines so that the floppy-disk system can operate properly. The software is usually called the *DOS*, which rhymes with “boss” or “dose” depending on whom you talk to.

Why Floppy Disk?

Let's take a look at the differences between cassette tape and floppy disk (vital statistics courtesy of Radio Shack's Computer Catalog RSC-6 and the *TRSDOS/Disk Basic Reference Manual*).

For both systems, the physical form of the stored data is the same: magnetized areas in a magnetizable coating. The data is both placed on the media and retrieved by a read/write head in both systems. However, the method and the speed of data *access* is quite different.

Cassette tape is relatively exasperating when it comes to finding a given spot somewhere on the tape. The tape has to be manually jockeyed back and forth to locate the desired area. In contrast, floppy-disk systems can very quickly position the read/write head anywhere on the media to pick out a particular portion of written data. A floppy disk is even more versatile because of the data *format* on the disks, which allows us to locate and access very small units of data. This would be analogous to a stereo turntable that could automatically find and play a group of several notes anywhere on the LP disk within seconds.

Furthermore, floppy-disk systems have a much faster I/O rate than cassette systems, which makes the former even more powerful. Cassette I/O rates for TRS-80s are either 500 or 1,500 baud, which is equivalent to about 54 or 171 *bytes* per second, respectively. Floppy disk I/O rates are on the order of tens of thousands of

bytes per second. In both cases, the figures are calculated for a continuous stream of data being read or written. An average access time would be the time elapsed for either system to find a given spot somewhere on the media. On a C-20 cassette (20 minutes running time), we could easily average one minute trying to find the spot and line the tape up fairly accurately. For a floppy disk, the time ranges from 1/4–3/4 second (and again, the disk access is fully automatic).

The disk usually contains more data than the cassette tape, too. Going back to our figures on cassette I/O, a 20-minute cassette can hold a theoretical total of 75,000–225,000 bytes of data, depending on the baud rate. Floppy disks can theoretically store 89,000–1,000,000 bytes, depending on disk size, data density, and whether one or two sides of the disk are used. (These figures do not include necessary system data, the so-called system overhead, which takes up some room on both cassette and disk.)

The floppy disk does have some drawbacks, however. Because of its precision and tight tolerances, it is more sensitive to the same problems that plague cassettes: motor speed variations, dirty or magnetized read/write heads, destroyed data from stray magnetic fields, physical contamination and mishandling of the media, power-line variations, and so on.

The major disadvantage to floppy disk is cost. To convert a system to floppy disk requires controller circuitry, at least one disk drive, miscellaneous cables and hardware, and

the DOS software. Additional RAM may have to be added (the DOS occupies a good chunk of memory), and it may be desirable to have more than one drive hooked up. Also, floppy-disk-based software is usually more expensive than cassette software (but more powerful and versatile, too). The total system investment depends on the type and brand of hardware/software purchased, and where it was obtained (Radio Shack versus mail order, computer store, and so on).

Both systems have their place depending on the individual user. Cassette tape is an excellent entry-level mass storage device, combining ease of operation with low cost, and allowing the maximum amount of memory available for other tasks. Once a user becomes more intimately acquainted with the computer, though, the cassette can become the proverbial tail wagging the dog by hampering more advanced operations. At this point, it is a good idea to seriously consider the move to floppy disk.

The Nuts and Bolts of Floppy Disks

The disk (Fig. 1) is either 5 1/4 or 8 inches in diameter. The disk is free to rotate within a jacket, which is specially lubricated for that purpose. The exposed central ring of the disk is gripped by the motor assembly of the disk drive. The jacket also has openings (the *read/write notches*) on either side, where the read/write head contacts the disk surface. The *write-protect notch* is analogous to the break-off tabs on cassettes; if a disk's write-protect notch is covered with an adhesive tab, data can-

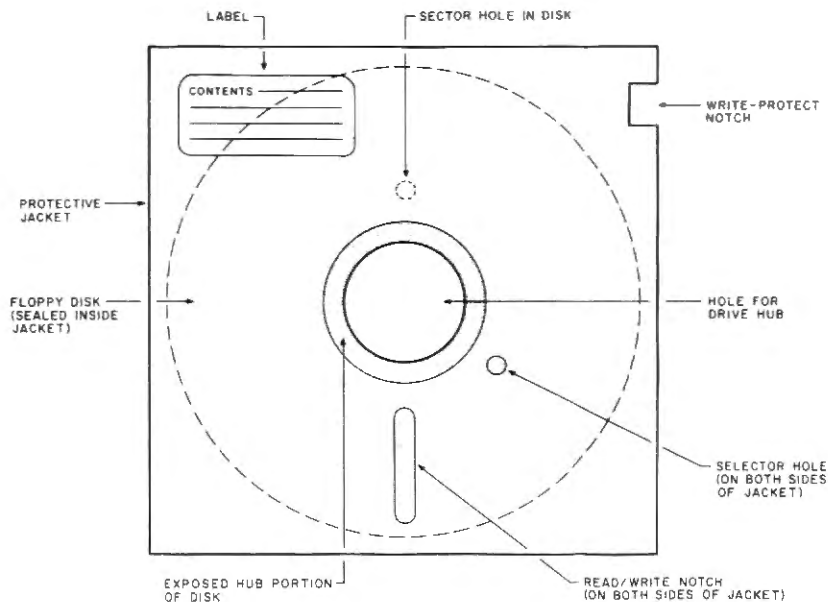


Fig. 1. A floppy disk. The actual disk is encased in a protective jacket

not be written to that disk.

The *sector holes* in the jacket and the disk communicates to the system the positioning of the disk, and enable the automatic location and access of the data. We will go into more detail about this process later.

There are various types of disks available. The following requirements are for those TRS-80 systems with all Radio Shack hardware and software. If your system includes any non-Radio Shack components, you may have to use a different type of disk.

The most obvious criterion is disk size. TRS-80s use 5¼-inch disks, except for the Model II which requires 8-inch disks.

Disks are certified as *single* or *double-sided*. Although both sides of the disk have a magnetic coating, sometimes only one side's coating is reliably applied and satisfactory for data storage. Most disks, whether single or double sided, have read/write notches on both sides, which means that it's possible to read/write data on a "bad" side (usually leading to various I/O errors). All TRS-80s use only one side of the disk. Double-sided disks work fine with no system modifications. However, you pay for a certified second side that the TRS-80 (unless modified) can't use.

Another specification is *single* versus *double density*. Certain systems have the capability of packing a larger amount of data in a given physical area on the disk. Because of this high data density, the magnetic coating must be more uniform and reliable to avoid loss of data. Except for the Model I, all TRS-80s require double-density media. (Although the Model I was set up for single-density disk I/O, double-density

disks can be used with no system modifications. In fact, the double-density is probably worth the extra money for its higher reliability. Radio Shack, by the way, sells only double-density media for the Model I and other TRS-80s).

Disks are also offered in *soft* and *hard-sectored* varieties. The difference is the number of sector holes in the disk (*not* the jacket—see Fig. 1). Soft-sectored disks have one hole; hard-sectored disks have a continuous ring of holes around the large hub hole (but hidden under the jacket). All TRS-80s require soft-sectored media, and unless modified, will not function if hard-sectored media is used.

Be suspicious of media priced far below the average going rate. El Cheapo disks usually have relatively poor coatings that lead to all sorts of headaches with lost or inaccessible data.

Better disks usually have *reinforced hub holes*; you can see the double-thickness edge of the exposed disk at the hub opening. The increased thickness prevents wear or elongation of the hub hole, which may result in unreliable disk operation. Kits are also available to apply reinforcing rings to nonreinforced disks.

Disks should be handled in a very careful manner, owing to the sensitivity of the written data. The disks should be filed vertically (on edge) in their protective envelopes, away from heat and sunlight, and not compressed against each other excessively. Even very minute particles on the media can jam between the read/write head and the rotating disk surface, and some of the magnetic coating can be gouged out. These offenders include dust, cigarette ashes, and even the particles in cigarette smoke (another good reason

to give up smoking). Disks should be kept away from stray magnetic fields, which can be produced by power cords, speakers, motors, tv and stereo receivers, video monitors, and so on.

When ready to shut off the computer, remove all disks from the drives. When writing on the disk label, use a felt-tipped marker; pencils, ball-point pens, and other hard-pointed instruments can mar the disk surface under the jacket.

Data Here, Data There

Examining how data is arranged on the disk will allow us to define some important concepts and buzzwords for later use. For now, however, don't worry about how the data is accessed, or other specifics about the I/O process.

Figure 2 shows a working TRS-80 disk with the jacket removed. Data is laid out on the disk in ring-shaped, concentric *tracks*. As shown, the read/write head on the drive can move in or out along the radius of the disk, positioning itself over a desired track. As the disk rotates, the head "sees" all the data contained on the track.

In addition, the data on a track is organized into a number of *sectors*, as indicated. There is no physical gap between the sectors; certain data patterns that are part of the system information distinguish the various sectors.

There is an important concept here: Each sector contains both *system information* and *user data*. The latter represents the actual data that the user is normally concerned with. As you would guess, the system information is for the benefit of the system itself. It performs such housekeeping tasks as delineating and identifying sectors, verifying the data, and so on. As we will see later, the system bytes form a skeletal structure on the disk, into which the user introduces the data to be stored. In general, the system bytes are invisible to the user, unless a utility such as Trakcess is used to access them.

The inner tracks and sectors are physically much shorter than the outer ones, but they both contain the same amount of data. If you feed your TRS-80 bargain-basement disks, those dense inner tracks may give you headaches with lost data due to inconsistency of the magnetic coating.

Putting Data in Its Place

To get some idea of how the data and system information work together, we'll briefly examine disk *formatting*. Any blank disk must be formatted before data is placed on it.

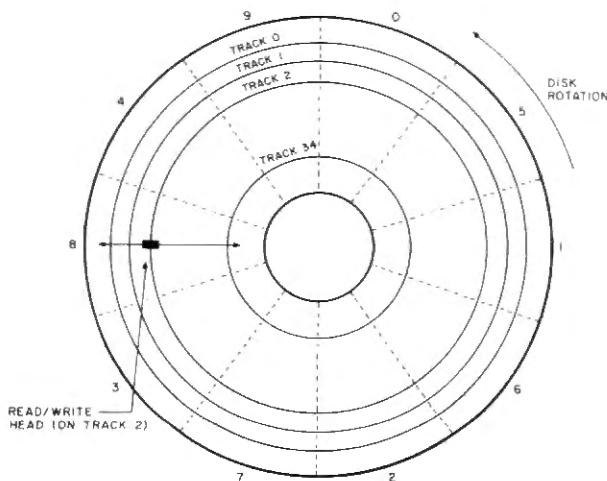


Fig. 2. A formatted disk. The number of tracks and sectors will vary, depending on the system. Note the staggered numbering of the sectors.

DOS packages include a format utility to accomplish this.

When a disk is formatted, it is first tested for flaws by actually writing a data pattern onto it, and then reading it back and verifying it. If any discrepancies are detected, the system assumes that a defect in the media was the cause (the most likely possibility, but hardware bugs can also cause similar problems). The system then locks out the questionable tracks by writing information onto the disk that later instructs the system not to write data to those tracks.

Once this is accomplished, the system gets to the heart of the matter. First, it establishes track and sector boundaries by writing a pattern of system information to the disk. This information also identifies each individual sector so they can be accessed at will later on.

The next step, a very important one, is to establish a *directory* (usually one track long) on the disk. The directory contains status information such as the location of locked-out tracks, access limitations (passwords or other protective functions), and so on. Later, as data is written to the disk, the directory keeps track of where everything is, and allows the user (and the system) to find it again.

Depending on the system, other data may be written during formatting. In the Model I, for example, a *bootstrap* routine (or *boot*), which is necessary for system operation, is put on the disk.

Notwithstanding some different options that may be offered, the basic actions during formatting are the same for all systems: checking the media and then preparing it to accept data.

The Little Gray Box

The *floppy-disk drive* performs the same function as the cassette recorder in a tape system. It executes commands to access existing data or to write new data. However, all the disk drive I/O functions are automatically controlled by the system, as opposed to the manual button pushing required in cassette systems. This is yet another factor contributing to the power and versatility of the floppy-disk system.

The drive incorporates the following subassemblies:

- A *drive motor*, with a hub assembly, grips the disk at its center hole and rotates it at an accurately controlled speed. The hub locks onto the disk when the drive's *access door* is closed
- The *read/write head* is positioned over the read/write notch in the jacket.

When data is to be accessed, the head is moved in and out along the radius of the disk by a *stepper motor*.

- The *write-protect switch* checks the write-protect notch on the disk.

- The *index/sector LED and detector* are positioned on either side of the disk at the sector holes. As the disk rotates and the sector hole lines up with the jacket holes, a flash of light falls on the detector, which then triggers logic circuitry to inform the system about the disk's position.

- *Logic circuitry* (either *control* or *read/write* circuits) coordinates all drive operations. Most circuits light an LED on the drive cabinet when the driver motor is running. *Do not* attempt to open the access door when the activity LED is lit!

Just as with disks, there are many variations of disk drives to choose from. Again, the following specifications are for unmodified Radio Shack TRS-80s.

Drives are supplied either as bare drives (not mounted in a cabinet, and usually without power supplies), or completely self-contained external units (with power supply and cabinet). There are also multiple-drive assemblies that incorporate two or more drives in one cabinet. The Model I and Color Computer each use up to four external drives. The Model III has space in its enclosure for two bare drives to be installed, and can support two more external drives. The Model II has one internal drive, and can support up to three additional drives. (Model IIs usually have a three-drive expansion bay for extra drives. The bay is a cabinet/power-supply unit with one drive installed, and two extra bare drives can be installed as needed.)

Some systems require that one drive incorporate *terminating resistors*, which provide a satisfactory electrical match in the disk interfacing. Usually, there is no difference in price between standard and *terminal* drives. For all TRS-80s (except the Model II), one of the external drives is usually a terminal drive.

On the Color Computer, the first drive purchased will be more expensive than additional drives. Similarly, on the Model III the first internal drive is more expensive than the second. In both cases, the *disk controller circuitry* is incorporated into the first drive. The Color Computer's first drive kit also contains a program cartridge containing the DOS and a cable for the drives.

The Model I is a different story; the controller is not found in either the computer or the first drive, but in the *expansion interface*,

an additional piece of hardware needed before any drives are hooked up.

Your drives need *track capability* to match the system's track setup. The Model I is set up for 35-track I/O, the Model III and Color Computer are 40 track, and the Model II is 77 track.

As with disks, the drive must be able to handle the appropriate data density. Specifically, the read/write head should be certified to handle double density I/O (except for the Model I, which is single density). Most drives available today, except for the lowest-priced models, are capable of both single and double-density I/O.

You should use double-density-capable drives in the Model I with no system modification. In this case, you would not have to replace the drives if you later decide to convert the system to double density.

Tell Me What You Want

The disk drive by itself is a rather stupid piece of sophisticated machinery. Its only real capabilities are that it can merrily spin a disk at several hundred rpm and step its head in and out (as well as several reporting functions, like checking the write-protect notch or the sector hole). Obviously, some direction from hardware or software is needed to perform worthwhile disk I/O. The disk controller circuit is an important example.

The controller circuit usually consists of little more than a single IC and a small handful of support components. However, it tremendously expands the repertoire of floppy-disk functions and data transfers. For example, the Western Digital FD 1771-01 controller chip (used in the Model I) enables reading/writing of bytes, sectors or tracks, formatting and enhanced seeking/locating capabilities.

The controller is functionally invisible to the user since it acts under command of the DOS. Unless you try to design your own DOS or a program with its own disk I/O routines, you do not have to delve too deeply into the controller operation. For those of you who are interested, references include Western Digital's documentation on the controller chip and Bill Barden's text on disk interfacing (see bibliography).

DOS Is the Boss

At this point, we have covered the physical components that comprise a TRS-80 disk system. However, in this raw state it is capable of only rudimentary disk operations under direct opera-

tor command (since the ROM has no disk I/O routines as such). In order to make this conglomeration of expensive hardware sprout wings and fly, we need a piece of software known as the *disk operating system*, or *DOS* for short.

To quote from the Radio Shack TRSDOS manual:

"An operating system is a master program that allows a complex computer system, including various input/output . . . devices, storage devices and programs, to interact efficiently and with apparent simplicity. The operating system makes sure that everything that has to be done gets done—and you don't even have to know what it is that 'has to get done.' "

As you can see, the DOS software is probably the most important part of the floppy-disk system. It acts as an extension of the ROM, in that it provides routines for all the various disk operations.

Some of you may be wondering, "How can a piece of software tie in with ROM, which cannot be physically modified?" The answer is that many of the ROM routines have a *detour* through some portion of accessible RAM memory. At certain points in these routines, execution "jumps out" to a RAM address, where the system or

operator could place any type of executable program.

In the non-disk system, these addresses (referred to as *DOS links* or *DOS exits*) are coded to redirect execution back to the ROM, resulting in a brief, unproductive loop out of ROM and back again. But we could replace that return instruction with a short routine that would then be executed, and we would have the option of not returning to the ROM afterwards. This is the basic principle of the DOS extension to the ROM.

In similar fashion, there are sets of addresses connected with the exclusive command keywords for the disk version of Basic. The Basic interpreter (in ROM) detects all Basic command words, most of which have associated execution code burned into the ROM. For the Disk Basic words, however, the ROM loops out into RAM for these routines. In non-disk systems, these addresses cause an immediate return to a ROM routine that displays the cryptic message "L3 Error" (or "Level III Error"—the authors of the ROM apparently referred to Disk Basic as Level III Basic). Once again, however, when a DOS is present, these keywords become valid, active commands because

the *calling addresses* are redirected to executable routines for the disk system.

The exception to this procedure is the TRS-80 Model II. This computer has essentially no operating code in ROM at all, except for a small initialization routine. What this does is to immediately fetch, from the disk drive, the whole operating system contained on the DOS disk, load it into memory and begin execution once you turn on the computer. The Model II DOS is, therefore, much more sophisticated, as it must include all of the fundamental routines that would otherwise have been in ROM, such as the Basic interpreter, keyboard and video display routines, and so forth. The big advantage is that the user is no longer constrained by a strict ROM code or a given language interpreter—the door has been opened to the use of powerful, esoteric operating systems and other high-level computer languages (Fortran, Cobol, Pilot, CP/M and so on).

A description of DOS features would quickly turn this article into a book, so I'll simply recommend that you go to the people who wrote the book—Radio Shack. Their operating manual for the TRSDOS operating



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system is first rate, extremely thorough, and (for the most part) understandable even by the rank amateur. The manual alone is available, or you can buy the entire package including the DOS disk.

TRSDOS itself is fairly simple to learn, and many of the competitive DOS packages are based on Radio Shack's. The other systems generally boast correction of bugs (errors) in TRSDOS, or special routines that TRSDOS doesn't include. At any rate, cut your teeth with TRSDOS and get a good idea of what the DOS is and does before buying one of the new-fangled, high-performance systems.

The market for Model I and III DOS packages is loaded with products, and if you ask 10 different users about their favorite DOS, you are likely to get 10 different answers. Some of the more well known names are Apparat's NEWDOS (there are several versions), Logical Systems' LDOS (formerly VTOS), Micro Systems Software's DOSPLUS, Level IV Products' ULTRADOS, and Cosmopolitan Electronics' MULTIDOS. Newer versions of these products are usually double-density compatible, which is an important factor in Model I and III soft-

ware interchangeability, and permit conversion of Model I systems to double density.

Before purchasing one of these products, find area computerists who use these systems and see if you can get some hands-on experience with them. Try not to buy on verbal recommendations alone. Also, steer clear of unauthorized copies of a DOS. You can never be sure what condition it is in, or whether it has been periodically upgraded or debugged. Also, you will not get the benefit of follow-up support by the author; most companies distribute upgrades or zaps (recommended corrections) to registered owners only.

Furthermore, there is the very real problem of software piracy, and the deprivation of royalties due to software authors. Granted, the price tags on original software often run high, but you will get continuing technical support from the authors and make it financially feasible for them to continue that support and turn out new material. ■

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Binary Breakfast

by Richard E. Esposito

All digital computers are based on the binary number system; the TRS-80 is no exception. The binary system is based on the number two; the decimal system is based on 10.

Consider 1,458; in base 10, it represents $1 \times 10^3 + 4 \times 10^2 + 5 \times 10^1 + 8$, while the number 1011 in base two represents $1 \times 2^3 + 0 \times 2^2 + 1 \times 2 + 1$.

In base 10, 10 represents $1 \times 10 + 0 = 10$. Therefore, we need symbols that can occupy the right position to represent zero through nine. The symbols we use are 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9.

In base two, 10 represents $1 \times 2 + 0 = 2$, so in base two arithmetic, we need digits representing only zero and one. It is useful to count in both bases (see Table 1).

One of the niceties of dealing with base-two numbers is there are only four addition facts:

- $1 + 1 = 10$
- $1 + 0 = 1$
- $0 + 1 = 1$
- $0 + 0 = 0$

Addition in base two is carried out in much the same way as addition in base 10. To add 10101 to 11011:

$$\begin{array}{r}
 (1) \ (1) \ (1) \ (1) \\
 1 \ 1 \ 0 \ 1 \ 1 \\
 1 \ 0 \ 1 \ 0 \ 1 \\
 \hline
 1 \ 1 \ 0 \ 0 \ 0 \ 0
 \end{array}$$

(d) = digits carried

Now you can understand the language of your Model I, III, or Color Computer—it's simple.

The multiplication facts are:

- $1 \times 1 = 1$
- $1 \times 0 = 0$
- $0 \times 1 = 0$
- $0 \times 0 = 0$

To multiply 101 by 111:

$$\begin{array}{r}
 111 \\
 \times 101 \\
 \hline
 111 \\
 000 \\
 111 \\
 \hline
 10011
 \end{array}$$

An integer word in the TRS-80 consists of two 8-bit integer bytes, a word being the unit of memory used to store a number.

Let's calculate the binary equivalent of 56. To do this, we use what is commonly known as the Chinese remainder theorem. The process is simple: Divide 56 by two; divide the quotient by two; repeat the process until a quotient of zero is obtained. For example:

$$\begin{array}{r}
 28 \\
 2 / 56
 \end{array}$$

$$\begin{array}{r}
 56 \\
 0 \text{ first remainder} \\
 14 \\
 2 / 28 \\
 28 \\
 0 \text{ second remainder} \\
 7 \\
 2 / 14 \\
 14 \\
 0 \text{ third remainder} \\
 3 \\
 2 / 7 \\
 6 \\
 1 \text{ fourth remainder} \\
 1 \\
 2 / 3 \\
 2 \\
 1 \text{ fifth remainder} \\
 0 \\
 2 / 1 \\
 0 \\
 1 \text{ sixth remainder}
 \end{array}$$

Since the sixth quotient is zero, we can terminate our division process.

The next step is to assemble our binary number. This is done by writing our remainders in the opposite order of their calculation. That is, starting from the left using 56 as the example: remainder six, remainder five, remainder four and so on, yielding 1 1 1 0 0 0, which is the binary equivalent of 56.

You can double check by doing this: $1 \times 2^5 + 1 \times 2^4 + 1 \times 2^3 + 0 \times 2^2 + 0 \times 2 + 0 = 56$.

The TRS-80 uses a 16-bit word for integers, so we will add enough zeros on the left to give us a 16-bit number. This yields:

$$0000000000111000$$

Now that we have the binary equiv-

Base 10	1	2	3	4	5	6	7	8	9	10
Base 2	1	10	11	100	101	110	111	1000	1001	1010

Table 1

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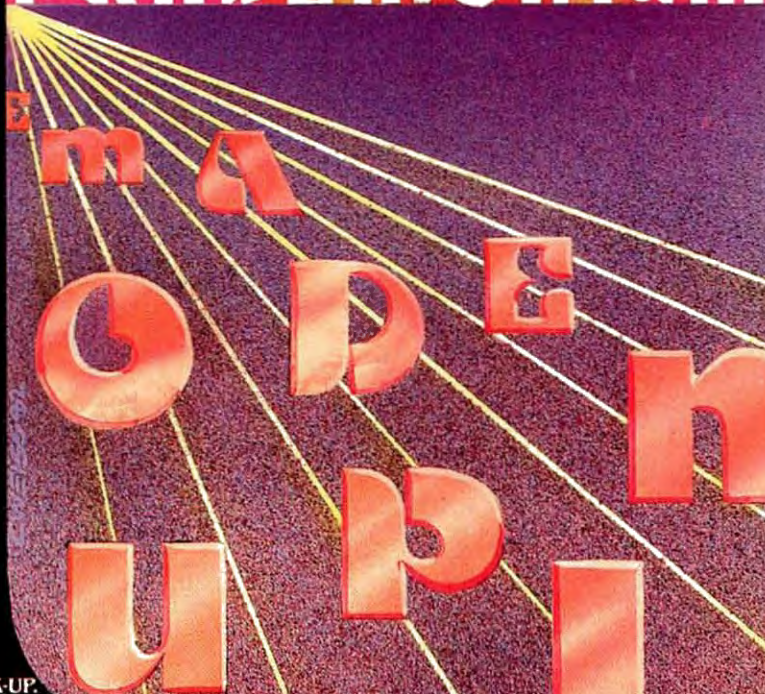
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alent of 56, how does this relate to the statement: $10 X\% = 56$? If you follow this statement with: `20 PRINT VAR PTR (X%)`, the computer will print the address of the first byte of the variable X%.

If you add the statements

```
30 PRINT PEEK (VARPTR (X%))
40 PRINT PEEK (VARPTR (X%) + 1)
```

you will get the results 56 and zero from the two locations. How does this compare with our computed binary number? Well, a 16-bit number must be broken into two 8-bit bytes. Doing this with 56 gives us 00000000 and 00111000. The byte on the left is called the high-order byte and the byte on the right is called the low-order byte.

The TRS-80 stores the high-order byte in the second byte of the word and the low-order byte in the first. If you convert the binary numbers from each of these bytes to base 10, you will come up with zero and 56, the same values that were PEEKed from memory.

If you understand everything up to this point, you should be able to explain why the following program yields the result of 32767:

```
10 X% = -1
20 POKE VARPTR (X%), 255
30 POKE VARPTR (X%) + 1, 127
40 PRINT X%
50 STOP
60 END
```

What about negatives?

If you read the *Level II Basic Reference Manual*, you will notice an integer variable may only be as large as 32767. If it were not for negatives, a 16-bit number could go as high as 65535.

The TRS-80 uses a scheme known as two's complement to represent negative integer numbers. What this scheme does is use half the possible 65536 values to represent positive numbers and the other half for negatives.

So how do we get -56? Recall that 56 was equal to 000000000111000. To compute -56, first calculate the one's complement by switching all ones to zeros and all zeros to ones. This gives us 1111111111000111. To the one's complement add one to come up with the two's complement. In the case of -56, this yields:

$$\begin{array}{r} 1111111111000111 \\ + 1 \\ \hline 1111111111001000 \end{array}$$

If this addition had resulted in a 17th

digit for our result, it would have been discarded. Now as before with 56, we split the result into two bytes, this time resulting in 11111111 and 11001000. Converting these bytes to base 10 results in 255 and 200.

You are now equipped to explain why this program yields -56:

```
10 X% = -1
20 POKE VARPTR (X%), 200
30 POKE VARPTR (X%) + 1, 255
40 PRINT X%
50 STOP
60 END
```

Floating Points

How does the TRS-80 handle floating-point numbers? To answer that question we must analyze the binary number system still further. In binary:

$$\begin{array}{l} 0.1 = 1/2 \\ 0.01 = 1/4 \\ 0.001 = 1/8 \\ 0.0001 = 1/16... \end{array}$$

To convert fractions to binary we multiply the decimal fraction by two. If the result is greater than zero, write down the number or else write down a zero.

Continue multiplying only the frac-

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tional part of the product until you have accumulated the proper number of bits. In the case of 56.1625, 56 gave us six bits but a single-precision variable in Level II Basic requires 24 bits in addition to the exponent, so we proceed as follows:

	.1625
	×2
Bit 1	0.325
	×2
Bit 2	0.65
	×2
Bit 3	1.3
	×2
Bit 4	0.6
	×2
Bit 5	1.2
	×2
Bit 6	0.4
	×2
Bit 7	0.8
	×2
Bit 8	1.6
	×2
Bit 9	1.2
	×2
Bit 10	0.4
	×2

Bit 11	0.8
	×2
Bit 12	1.6
	×2
Bit 13	1.2
	×2
Bit 14	0.4
	×2
Bit 15	0.8
	×2
Bit 16	1.6
	×2
Bit 17	1.2
	×2
Bit 18	0.4

We now have 18 additional bits in 56.1625 = 111000.001010011001100110. Now we normalize the number by moving the binary point (binary point is to the binary system as decimal point is to the decimal system) to the leftmost position and put the number into scientific notation. The result is a binary point, followed by a one, followed by additional bits. If the original number were a fraction, the binary point would be adjusted to the right to achieve this status. (You may also have to calculate more bits to achieve the required preci-

sion: 24 bits to the right of the binary point.) This yields 56.1625 = .11100001010011001100110 × 2⁶. Now break the number into bytes as we did with the integer variable. This yields: most significant byte = 11100000; next most significant byte = 10100110; and least significant byte = 01100110.

Now take the power of two and add it to 128. In this case, we get 134. For a positive value, change the leftmost bit of the most significant byte (the byte closest to the binary point) from a one to a zero. For a negative value, omit this step. This is the system adopted by Microsoft for representations of positive floating-point numbers. It is by no means universal. In the case of 56.1625, we have 01100000.

Next convert your three significant bytes to base 10. We now have 96, 166 and 102. The number 56.1625 would be stored in the TRS-80 using four consecutive bytes:

Byte 1 (least significant byte) = 102
 Byte 2 (next most significant byte) = 166
 Byte 3 (most significant byte) = 96
 Byte 4 (exponent) = 134

If the following program is run on the TRS-80, the printout would yield



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56.1625:

```

10 X = -1
20 V = VARPTR (X)
30 POKE V,102
40 POKE V + 1,166
50 POKE V + 2,96
60 POKE V + 3,134
70 PRINT X
80 STOP
90 END

```

For TRS-80 double precision, the process is similar, except you need 56 bits to the right of the binary point in the normalized number.

In the case of 56.1625: 56.1625 = 111000.00101001100110011001100110. After changing to scientific notation, we have: .1110000010100110011001100110011001100110011001100110 $\times 2^6$. The bytes going from most significant to least significant and converting to base 10 are:

```

01100000 = 96 (the left bit was stripped as
           before.)
01001110 = 166
01100110 = 102
01100110 = 102
01100110 = 102
01100110 = 102
01100110 = 102

```

and, as before, the exponent is 128 + 6 = 134.

The number is stored in very much the same way as in single precision except it uses 8 bytes. If we run the following program, the result would be 56.1625:

```

10 X# = -1
20 V = VARPTR (X#)
30 POKE V, 102
40 POKE V + 1,102
50 POKE V + 2,102
60 POKE V + 3,102
70 POKE V + 4,102
80 POKE V + 5,166
90 POKE V + 6,96
100 POKE V + 7,134
110 PRINT X#
120 STOP
130 END

```

For the TRS-80 Color Computer, let's again consider the number 56.1625. The Color Computer only has one type of variable, which is a five-byte, floating-point number.

As before, convert 56.1625 to binary, this time to 32 bits: 56.1625 = 111000.00101001100110011001100110. After changing to scientific notation we have: .111000001010011001100110011001100110 $\times 2^6$. Break into bytes and convert to base 10:

```

01100000 = 96 (the left byte was stripped as
              before)
01001110 = 166
01100110 = 102
01100110 = 102

```

and as before, the exponent is 128 + 6 = 134.

Unlike before, the numbers are stored in the reverse order of those in the Models I and II. This order is used in most computers. The real oddball in this case is the Z80. The TRS-80 uses Motorola's 6809 chip.

As before, if we run the following program, 56.1625 will be our result:

```

10 X = -1
20 V = VARPTR (X)
30 POKE V,134
40 POKE V + 1,96
50 POKE V + 2,166
60 POKE V + 3,102
70 POKE V + 4,102
80 PRINT X
90 STOP
100 END

```

The following program written in TRS-80 Basic divides an input number by two by changing the value of the exponent of the stored floating-point number:

```

10 INPUT X
20 V = VARPTR (X)
30 E = PEEK (V + 3)
40 E = E - 1
50 POKE V + 3,E
60 PRINT X
70 STOP
80 END

```

The corresponding program for the Color Computer follows:

```

10 INPUT X
20 V = VARPTR (X)
30 E = PEEK (V)
40 E = E - 1
50 POKE V,E
60 PRINT X
70 STOP
80 END

```

Now consider this problem raised by Michael Binkhurst ("80 Aid," *80 Micro*, February 1981): "When the following program is run, why is the result .0100002 instead of the expected .01?"

```
120 A = 20.01:B = 20:PRINT A-B
```

To see why, convert both numbers to binary as the TRS-80 does.

```

20 = 10100
.01 = .0000001010001111010

```

(19 places are required in this problem)

In scientific notation:

```

20.01 = .101000000001010001111010  $\times 2^1$ 
20 = .101000000000000000000000  $\times 2^1$ 

```

If we subtract the two, we obtain:

```

?
.01 = .000000000001010001111010  $\times 2^1$ 

```

This result must now be normalized resulting in:

```

?
.01 = .101000111101000000000000  $\times 2^{-6}$ 

```

(the underlined zeros were added to retain 24 bits of accuracy)

Converting our result back to base 10 yields: $(1/2 + 1/8 + 1/128 + 1/256 + 1/512 + 1/1024 + 1/4096) \times 2^{-6} = .0100002$

The error introduced into this calculation plagues computers that use scientific notation. One way to avoid this problem is to use the binary-coded decimal arithmetic scheme where each decimal digit is represented by four bits and the computer then calculates in much the same manner as one would using pencil and paper. This technique is fine for business problems, but it uses more memory and is slower.

In the world of big computers, both systems are used: Fortran (with floating-point arithmetic) for scientific problems and Cobol (with binary-coded decimal arithmetic) for business problems.

Some possible solutions to this problem include:

- Use double precision. It will not eliminate the error completely, but it will be made smaller.
- Get a computer that uses BCD arithmetic. An example of one is the APF Imagination Machine.
- Use the technique called "fuzzing." If a number is within a certain tolerance of a base-10 number, print that base-10 number. This scheme is used in APL. In APL, the "fuzz" is adjustable. ■

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Nine Programming Tricks

by David D. Busch

Try these shortcuts for faster Basic programming—easier backups, macro commands, renumberings, cross references, and block moves.

Many programmers do not use all the tools available to them as they write their code. When a programmer lets his machines handle as much of the drudgery as possible, he can then devote a full effort to the creative aspects of programming.

Leading software suppliers have helped by offering utilities, disk operating systems with enhanced Disk Basics, and other tools to make programming easier. Even so, while the documentation for these time-savers is usually adequate, it lacks real-life examples on how to use them to optimize your programming productivity. I will present nine shortcuts that make my programming easier.

Easier Backups

As you develop a program, it is good practice to periodically save the work in progress either to cassette or disk. Thus, should a power failure occur, hours of work are not lost. With a disk-based system, making backups is easy—so simple that when I end a session and look at the working disk's directory, I see 10 or more versions of my program tucked away (PROGRAM/VI, PROGRAM/V2 and so on). This system works well, but when saving, I can never remember what I called the last version. I must either invoke a CMD"DIR" to check, or play it safe and skip a number or two.

Here is a short program disk users can append onto the end of any program they are working on and use to automatically save an updated version

of a program under an appropriate file name. To use it, remember to turn on your clock. Then, by typing GOTO 30000 at any point during program development, the module will collect the current TIME\$, extract the hour and minutes, and use that to make the file name.

```
30000 B$ = TIME$:H$ = MID$(B$,10,2)
30010 M$ = MID$(B$,13,2)
30020 F$ = "PROG" + H$ + M$
30030 SAVE F$
```

Save this in ASCII form on your disk, and then append or merge it to any program you choose (which does not have line numbers that conflict). You may want to edit line 30020, replacing the string "PROG" with any four letters that are more meaningful for the program you are developing. If you want to back up the program to two (or more) disk drives automatically, add the following lines:

```
30025 F1$ = F$ + ":1":F2$ = F$ + ":2"
30035 SAVE F1$:SAVE F2$
```

This automatic save feature provides you with valuable added security.

Macro Commands

Computer users who have an operating system or utility (such as IRV) that provides a keystroke multiplier or defined key functions can speed up their program development even more. You can store the short program above in one of IRV's defined keys and in-

voke it by hitting one or two keys. Other frequently used commands, such as CMD"DIR :1" or RENUM 10,10, can also be applied to user-programmable keys.

Though programmers most frequently use such utilities to speed the entry of keywords (I instead of Input), you can define and reuse longer, more complex strings. How often have you typed the following:

```
AS = INKEY$:IF AS = "" GOTO
OPEN "O",I,F$
HIT ANY KEY TO CONTINUE
CLS:PRINT:PRINT
```

Defining these will save you many more keystrokes than simply bypassing Input with I. Try it.

Moving Blocks of Code

Renumbering programs is a basic programming tool. Even if you code with line numbers in increments of 50, some day you will have to fit a line between line 350 and line 349. Renumbering utilities such as NEWDOS80 2.0's RENUM make this problem trivial. Almost as quickly as you can type RENUM 10,10, (or RENUM ,) the entire program will be renumbered with plenty of room to add new lines.

But wait a minute! While writing the code, don't you keep many line numbers in your head? It is handy not to have to search for your main menu routine and just type GOTO 200 at the end of each module. If you renumber frequently, a module that was at line 200 might have been moved back to line 180, or ahead to line 220. You were careful to put the subroutines at lines 2000, 3000, 4000 and 5000 so you could find them. Now they have been renumbered to lines 1340, 1350, 1360 and 1370. NEWDOS80 2.0's RENUM can be very flexible. Try these formats, all carefully explained in the document-

ation, but not often used. If necessary, write them on a sticker and place it on your computer for reference. These formats save time: RENUM first line, increment, first line renumbered, last line renumbered.

In this example, first line should be the beginning line number for the renumbered section. Increment should be the amount of space desired between lines, while the last two entries are the first line to be renumbered and the last to be renumbered. This format allows you to renumber only *part* of a program, without interfering with the rest of the code.

Suppose you are running out of space between lines 300 and 400, but have no additional program lines written between lines 400 and 500. You can expand the code-filling lines 300-400 to include all numbers between lines 300 and 500.

RENUM 300,10,300,500 accomplishes this. You can use two commas to replace the 10, a default value, so that RENUM 300,,300,500 accomplishes the same thing. All program lines beginning at line 300 and ending at line 500 will be renumbered with an increment of 10. The first line will be assigned 300, the second 310, and so

forth. The highest-numbered line of the old module, line 400, will now have a higher number past 400, possibly as high as 500. The other lines will be separated by 10 lines in the code. The rest of your program remains unchanged.

Have you written a title block, remarks, or some other piece of code at the beginning of a program that you do not want to renumber? In this case, you want to renumber the program from line X onward. Use this format: RENUM first line number, increment, first line to be renumbered.

If I wanted to renumber all program lines from 10 onward with an increment of 5 and use line 25 as the first line number for that module, I would enter RENUM 25,5,10.

Because there is no fourth entry (last line number), the utility renumbers all remaining lines in the program.

How about moving blocks of program lines? NEWDOS80 2.0 has a quick and dirty DI and DU command that moves single lines fast (or duplicates them in a new location). Unfortunately, this feature does not change any GOTOs that might be affected by the change. If your program contains a branch to a line that was moved, you must find the line and

make the correct change. This is not difficult (using REF, discussed later), but is an additional opportunity for bugs to creep in.

However, RENUM can be a better way of moving whole blocks of code, because all GOTOs and GOSUBs are updated to take into account the change. Although the syntax is identical, I have phrased it slightly differently in the following example to make it clearer exactly what is taking place: RENUM new location, increment, first line moved, last line moved.

This format takes a section of code and renumbers it (if necessary) while dropping it neatly into a new location. As an example, assume we want to move all lines between line 300 and line 400 to a space between line 1000 and line 2000. I will use a line number increment of 10. Type RENUM 1000,10,300,400.

That's all there is to it. Once you are comfortable moving blocks of code around, you might want to try one other trick: Save modules that are frequently used in ASCII form on your disk. These may be disk I/O routines, menus, title blocks and so forth. Then merge or append them with the program under development, and move

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them as you see fit. All the internal GOTOs and GOSUBs within the modules will be renumbered to match the new location. You merely need to add references to transfer control to and from your transplanted subroutines.

RENUM has one other useful programming feature. You may type RENUM U, and the utility will not actually do any renumbering. Instead, it will search through your program and find any undefined line numbers and other errors that would abort a renumber. In this way, you may find and delete redundant blocks of code or errors.

Cross-Reference Utilities

A number of sources have cross-reference utility programs that search your Basic code or find all occurrences of a variable, line number, or text strings. These can be useful debugging tools. Are you interested in finding out why a variable changes value when it is not supposed to? Check out all uses of that variable. You may find A\$ was used in an INKEY\$ line within a module that also includes a LINE-INPUT A\$ statement.

Long-time NEWDOS80 1.0 and 2.0 users are not aware of all the things

REF can do. Most know that typing REF A produces a listing of all uses of A as a variable, either string, integer, array, double precision or single precision. But then they laboriously type LIST 10, LIST 300, LIST 1000, and so forth to check each use.

This is unnecessary! After invoking the REF variable, simply type REF with no argument. The utility will list the first line where the variable is used. You may edit that line or ignore it as you prefer. Type REF again and the next text line with that variable will be shown. Text End appears when all have been displayed. This is simple, but often overlooked.

REF will also search for character sequences, such as PRINT, HIT ANY KEY, and so forth, up to 16 characters. By prefacing the string with a quotation mark (REF" text string) the program will search strings and comments for the desired characters. This is a fast way to find a certain block of code, or to change all Prints to LPRINTs or do some other work.

These nine programming tricks should be useful to anyone doing more than casual programming. After all, the computer should be doing as much of the work as possible. ■

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The Sum of Its Parts

by Spencer Weersing

Good Basic programming begins with an organized game plan. This article explains how to tackle your programming in a logical manner.

"A confusion of aims and a profusion of means seems to be our main problem."—Albert Einstein

Beginning students of Basic often have difficulty writing programs that work properly because they use poor design techniques. But if you plan your work, then work your plan, you will be successful. Follow these five steps of good design technique; they will lead you to proficiency:

- State the purpose of the program.
- Make an organizational chart.
- Make a pseudocoded outline.
- Code and check the fundamental program.
- Code and check the completed program.

The First Step

Succinctly state the purpose of the program. Be as specific as possible without stating the method by which you plan to accomplish that purpose. You need to be clear, concise, and complete. Ambiguous writing and disorganized thoughts will destroy a program before it is born.

If there are multiple things that the program must do, divide it into appropriate subprograms and state the purpose of each. (A subprogram performs a major part of the work of the whole program.) If you divide your task into parts, you can write and check manageable portions to see that each part performs its functions properly. The sum of the parts, each fulfilling its purpose, equals the whole. Complex programs are hard to write any other way because, without subprograms, you have to contend with the entire mass of computer code; this defies understanding. Split the program into parts that you can easily handle.

As an example, let's write a program that has practical value when you are considering purchase of real estate. Assume that you want to know if the

proposed terms of a land contract are reasonable and within your means. You have to judge if the proposed amount of the total loan, the down payment, the monthly payments, and the interest seem satisfactory, and you want a program that calculates the duration of the contract in order to facilitate that judgment.

For instance, if the down payment or the monthly payments are too low, the monthly interest would not be covered or the contract would run for an excessive number of years. If the contract is not satisfactory with the given terms, how long would it run with other terms? Alternatively, if you know the principal, interest rate, and duration, how much would the monthly payments have to be?

Once all terms seem satisfactory, you want to know four things each month: how much of the current monthly payment covers interest; how much of the current monthly payment reduces the principal; how much the new principal is; and the total to date of interest payments (for tax pur-

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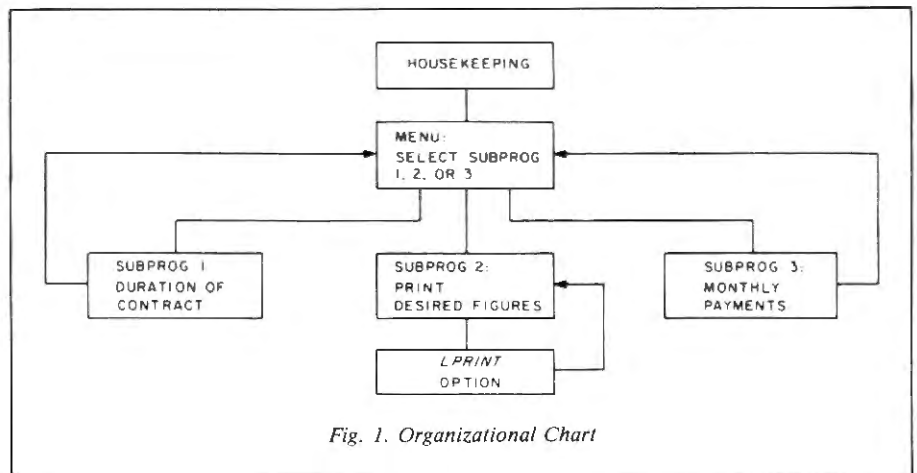


Fig. 1. Organizational Chart

poses). The program, to be useful for others who may not have the same hardware and peripheral equipment that you do, must have an option to print copy if a printer is available.

Now that you have considered your needs, state the purpose of the program: calculate a land contract. First, calculate its duration, given the principal, interest rate, and monthly payments. Second, for each month, display payment portion for interest, payment portion reducing principal,

new principal, and total interest to date. Have an option to print a payment schedule on a line printer. Third, calculate monthly payments if the duration is known.

Plan on three subprograms to fulfill your needs.

Step Two

Next, make an organizational chart (see Fig. 1). This is a simple way to visualize the sequence of the major parts of the program. Do not confuse

this with a flowchart, a diagram that is helpful to demonstrate how the computer follows a specific instruction. After you have written the program, flowcharts help you understand computer logic, but they are far too detailed at this stage. If you attempt to make a flowchart too early in programming, you become so immersed in the minor details of Basic technique that you lose the overall design. Do not concern yourself with coding techniques at this stage, only with the overall goals of the programs and subprograms. You have to know where you want to go before deciding if it is better to take a train or a bus! The road map that guides you to your destination is the organizational chart.

The first item in the organizational chart is housekeeping, a part that sets things up in preparation for a data-processing operation. The second item in the chart is normally the master program (do not confuse this with the main program itself). The master program directs the proper sequence of subprograms to accomplish the overall purpose. If the sequence of subprograms is under operator control by means of keyboard input, the master program is often called the menu, because the operator makes selections from a list of subprograms. The master program also allows flexibility in the sequence of operations and easily traced program flow.

In the land contract organizational chart, the menu offers a choice of any of the three subprograms. Following subprogram one or three, program flow returns to the menu. Following subprogram two, the user may produce a printout by rerunning subprogram two with the necessary instructions. You can easily visualize program flow by using an organizational chart.

The Third Step

Next, outline each subprogram (see Fig. 2). Write the purpose of each, and list (in appropriate sequence) the data you need to give to the computer (input), what you expect the computer to do with it (process), and what results you expect (output). These are the three parts of a computer program. A parallel outline under these headings is called pseudocode. Pseudocode is not code that the computer understands, but detailed directions that make actual coding obvious.

Input may be accomplished from the keyboard, from a data file on tape or disk, or from previous computer process. The process section is the actual

Subprogram 1: Calculated duration of proposed land contract.

Input	Process	Output
total amt TA		
down payment D	TA - D	P = amt of contract
% interest I	I/100	decimal form
monthly payment MP		
month X = 0	X + 1	X = next month
	P*I/12	MI = amt for interest
	IF MP < MI	Stop
	MP - MI	MR = amt applied to P
	P - MR	P = new principal
	IF P ≤ 0	Print X (= # months)
		Restore input
	GOTO start	GOTO Menu

Subprogram 2: For each month (with option to print via line printer) display month, payment portion for interest, payment portion reducing principal, new principal, and total interest to date.

Input	Process	Output
same	X + 1	X = total # months
	P*I/12	MI = amt for interest
	MP - MI	MR = amt applied to P
	P - MR	P = new principal
	MT + MI	MT = total I to date
		Print X MI MR P MT
	IF P ≤ MP	Print "Pay" P + P*I/12
		Total = MT + P + P*I/12
	GOTO start	GOTO LPRINT option
	make flag to LPRINT via subroutines	
	restore input	
	GOTO start	

Notes:

Make P and MT double-precision values if over 6 significant figures; store them without trailing garbage digits. Precede Menu with input that is common to all subprograms. Include line to restore X, MT, and P.

Subprogram 3: Calculate monthly payment if given term.

Input	Process	Output
same		
term (years) N	I*100	% form
	P*I/1200	Y = intermediate for MP
	(1 + I/1200) ^(12*N)	Z = intermediate for MP
	Y/(1 - 1/Z)	MP = monthly payment
	I/100	decimal form
	GOTO Menu	

Note: Round off MP to \$.01.

Fig. 2. Outline

tions, separate each part widely and use an interval of 10 between line numbers. You can renumber the program later, if you desire.

Begin the housekeeping section with a remark statement giving a proper file name, current date, and the author's name. This important information allows proper magnetic storage of the program in a file, identifies the file later, and tells the user which modification the program is. You are limited to eight alphanumeric characters for the file name, and the first character must be alphabetic. Truncate the program title "Land Contract Schedule" to LANDCONT for an acceptable file name that helps you remember which program it is. Radio Shack's Level II Basic allows you to put an extension of three characters following a slash on the file name to identify the data the file contains. Use /BAS because this file contains a program written in Basic. The author's name is important for proper credit—or to assign responsibility if the program fails to operate properly!

Add additional remark statements throughout the program as needed for clarity. While this consumes memory and makes the program run more slowly, remark statements help recall essential information about any particular operation that you are instructing the computer to do. Once the program is perfected you can delete remark statements, but keep an annotated printout for your reference library.

Set aside housekeeping line numbers 500–799 for subroutines. A subroutine is a set of instructions that will be needed more than once. Rather than

requiring you to repeat the same instructions, Basic allows access to those instructions via the subroutine function. After performing the work directed by the instructions, program flow returns to the location of origin in the main program. You can use one set of instructions multiple times from any part of the program (even from another subroutine). Include a remark statement with each subroutine indicating which lines call it, so you may easily trace program flow.

Line 500 restores original input values to allow succession of subprograms without having to repeat input. Lines 600 and 610 are reserved for the print option in the completed program.

Do not use any housekeeping functions in the fundamental coding that are not absolutely required. Discipline yourself to include essentials only, regardless of how desirable nonessentials are. You can add elegance after the program functions perfectly. (Modify it to run faster, or produce an ideal display or attractive printout, for example.)

Lines 900–940 are not part of housekeeping. Some identical keyboard input is required by all of the subprograms, so this input precedes the subprograms.

The next section, lines 1000–1040, is the menu, which allows a choice of any subprogram.

Now, code each subprogram. Once again keep your priorities clear: Make the program run correctly before worrying about attractive output, speed running, and nonessential process. As you work, update the list of variables and their purposes. You must know if you have used a variable previously,

and if you have defined it in the housekeeping section in a manner that currently makes it an inappropriate choice. (If you want to use a single-precision variable, you must know if you have previously defined it as an integer or a string variable.)

Subprogram 3 is based on the following formula:

$$M = \frac{PI/1200}{1 - 1/(1 + 1/1200)^{12N}}$$

in which M is the monthly payment, P is the principal of the land contract, I is the interest rate in percent, and N is the length of the mortgage in years.

Accustom yourself to writing and reading code without any spaces between characters. Spaces waste memory and room on the video screen. You can get used to reading packed programs and the increased efficiency is worth it! Avoid multiple statement lines during the first coding because they make additions and editing difficult. Also, if you ever find yourself coding a repetitive, endless series of steps, stop! Get advice from a more experienced Basic programmer who may know a way to accomplish the task more efficiently.

Debug each subprogram as it is written. Run it with appropriate input and be sure the output is exactly correct (see Fig. 3). Take nothing for granted. Computer outputs look so credible that it is easy to believe that the results must surely be correct. However, computers make mistakes more quickly than any other human contrivance! Use the highest and lowest expected values to be sure the program can handle them. Put the program through every imaginable test. At this stage you will appreciate having kept everything as simple as possible. After the fundamental program runs satisfactorily, be assured that you have accomplished the most difficult part of your task.

Last Step

The final step for good program design is to code and debug the completed program (see Program Listing 2). Modify the fundamental program to decrease the running time, increase accuracy, improve the video display and line-printer output, and make the final result exactly what you stated in step one. Carefully debug each feature you add as it is written, otherwise a formidable task lies ahead!

I expanded the housekeeping section from the lone, but important, remark statement of the fundamental program. CLEAR 100 reserves 100 bytes

WEERSING/GREEN Land Contract
25500 less 5000 down = 20500 initial principal at 11% interest
Payment of 350 due each month on 7th

Month	Monthly interest	Principal reduced	New principal	Interest to date
1	187.92	162.08	20337.92	187.92
2	186.43	163.57	20174.35	374.35
3	184.93	165.07	20009.28	559.28
4	183.42	166.58	19842.70	742.70
5	181.89	168.11	19674.59	924.59
•	•	•	•	•
79	19.75	330.25	1824.18	8974.18
80	16.72	333.28	1490.90	8990.90
81	13.67	336.33	1154.57	9004.57
82	10.58	339.42	815.15	9015.15
83	7.47	342.53	742.62	9022.62
84	4.33	345.67	126.95	9026.95

Final payment of 128.11 next month
Total interest on land contract will = 9028.11

Fig. 4. Final Payment Schedule

computation that is required for each step in every subprogram. The output may be the desired end product, or it may be data that will be input once more for further computer process.

Study Fig. 2, which shows pseudocoding of the land contract program. Particularly note these important features:

- The pseudocoding for each subprogram is short. You have to consider only a small portion at a time.

- The format of the outline leads you to work as a computer does: input, process, and output.

- Each variable is defined accurately when first introduced. Keep a separate list of variables (Fig. 5) to avoid confusion when you later assign variable names in other subprograms.

- Any helpful notes are included at the bottom of each subprogram.

- The outline contains only the essentials; all unnecessary features are left

out. This helps prevent errors that are difficult to find and correct.

Coding this plan will be easy, checking it will be easy. After the initially coded program is functioning perfectly, you will have ample opportunity to flesh out the program to make it run more quickly and accurately, and to produce an attractive output on screen and paper.

Prior to the actual coding, rewrite any of the preceding three steps you think necessary. This is important. The extra time you take to think through each subprogram will be amply repaid when coding and debugging your program. (Debugging a program means finding and fixing any errors in it. Debugging a program can often take longer than writing it!) Do not hesitate to rewrite and edit your work if you can think of any improvements.

Debugging can be relatively painless if you split programs into subprograms, with each procedure of each subprogram divided into the three components of computer process: input, process, and output. Keep your outlines as simple as possible. Fancy output should follow the development of a working program, not precede it.

Step Four

After you are satisfied with your preceding work, write the fundamental program in Basic (see Program Listing 1). Assign line numbers 1-999 for housekeeping, 1000-1999 for the menu, 2000-2999 for subprogram one, 3000-3999 for subprogram two, 4000-4999 for the option to print, and 5000 on for subprogram three. To accommodate later refinements and addi-

```

INPUT TOTAL AMOUNT? 25500
INPUT DOWN PAYMENT? 5000
INPUT % INTEREST? 11
INPUT MONTHLY PAYMENT? 350
INPUT 1 TO FIGURE NUMBER MONTHS
INPUT 2 TO FIGURE DETAILS AND PRINT
INPUT 3 TO FIGURE MONTHLY PAYMENT
?1
  85 MONTHS TO RUN
INPUT 1 TO FIGURE NUMBER MONTHS
INPUT 2 TO FIGURE DETAILS AND PRINT
INPUT 3 TO FIGURE MONTHLY PAYMENT
?2

```

1	187.917	162.083	20337.9	187.917
2	186.431	163.569	20174.3	374.348
3	184.932	165.068	20009.3	559.279
4	183.418	166.582	19842.7	742.698
5	181.891	168.109	19674.6	924.589
6	180.35	169.65	19504.9	1104.94
•	•	•	•	•
79	19.7488	330.251	1824.16	8974.17
80	16.7215	333.279	1490.88	8990.89
81	3.6664	336.334	1154.55	9004.55
82	10.5834	339.417	815.135	9015.14
83	7.47207	342.528	472.607	9022.61
84	4.33223	345.668	126.939	9026.94

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Fig. 3. Run of Fundamental Programs

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for string use. (Fifty bytes are automatically reserved, but more are needed because of line 520.) All numeric variables beginning with X are defined as integers. C\$ and M\$ are field specifiers for Print Using statements. Your program may also need housekeeping chores such as dimensioning arrays or defining integral, single, and double precision of other variables. In long programs, define integers for use in For . . . Next loops for faster program execution, unless you require greater precision. Strings may also need to be defined.

You may need to define commonly used values with variables (instead of repeatedly using constants), because it takes less time to access a variable than to convert a constant to floating point representation. Define the most commonly used variables first so they are at the top of the variable table list, because the computer searches the table from top to bottom to find the variable.

You may need to initiate an On Error GOTO statement, or to code Read . . . Data statements, or to enable the use of machine-language subroutines through the DEFUSR function.

Use the list of variables (see Fig. 5) to

Program Listing 1. Fundamental Program

```

10 'LANDCONT/BAS, 11/18/81, by Spencer Weersing. Land Contracts
500 GOTO900' * * * * * Subroutines 500-899
510 P=OP:MT=0:X=0:RETURN' restores input 2060 4010 5060
600 RETURN' future LPRINT 3070
610 RETURN' future LPRINT 3080
900 ' * * * * * input for subprograms
910 INPUT"Input total amount";TA
920 INPUT"Input down payment";D:P=TA-D:OP=P' orig principal
930 INPUT"Input % interest";I:I=I/100' decimal form
940 INPUT"Input monthly payment";MP
1000 ' * * * * * * * * * * menu
1010 PRINT"Input 1 to figure number months"
1020 PRINT"Input 2 to figure details and print"
1030 PRINT"Input 3 to figure monthly payment"
1040 INPUTX1:ONX1GOTO2000,3000,5000
2000 ' * * * * * * * * * * subprogram 1
2010 X=X+1' number of month
2020 MI=P*I/12' amt for interest
2030 IFMP<MIPRINT"Won't work!":STOP
2040 MR=MP-MI' amt reducing principal
2050 P=P-MR' new principal
2060 IFP<=0PRINTX"months to run":GOSUB510;GOTO1000
2070 GOTO2010
3000 ' * * * * * * * * * * subprogram 2
3010 X=X+1
3020 MI=P*I/12
3030 MR=MP-MI
3040 P=P-MR
3060 MT=MT+MI' total interest to date
3070 PRINTX;MI,MR,P,MT:IFFL=1GOSUB600' FLag for LPRINT option
3080 IFP<=0MPPRINT"Pay"P+P*I/12"next month; total interest to date
will ="MT+P*I/12:IFFL=1GOSUB610:ENDELSE4000
3090 GOTO3010
4000 ' * * * * * * * * * * LPRINT option
4010 INPUT"Print, Y or N";X$:IFX$="Y"THENFL=1:GOSUB510;GOTO3000
4020 END
5000 ' * * * * * * * * * * subprogram 3

```

Listing 1 continues

Gold Plug 80—E.A.P. Company
P.O. Box 14 Keller, TX 76248
817-498-4242

~216

A hhhh, instant relief! At last there is a permanent cure for contact oxidation on Model I edge connectors. Many TRS-80 users are familiar with the symptoms: untimely resets, spontaneous reboots, or the inability to get the computer started at all without a frustrating session with a pink eraser.

The Gold Plug 80 is a well made device consisting of an edge-card plug with gold plated contacts, available with either 34 or 40 contacts. The rear of the plug has ter-

minial tabs which fit exactly over the existing foil fingers on the TRS-80's connectors. After installation, the original plugs have been extended about a half inch, meaning that the plastic door covers no longer fit. This did not trouble me, but you should take it into consideration. E.A.P.'s advertising leaflet, by the way, cautions you about the doors, which is refreshing. They also have the excellent policy of permitting you to return any plugs ordered for a refund if after seeing them you are un-

willing to undertake the installation.

An excellent set of instructions accompany the plugs, and they are shipped promptly. I ordered mine by mail on a Monday and received my set of plugs by first class mail on Tuesday of the next week.

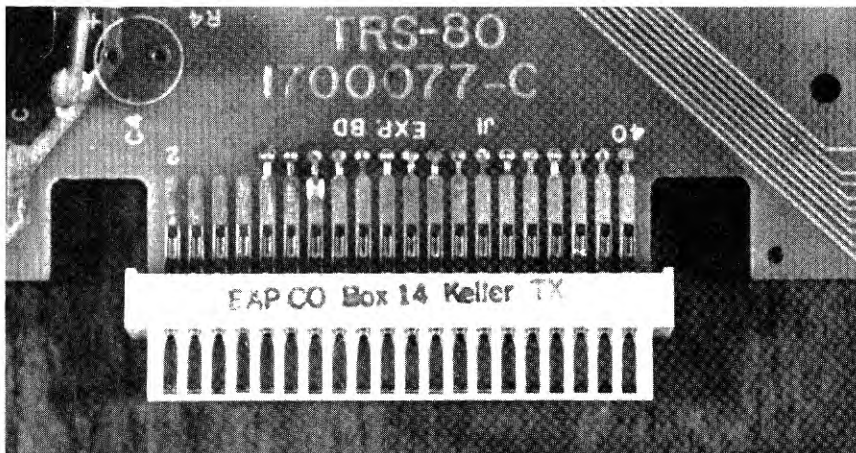
Installation

Installation requires a soldering iron (I use a 40-watt Weller), Rosin-core solder, a Phillips screwdriver, and your last Pink Pearl. The keyboard and Expansion Interface have to be disassembled to get at the connectors, which are then cleaned—the eraser's last fling. The Gold Plug 80 is fitted over the existing plug with the contacts centered, and then soldered to the board. I have some soldering experience, but it proved to be an easy, safe job. The contact is heated, a very small amount of solder applied, and then you go on to the next contact. It took about an hour to do all six plugs.

If you are a little nervous about this kind of work, note that all the contacts on the underside of the RS-232 output connector are grounded—that is, they are all connected. Start there; you can do no harm and the practice will be helpful.

The Gold Plug 80 set I bought included all six plugs. The plugs are available individually for \$9.95, or you can get a pair for the keyboard to Expansion Interface cable for \$18.95.

As I said earlier, I did resolder every connector on the machine, and I haven't had a single unwanted reset since. ■



The Gold Plug 80

ADVERTISEMENT

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```

5010 INPUT"Input term in years";N:X2=N*12'      X2=term in mos
5020 I=I*100'                                    % form
5030 Y=P*I/1200;Z=(1+I/1200)[(12*N):MP=Y/(1-1/Z)'  MP formula
5040 PRINT"Monthly payments =";PRNTPMP
5050 MP=INT(MP*100+.5)/100'                      round to .01
5060 I=I/100;GOSUB510;GOTO1000'decimal form, restore, goto menu

```

Program Listing 2. Completed Program

```

10 'LANDCONT/BAS, 11/30/81, by Spencer Weersing. Land contracts
100 ' * * * * * * * * * * * * * * * * * * * * * * * * * * * *
110 CLEAR100'                                    bytes for strings
120 DEFINTX:C$="#####.##":M$="###"            format LPRINTUSING
130 CLS:PRINT"Land Contract Schedule":GOSUB520
500 GOTO900' * * * * * * * * * * * * * * * * * * * * * * * *
510 P=IP:QT=0:X=0:F1=0:RETURN' restores input 2060 4010 5060
520 PRINTSTRINGS(64,"-");RETURN'                130 3070
530 LPRINTSTRINGS(43,"-"):LPRINT:RETURN'        640 660
540 T#=P:DEFDBLP:P=T#:RETURN' converts P to dbl prec 3016
550 T!=P:DEFSNGP:P=T!:RETURN' converts P to sng prec 3018
560 T##=QT:DEFDBLQ:QT=T#:RETURN' converts Q to dbl prec 3046
600 CLS:INPUT"Input name/name of parties involved";A$' check
610 INPUT"Input day each month that payment is due";B$
620 PRINT"Beginning principal =";:PRINTUSINGC$;P
622 PRINT"Interest rate in % =";:PRINTUSINGC$;I*100
624 PRINT"Monthly payment =";:PRINTUSINGC$;MP
625 IFX2=0THEN628' if MP not yet figured
626 IFX2<>0PRINT"Term of contract =";:PRINTINT(X2/12)"years,"
X2=INT(X2/12)*12'months
628 PRINT:INPUT"Is all this correct, Y or N";X$:IFX$="N"RETURN
630 LPRINTAS"Land Contract":LPRINTTA"less"D"down ="P"initial pr
   incial":RETURN' begin LPRINT if input O.K. 3006
640 GOSUB530:LPRINT"Payment of"MP"due each month on "B$:GOSUB530
:LPRINT" Monthly Principal New Interest":LPRINT"Mon
Interest Reduced Principal To date":LPRINT"---
-----":RETURN' 3008
650 LPRINTUSINGM$;X;:LPRINTUSINGC$;MI;MR;P;QT:RETURN' 3060
660 LPRINT"Final payment of";:LPRINTUSINGC$;P+P*I/12;:LPRINT" ne
xt month.":LPRINT"Total interest on land contract will =";:LPRIN
TUSINGC$;QT+P*I/12;GOSUB530:RETURN' 3070
900 ' * * * * * * * * * * * * * * * * * * * * * * * *
910 INPUT"Input total amount";TA
920 INPUT"Input down payment";D:P=TA-D:IP=P' initial principal
930 INPUT"Input % interest";I:I=I/100' decimal form
940 PRINT"Input monthly payment"
950 INPUT"(if monthly payment is to be figured, input 0)";MP:IFM
P=0THEN5000
1000 ' * * * * * * * * * * * * * * * * * * * * * * * *
1010 PRINT:PRINT"Input 1 to calculate term in months"
1020 PRINT"Input 2 to video print a payment schedule"
1025 PRINT"Input 3 to video print and line print schedule"
1030 PRINT"Input 4 to figure monthly payment, given term"
1040 INPUTX1:ONX1GOTO2000,3000,2090,5000
2000 ' * * * * * * * * * * * * * * * * * * * * * * * *
2010 X=X+1' number of month
2020 MI=P*I/12' amt for interest
2030 IFMP<MIPRINT"Down payment and/or monthly payment must be in
creased":GOTO900' return for different input
2040 MR=MP-MI' amt reducing principal
2050 P=P-MR' new principal
2060 IFP<=0PRINTX;"months total to fulfill contract":GOSUB510;GO
TO1000
2070 GOTO2010' next month
2090 FL=1' FFlag for LPRINT option
3000 ' * * * * * * * * * * * * * * * * * * * * * * * *
3006 IFFL=1GOSUB600:IFX$="N"GO900' subprogram 2
3008 GOSUB520:PRINT"Payment of"MP"due each month on ";B$:GOSUB52
0:PRINT" Monthly Principal New Interest":PRINT"Mon
Interest Reduced Principal To date":PRINT"---
-----"
-----":IFFL=1GOSUB640
3010 X=X+1
3012 IFP1=2THEN3020' P < 6 sig figs, no check req
3014 IFP1=1THEN3018' P is dbl prec, is sng req?
3016 IFP>=10000THENF1=1;GOSUB540' check if P over 6 sig figs
3018 IFP<=10000THENF1=2;GOSUB550' check if P under 6 sig figs
3020 P2=P*I/12:P2=INT(P2*100+.5)/100;MI=P2' rounds # to .01
3030 MR=MP-MI
3040 P=P-MR' same as subprogram 1
3044 IFP2=1THEN3050
3046 IFQT>=10000THENF2=1;GOSUB560' check if QT over 6 sig figs
3050 QT=QT+MI' QT=total interest to date
3060 PRINTUSINGM$;X;:PRINTUSINGC$;MI;MR;P;QT:IFFL=1GOSUB650
3070 IFP<=MPPRINT"Final payment of";:PRINTUSINGC$;P+P*I/12;:PRIN

```

Listing 2 continues

carefully name the variables so that their functions are suggested. QT replaces MT to allow defining it as double precision without affecting the other variables beginning with M. Lines 620-628 allow you to verify that all input is correct before printing the payment schedule. I added line 1025 to allow the print option without first running through Subprogram 2, because that can take a long time when term is, for example, 25 years. Flags F1 and F2 avoid unnecessary branching to subroutines.

A Few More Points

When checking your program, note if you require accuracy greater than six significant figures. If so, you will need double-precision values, but double-precision calculations consume so much memory and take so long that

"Double-precision calculations consume so much memory and take so long that you should use them only when required."

you should use them only when required. Subprogram 2 has an instruction to examine the two variables (P and QT) that may involve more than six significant figures and switch them from single to double precision as needed. As the program runs you can easily tell by the speed of the output whether the calculation involves double precision or not.

Accuracy in calculations involving money requires that the result be rounded to \$0.01 following multiplication or division in order to remove trailing digits before addition or subtraction. Two calculations need this procedure in LANDCONT/BAS—in lines 3020 and 5030. The results of the calculations are immediately rounded to maintain the current degree of precision and trailing digits are removed.

During debugging procedures, check the accuracy of results. There is an easy way to do this: Temporarily define all variables to double precision (DEFDBLA-Z), and then redefine any variable as integral or single precision if you must. (For example, For . . . Next loops cannot work if the variable following For is a double-precision variable.) Use a double-precision type declaration (#) on all constants. Now run your program. It will take a long

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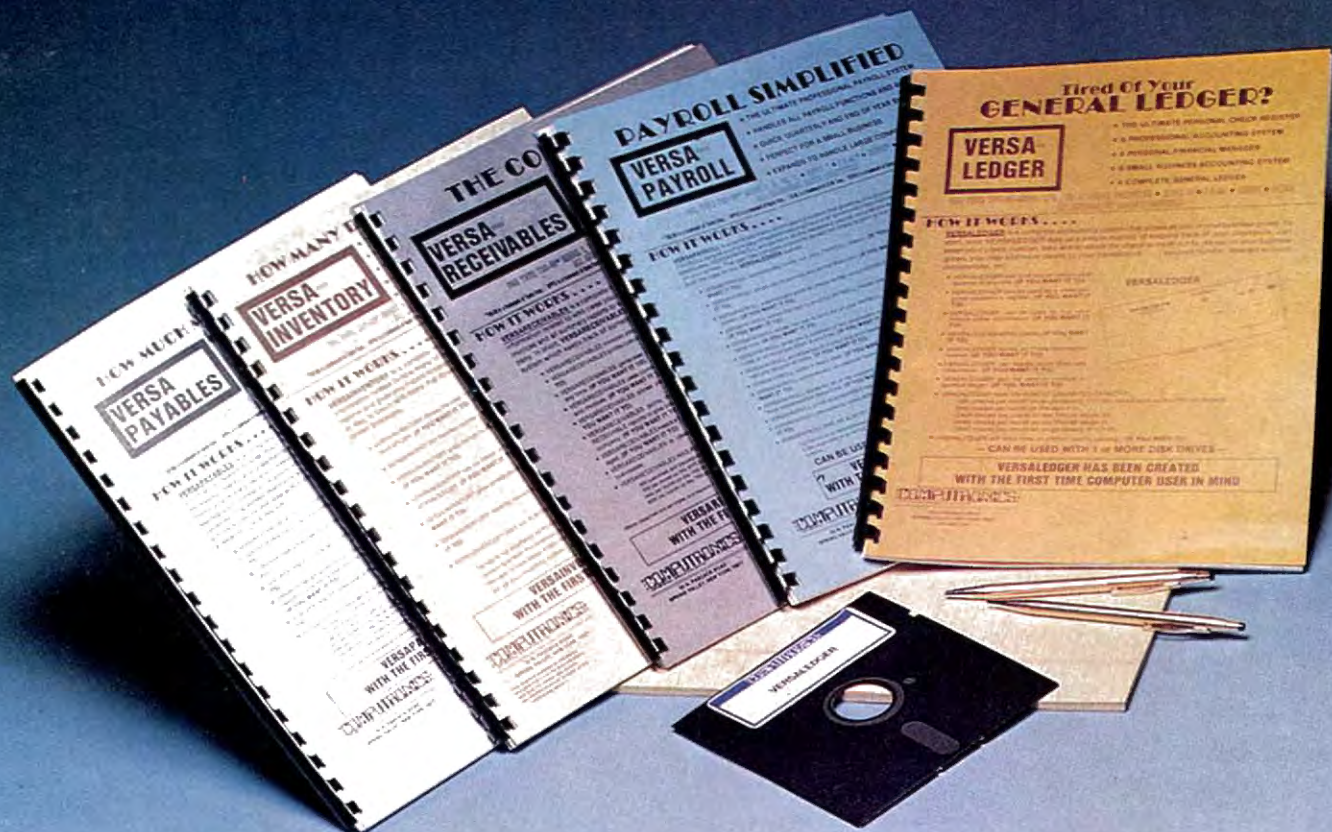
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```

T* next month.:PRINT"Total interest on land contract will =";:P
RINTUSINGCS;QT+P*I/12:GOSUB520:IFFL=1GOSUB660:ENDELSE4000
3000 GOTO3010'                                     next month
4000 ' * * * * * * * * * * * * * * * * * * * * * * * * * * * *
4010 INPUT"Lineprint this, Y or N";X$:IFX$="Y"THENFL=1:FL=0:P2=0
:GOSUB510:GOTO3006'                               FLag for LPRINT option
4020 END
5000 ' * * * * * * * * * * * * * * * * * * * * * * * * * * * *
                                         subprogram 3

5010 INPUT"Input term in years";N:X2=N*12' term in yrs and mos
5020 I=I*100' interest in decimal form
5030 Y=P*I/1200:Z=(1+I/1200)[(12*N):MP=Y/(1-1/Z)' MP by formula
5040 PRINT"Monthly payments =";:PRINTUSINGCS;MP
5050 MP=INT(MP*100+.5)/100' round to .01
5060 I=I/100:GOSUB510:GOTO1000'decimal form: restore: goto menu

```

time to execute, but you may compare the results to those previously derived to verify accuracy.

The results of calculations will have the same degree of precision as the most precise operand. Precision is limited by the type declaration of the variable that stores the result. Constants that contain an arithmetic expression (e.g. 1/3) are single precision—accurate to seven significant digits stored, and six displayed or printed. If a single-precision constant is stored in a double-precision variable, the digits following the seventh will be meaningless. You can prevent this by using the double-precision type declaration sign # (1/3# rather than 1/3).

Converting to double precision from single must be done with care because only the first seven digits will be accurate, fewer if the single-precision number contained fewer.

Double-precision values are stored with 17 significant digits, and displayed or printed with 16. (For further information see the reference manual for Level II Basic.)

With the help of Fig. 5, the list of variables, and the remark statements that are added to most of the lines in the completed program, you should understand the purpose of each line of the program.

Debug your program carefully following each modification or addition.

AS	string variable, names of parties
BS	string variable, monthly payment due date
CS	specifies field for PRINTUSING statement
D	down payment
FL	flag: GOTO LPRINT subroutine
F1	flag: is P six significant figures or not
F2	flag: is QT six significant figures or not
I	interest rate: 1/100 is decimal form, I*100 returns it to %
IP	initial principal
MI	amount of monthly payment that pays interest
MP	monthly payment
MR	amount of monthly payment that reduces principal
MT	total MI to date (fundamental program only)
MS	specifies field for PRINTUSING statement
N	term in years
P	principal
P2	temporary MI, allows either double or single precision
QT	total MI to date (allows double precision)
TA	total amount
T!	temporary variable, single precision
T#	temporary variable, double precision
X	number of current month
X1	variable integer
X2	term in months
Y	intermediate for MP formula
Z	intermediate for MP formula

formula for subprogram 3:

$$M = \frac{PI/1200}{1 - 1/(1 + I/1200)^{12N}}$$

Fig. 5. Variable List

Contrast Figs. 4 and 5. Particularly note the difference that using double precision makes as well as the appearance of the output.

The five steps are complete; your program is written and debugged. After everything has been satisfactorily accomplished, place a printout of your completed program, including the remark statements, in your reference library. Also, include your other work: the statement of purpose, the organizational chart, the pseudocoded outline, the fundamental program, the list of variables, and any helpful notes you have made. When a question concerning the program arises in the future, or a modification is desirable, it will be easy to recall necessary details by referring to these records.

You may elect to pack the program by eliminating remark statements and by further use of multiple-statement lines. You may use commercial software utilities, or if you have a disk drive and Scripsit, try this excellent method. Save your program in ASCII format (SAVE "LANDCONT/BAS",A) and then load it into Scripsit for easy editing (move blocks of program text, change line numbers, eliminate line numbers by use of multiple-statement lines, and use the global search and replace function to change, for example, Print to LPRINT or the name of a variable throughout the program). When editing is complete save the text in ASCII format again (S,A LANDCONT/BAS) to allow access to the file via Disk Basic. Begin each new line with a line number, and do not leave format instructions in the text or the file will not load. You will get a "Direct Statement in File" error message instead.

Basic

Basic is an acronym for Beginner's All-purpose Symbolic Instruction Code, but do not be deceived by the term "Beginner's" in its name. Basic is a powerful and sophisticated computer language that is appropriately used for a truly amazing variety of purposes. Use it to write individual programs to satisfy your specific needs. Program design and writing is rewarding and enjoyable. With good design procedures you will find it is true in programming as well as in traveling, "Getting there is half the fun!" ■

Spencer Weersing practices dentistry. He can be reached at the Professional Building, Montague, MI 49473.

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NAME	DESCRIPTION
1 RULE78	Interest Apportionment by Rule of the 78's
2 ANNU1	Annuity computation program
3 DATE	Time between dates
4 DAYYEAR	Day of year a particular date falls on
5 LEASEINT	Interest rate on lease
6 BREAKEVN	Breakeven analysis
7 DEPRSL	Straightline depreciation
8 DEPRSY	Sum of the digits depreciation
9 DEPRDB	Declining balance depreciation
10 DEPRDDB	Double declining balance depreciation
11 TAXDEP	Cash flow vs. depreciation tables
12 CHECK2	Prints NEBS checks along with daily register
13 CHECKBK1	Checkbook maintenance program
14 MORTGAGE/A	Mortgage amortization table
15 MULTMON	Computes time needed for money to double, triple, etc.
16 SALVAGE	Determines salvage value of an investment
17 RRVARIN	Rate of return on investment with variable inflows
18 RRCONST	Rate of return on investment with constant inflows
19 EFFECT	Effective interest rate of a loan
20 FVAL	Future value of an investment (compound interest)
21 PVAL	Present value of a future amount
22 LOANPAY	Amount of payment on a loan
23 REGWITH	Equal withdrawals from investment to leave 0 over
24 SIMPDISK	Simple discount analysis
25 DATEVAL	Equivalent & nonequivalent dated values for oblig.
26 ANNUDEF	Present value of deferred annuities
27 MARKUP	% Markup analysis for items
28 SINKFUND	Sinking fund amortization program
29 BONDVAL	Value of a bond
30 DEplete	Depletion analysis
31 BLACKSH	Black Scholes options analysis
32 STOCVAL1	Expected return on stock via discounts dividends
33 WARVAL	Value of a warrant
34 BONDVAL2	Value of a bond
35 EPSEST	Estimate of future earnings per share for company
36 BETAALPH	Computes alpha and beta variables for stock
37 SHARPE1	Portfolio selection model-i.e. what stocks to hold
38 OPTWRITE	Option writing computations
39 RTVAL	Value of a right
40 EXPVAL	Expected value analysis
41 BAYES	Bayesian decisions
42 VALPRINF	Value of perfect information
43 VALADINF	Value of additional information
44 UTILITY	Derives utility function
45 SIMPLEX	Linear programming solution by simplex method
46 TRANS	Transportation method for linear programming
47 EOQ	Economic order quantity inventory model
48 QUEUE1	Single server queueing (waiting line) model
49 CVP	Cost-volume-profit analysis
50 CONDPFROF	Conditional profit tables
51 OPTLOSS	Opportunity loss tables
52 FQJQOQ	Fixed quantity economic order quantity model
53 FQEOQWSH	As above but with shortages permitted
54 FQEOQFPB	As above but with quantity price breaks
55 QUEUECB	Cost-benefit waiting line analysis
56 NCFANAL	Net cash-flow analysis for simple investment
57 PROFIND	Profitability index of a project
58 CAP1	Cap. Asset Pr. Model analysis of project

59 WACC	Weighted average cost of capital
60 COMPBAL	True rate on loan with compensating bal. required
61 DISCBAL	True rate on discounted loan
62 MERGANAL	Merger analysis computations
63 FINRAT	Financial ratios for a firm
64 NPV	Net present value of project
65 PRINDLAS	Laspeyres price index
66 PRINDPA	Paasche price index
67 SEASIND	Constructs seasonal quantity indices for company
68 TIMETR	Time series analysis linear trend
69 TIMEMOV	Time series analysis moving average trend
70 FUPRINF	Future price estimation with inflation
71 MAILPAC	Mailing list system
72 LETWRT	Letter writing system-links with MAILPAC
73 SORT3	Sorts list of names
74 LABEL1	Shipping label maker
75 LABEL2	Name label maker
76 BUSBUD	DOME business bookkeeping system
77 TIMECLCK	Computes weeks total hours from timeclock info.
78 ACCTPAY	In memory accounts payable system-storage permitted
79 INVOICE	Generate invoice on screen and print on printer
80 INVENT2	In memory inventory control system
81 TELDIR	Computerized telephone directory
82 TIMUSAN	Time use analysis
83 ASSIGN	Use of assignment algorithm for optimal job assign.
84 ACCTREC	In memory accounts receivable system-storage ok
85 TERMSPAY	Compares 3 methods of repayment of loans
86 PAYNET	Computes gross pay required for given net
87 SELLPR	Computes selling price for given after tax amount
88 ARBCOMP	Arbitrage computations
89 DEPRSF	Sinking fund depreciation
90 UPSZONE	Finds UPS zones from zip code
91 ENVELOPE	Types envelope including return address
92 AUTOEXP	Automobile expense analysis
93 INFILE	Insurance policy file
94 PAYROLL2	In memory payroll system
95 DILANAL	Dilution analysis
96 LOANAFFD	Loan amount a borrower can afford
97 RENTPRCH	Purchase price for rental property
98 SALELEAS	Sale-leaseback analysis
99 RRCONVBD	Investor's rate of return on convertible bond
100 PORTVAL9	Stock market portfolio storage-valuation program

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by David Clapp

This method is usually used by mainframes to solve complex problems. Dr. Clapp gives a simple demonstration, so you can use it, too.

Linear programming is a powerful technique for analyzing decision problems. The technique has been in use for many years, although primarily for analysis of large-scale problems on large computers. While large computers are necessary for analyzing some linear programming problems, you can solve many complex problems using a simple algorithm on a microcomputer.

I will describe a simple linear programming routine that you can use to solve maximization and minimization problems. The size of the problem that may be solved is limited only by your microcomputer's memory. To enlarge the program's capacity, change only the dimension statement.

Linear Programming

Linear programming is a relatively complex mathematical procedure. I will explain the technique by reference to simple examples.

Consider the ABC Toy Company. This company (as with most) is interested in making a profit from its operations. Assume that ABC manufactures only two toys: xylophones and yoyos. For convenience, label the number of each produced in a production period as X and Y, respectively. To make the

maximum profit, ABC should make an infinite number of each toy, sell them, and accumulate an infinite amount of cash.

In reality, however, no company can make an unlimited number of anything. The availability of raw materials, production capacity of machines, storage space for produced products as well as investment capital all are examples of restrictions on total possible production. These restrictions are called constraints in a linear programming problem. The goal of linear programming is to allocate limited resources to production in order to maximize profit.

For the ABC problem, I have built some simple, arbitrary constraints. For example, assume that only two machines are used in production (machine A and machine B). The number of production hours on each machine is limited by hours in the day as well as by skilled operator time.

For our example, assume that machine A is available only for 1,000 hours per production period (per week, for example) and machine B is available for 800 hours per period. It takes twice as long to produce a xylophone than a yoyo on machine A, while it requires equal time for each toy on machine B. These production restrictions can be expressed mathematically as:

$$\begin{aligned} 2X + Y &\leq 1000 \\ X + Y &\leq 800 \end{aligned}$$

The expressions above are called inequalities since production can be any

value up to and equal to the hours available. Making these expressions inequalities allows a wide variation of possible solutions. If they are equalities (e.g., $2X + Y = 1000$), all available hours on machine A must be used. Clearly, the inequalities make more sense since it may be more economical not to use all of the machine capacity available.

As additional simple constraints on this problem, we have specified that no more than 400 xylophones or 700 yoyos can be made in any production period. This type of constraint could be the result of expected sales, available raw materials, or available investment capital. These constraints may also be expressed mathematically as $X \leq 400$ and $Y \leq 700$.

Again, the inequalities make sense since we may decide to produce up to the limit, but still at some lower level.

Finally, we must express the objective of our decision problem—to make the most money. This expression, called the objective function, is expressed mathematically as:

$$\text{Maximize } Z = 0.4X + 0.3Y$$

This expression reflects the selling price of each toy (40 cents for xylophones and 30 cents for yoyos), and our purpose (to maximize). Thus, Z can be any value depending on how many toys we make. If we make ten of each toy then Z equals \$7; hence, the objective function expresses the value of each possible solution in dollars. We wish this to be the greatest amount possible, subject to the constraints.

The decision problem described so far can be summarized as:

$$\begin{aligned} \text{Maximize } Z &= 0.4X + 0.3Y \\ \text{subject to:} \\ 2X + Y &\leq 1000 \\ X + Y &\leq 800 \\ X &\leq 400 \\ Y &\leq 700 \end{aligned}$$

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The only solutions we are interested in have positive variable values (we cannot manufacture a negative number) and integer or whole number solutions (we cannot manufacture fractions of yoyos or xylophones).

Regarding the integer constraints, it so happens that all the solutions of interest in this problem are whole numbers, or integers. This is not always the case. If non-integer solutions did exist, an integer programming algorithm would be required. In many linear programming problems, non-integer solutions are perfectly acceptable (see the nutrition example I will give later).

The easiest way to visualize the ABC Toy solution is with a graph. Figure 1 shows a plot of the constraints for this problem. Note that the constraints are simply straight lines on the graph relating numbers of X we can make to numbers of Y. All solutions must be within the dotted lines (called the feasible region) to satisfy the problem's constraints.

The objective function is not a single line, but a "family" of lines depending on the value of Z. Two typical values of the objective function are plotted (for Z equals \$120 and Z equals \$240) as solid lines on the graph. These are called "iso-profit" lines, since the profit (Z) is the same at any point along the line. For the Z-equals-\$120 line, the profit is \$120 at either end (X equals 0 and Y equals 400 or X equals 300 and Y equals 0) and at any point between.

You can make several important observations by looking at the objective function lines. First, the value of Z increases as the lines move away from the origin (the 0,0 point). Also, the best solutions occur only at corners of the feasible region.

This is the key to the linear programming algorithm—the best solutions occur at corners. We want to move the objective function line as far from the origin as possible (getting larger values of Z, or profit) and still just barely touch the feasible region. Clearly, this can only happen at corners. Imagine a ruler parallel to the sketched objective function lines. This ruler is moved out as far as possible, remaining parallel to the plotted lines, to achieve the highest Z. The best solution must be at a corner and not at any interior point.

Looking at the sketch, there are six possible solutions or corners to choose from. These are in Table 1. The solution (4) produces a profit of \$260, yet remains within the constraints of the problem. You can see this solution by

moving the imaginary ruler from the origin. Point 4 is the furthest the ruler can travel parallel to the sketched objective function lines and still touch the feasible region.

The fact that the solutions to the

problem must occur at corners suggests the mathematical method to solve this problem. Corners in the graph are intersections of lines, or simultaneous solutions to linear equations. For example, point 4 is the solution to the

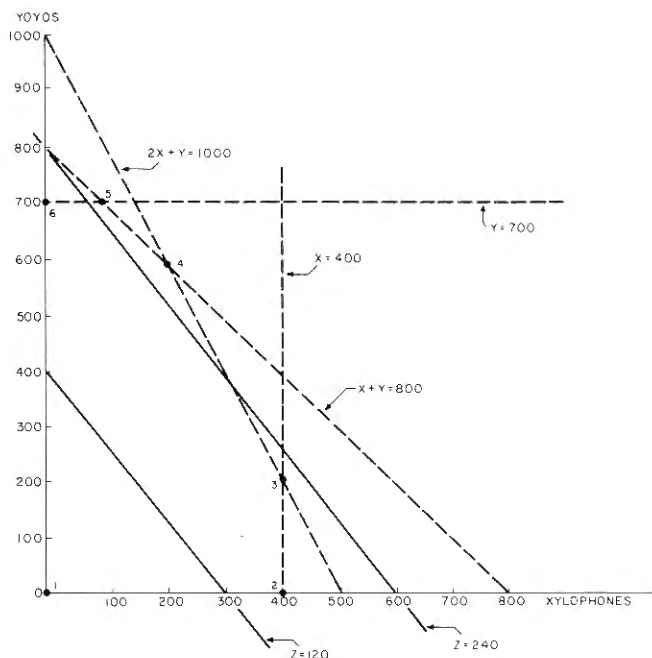


Figure 1

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equations:

$$\begin{aligned} 2X + Y &= 1000 \\ X + Y &= 800 \end{aligned}$$

You can solve these equations algebraically and find the solution X equals 200 and Y equals 600, which we confirmed graphically earlier (for which Z equals \$260).

The purpose of linear programming, then, is to find solutions of systems of linear equations or find solutions at each corner of the feasible region. The linear programming algorithm achieves this logically by moving from one corner to the next until it finds the highest value of Z.

The first step in setting up a linear programming problem is defining the objective function and constraints for the decision problem under study. In our ABC problem, we have already completed this step. The second step is

to convert the inequalities to equations:

$$\begin{aligned} 2X + Y + M &= 1000 \\ X + Y + N &= 800 \\ X + O &= 400 \\ Y + P &= 700 \end{aligned}$$

Note the slack variables M, N, O, and P, aptly named since they take up the slack in converting the inequalities to equalities. (We must do this because there is no algebraic way to solve inequalities.) In the final solution the slack variables express the amount of

unused resource. For our optimal solution of X equals 200 and Y equals 600 there is no slack in the first two constraints (or M and N equal zero); however, there is slack in the last two constraints since we are not making 400 xylophones or 700 yoyos. In the final solution, O equals 200 and P equals 100. The meaning of slack variables should become clearer as we move on.

The equations are difficult to solve algebraically. We can only solve systems of equations where the number of

1. Make no toys profit = \$0
2. Make 400 xylophones profit = \$160
3. Make 200 yoyos, 400 xylophones profit = \$220
4. Make 600 yoyos, 200 xylophones profit = \$260
5. Make 700 yoyos, 100 xylophones profit = \$250
6. Make 700 yoyos profit = \$210

Table 1

```

10 CLEAR 500
20 DEF: SNG A-Z
30 DIM D(20,20),P(20),IV(20),SC(20)
40 CLS
50 PRINT TAB(23) "LINEAR PROGRAMMING"
60 PRINT
70 REM ENTER DATA BY APPENDING DATA STATEMENTS TO THIS PROGRAM
80 REM 1ST DATA STMT CONTAINS NUMBER OF ROW, NUMBER OF COLUMNS, AND NUMBER OF
  F REAL (ACTUAL DECISION) VARIABLES IN THE PROBLEM
90 REM 2ND DATA STMT CONTAINS COEFFICIENTS OF OBJECTIVE FUNCTION
100 REM REMAINING DATA STMTS CONTAIN COEFFICIENTS OF EACH ROW IN THE INITIAL
  TABLEAU INCLUDING RHS. A SIMPLE EXAMPLE IS INCLUDED WITH THIS LISTING
110 READ IW,IZ,IY
120 IX=IZ-1
130 INPUT "DO YOU WISH SUCCESSIVE TABLEAUX PRINTED (YES/NO)";IBS
140 FOR M=1 TO IX
150 READ P(M)
160 NEXT M
170 FOR M=1 TO IW
180 FOR N=1 TO IZ
190 READ D(M,N)
200 NEXT N
210 NEXT M
220 INPUT "DO YOU WANT OUTPUT TO GO TO THE PRINTER (YES/NO)";POS
230 IF LEFT$(POS,1)="Y" OR LEFT$(POS,1)="y" THEN PO=1
240 IF PO=1 THEN PRINT "PRINTING...";A1=PEEK(16414);A2=PEEK(16415);POKE 1641
  4,PEEK(16422);POKE 16415,PEEK(16423)
250 PRINT " "
260 PRINT "THE INITIAL TABLEAU IS:"
270 FOR N=1 TO IX
280 PRINT USING "*****";N;
290 NEXT N
300 PRINT
310 FOR M=1 TO IX
320 PRINT USING "*****";P(M);
330 NEXT M
340 PRINT
350 FOR M=1 TO IW
360 FOR N=1 TO IZ
370 PRINT USING "*****";D(M,N);
380 NEXT N
390 PRINT
400 NEXT M
410 FOR N=IY TO IX
420 FOR L=1 TO IW
430 IF D(L,N) = 1 THEN 460
440 NEXT L
450 GOTO 470
460 IV(L)=N
470 NEXT N
480 Z=0
490 FOR M=1 TO IW
500 IM=IV(M)
510 Z=Z+D(M,IZ)*P(IM)
520 NEXT M
530 NP=1
540 SX=0
550 FOR N=1 TO IX
560 FOR I=1 TO IW
570 IF N=IV(I) THEN 680
580 NEXT I
590 SM=0
600 FOR I=1 TO IW
610 J=IV(I)
620 SM=SM+P(J)*D(I,N)
630 NEXT I
640 SC(N)=SM-P(N)
650 IF SC(N)>SX THEN 680
660 SX=SC(N)
670 IC=N
680 NEXT N
690 FOR M=1 TO IW
700 IM=IV(M)
710 SC(IM)=0
720 NEXT M
730 IF LEFT$(IBS,1)<>"Y" AND LEFT$(IBS,1)<>"y" THEN 920
740 PRINT " "
750 PRINT "TABLEAU NO. ";NP
760 FOR N=1 TO IX
770 PRINT USING "*****";N;
780 NEXT N
790 PRINT
800 FOR M=1 TO IW
810 FOR N=1 TO IZ
820 PRINT USING "*****";D(M,N);
830 NEXT N
840 PRINT
850 NEXT M
860 FOR J=1 TO IX
870 PRINT USING "*****";SC(J);
880 NEXT J
890 PRINT
900 PRINT "THE OBJECTIVE FUNCTION VALUE IS";Z
910 NP=NP+1
920 IF SX=0 THEN 1200
930 SV=999999
940 IR=-1
950 FOR M=1 TO IW
960 IF D(M,IC)<=0 THEN 1010
970 QU=D(M,IZ)/D(M,IC)
980 IF (QU-SV)>=0 THEN 1010
990 IR=M
1000 SV=QU
1010 NEXT M
1020 IF IR=-1 THEN PRINT "UNBOUNDED SOLUTION";GOTO 1270
1030 IV(IR)=IC
1040 DI=D(IR,IC)
1050 FOR N=1 TO IZ
1060 CK=D(IR,N)
1070 D(IR,N)=CK/DI
1080 NEXT N
1090 FOR M=1 TO IW
1100 IF M=IR THEN 1170
1110 CM=-D(M,IC)
1120 FOR N=1 TO IZ
1130 TM=D(IR,N)*CM
1140 SK=D(M,N)
1150 D(M,N)=SK+TM
1160 NEXT N
1170 NEXT M
1180 Z=Z-SV*SX
1190 GOTO 540
1200 PRINT " "
1210 PRINT "THE OPTIMAL TABLEAU IS:"
1220 FOR M=1 TO IW
1230 AS=RIGHT$(STR$(IV(M)),LEN(STR$(IV(M)))-1)
1240 PRINT "X("AS") = " USING "*****";D(M,IZ)
1250 NEXT M
1260 PRINT "THE OBJECTIVE FUNCTION VALUE IS";Z
1270 IF PO=1 THEN POKE 16414, A1 : POKE 16415, A2 : CLS
1280 END
1290 DATA 3,7,3
1300 DATA -2,-1,0,-100,-100,0
1310 DATA 3,1,0,1,0,0,3
1320 DATA 4,3,-1,0,1,0,6
1330 DATA 1,2,0,0,0,1,3

```

Program Listing

equations equals the number of unknowns. Above there are six unknowns and only four equations. The theory of linear programming suggests considering only m variables for solutions at any given time, where m is the number of equations. In our example, we want to have only four variables under consideration at a time so that we can calculate a unique solution with the four available equations. This set of variables is called the "basis."

An initial basis to start with would be to set the variables X and Y equal to zero and solve for the remaining four variables. Looking at the equations above, this particular solution is M equals 1000, N equals 800, O equals 400 and P equals 700. This solution is the "do nothing" alternative; we are making no toys and profit is \$0. Furthermore, all production is at slack levels: None of the resources are used at all. This solution corresponds to point 1 in the graph.

Obviously, we wish to make some toys. What variable should now come into the solution and which should go out (only four can be in the basis at any time)? We make more money from xylophones, so common sense suggests trying to make some X . Pivoting, the process of bringing the variable X into the solution and taking out another variable, is especially amenable to computer solution.

The Program

Following the simple instructions in the comment lines in the Program Listing, set up the data for this problem as:

```
1400 DATA 4,7,3
1410 DATA .4,3,0,0,0
1420 DATA 2,1,1,0,0,1000
1430 DATA 1,1,0,1,0,800
1440 DATA 1,0,0,0,1,0,400
1450 DATA 0,1,0,0,0,1,700
```

Merge this data with the program with the Basic Merge command or by typing the data statements into the program directly. You could easily modify the program to accept data via an Input command, but with a disk system and Merge you can rapidly input different sets of fairly complex data to the program.

The program will respond with the output shown in Fig. 2. The initial tableau simply places the input data in convenient columnar format. Check this data carefully with the statement of the problem. The objective function is displayed on the top row of the tableau. You can identify the current solution by locating the identity matrix.

The identity matrix is a set of columns of zeros and ones which looks like:

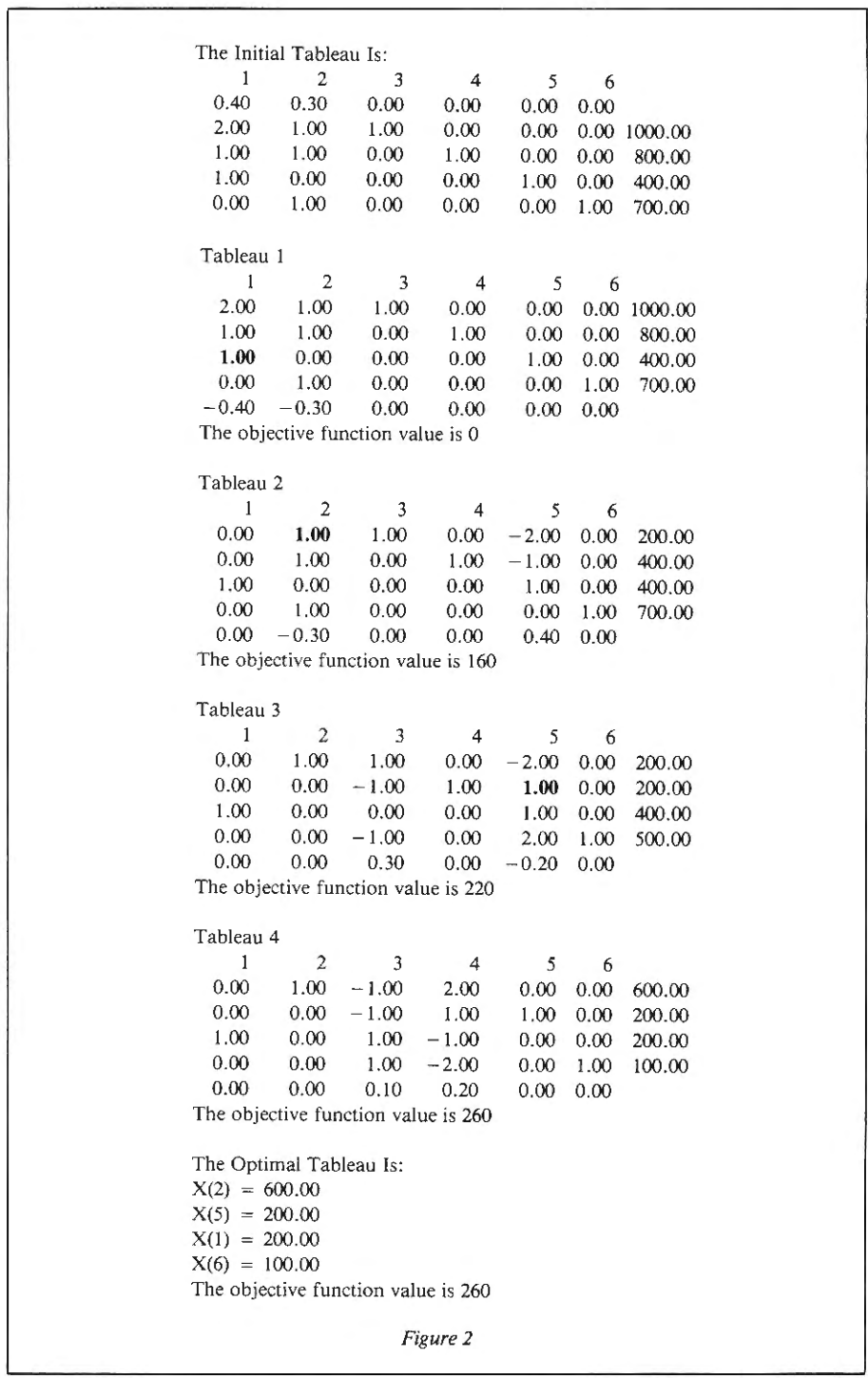
```
1 0 0 0
0 1 0 0
0 0 1 0
0 0 0 1
```

In the initial tableau, the identity matrix is the rightmost four columns under variable numbers 3, 4, 5 and 6, or the variables M , N , O and P . This corresponds to the solution in which we produce no toys.

The second tableau is identical to the first except the objective function has been arrayed on the bottom row with

negative signs. This prepares the analysis for selecting the first pivot point. This row is not always identical to the objective function row in the initial tableau; in minimization problems (as in the nutrition problem below), this row is quite different.

The selection of the pivot point requires only two checks. First, check for the most negative coefficient in the bottom row to identify the most promising incoming variable (xylophones, in our example). Next, check for the outgoing variable by forming a ratio of the right side over the coefficient in the pivot column, and choose the element



that produces the lowest ratio.

Examine Fig. 2 to identify the pivot point in Tableau 1. Look for the pivot in column 1 (xylophones) since -0.4 is the smallest coefficient. Next, form the ratios $1000/2$, $800/1$, and $400/1$. The smallest value is 400. The pivot point in tableau 1 is in bold type. When finding ratios, always ignore negative ratios or division by zero.

You are now ready to develop tableau 2. Your objective is to produce a column of zeros and a one under column 1 (that is, create a column of the identity matrix). The one must appear at the pivot point. By examining column 1 in tableau 2, you can see the desired column of zeros and a one. To obtain this column use the pivot row to eliminate variable one from all other rows in the tableau. Thus, to eliminate the one from row 2 in tableau 1, subtract the entire row 3 (pivot row) from row 2. (This is equivalent to algebra's Gauss-Jordan Reduction, where we subtract one equation from another to solve systems of equations.)

Subtraction continues until zeros are produced in the pivot column, including the objective function row. Eliminate the two in row 1 by multiplying row 3 by two and subtracting the result from row 1. In all cases, the pivot element must be a one before beginning these operations. If it is not, simply divide through the equation to produce a one before beginning the row operations. To fully understand the solution, subtract all rows in tableau 1 to produce tableau 2.

The linear programming algorithm now continues until there are no more

negative coefficients in the bottom row. For the ABC Toy problem this occurs at tableau 4, which displays the solution 600, 200, 200, and 100. To identify which variables in tableau 4 correspond to which solution, look for the identity matrix (it will not be in order). Also, the program reprints the solution with the appropriate variable identified. This solution corresponds to the graphical solution shown earlier.

It is interesting to follow the route of the algorithm on Fig. 1 as it moves from corner to corner of the feasible region. As expected, tableau 1 is the origin (point 1 on the graph). Then, the solution moves to points 2, 3 and 4 (tableaus 2, 3 and 4). Calculations terminate at point 4 because a move to point 5 only results in a lower profit. The theory of linear programming includes a mathematical proof that point 4 is the optimal point and any further search will be fruitless. Such a characteristic is a real boon since the solution must occur after a series of finite steps. The technique is a powerful analytical application for computer processing.

Nutrition

To further explain linear programming and interpretation of the output, I will give another example. This nutrition problem provides an opportunity to present additional features, including minimization and the use of artificial variables. This problem is a lot closer to reality than the ABC Toy Co.

Nutritionists have determined that an adult must consume at least 75 grams of protein, 90 grams of fats and 300 grams of carbohydrates daily to main-

tain good health. Table 2 lists several common foods with protein, fat and carbohydrate content, as well as an approximate cost. All data is grams per ounce of the food item. Suppose we want to produce a meal which will supply these substances at the lowest cost. This is a minimization problem; the formulation should look like Fig. 3.

Special techniques are needed to deal with a minimization problem as defined in Fig. 3. First, the computer program is designed to maximize; you must trick it into minimizing by multiplying through the objective function with a -1 . The program will try to make the result as negatively large as possible (or as small as possible).

We have other problems with the constraints. Consider Constraint 3, for example:

$$15.8X_1 + 11.4X_5 + .9X_6 + 18X_7 - A = 300$$

Here, we converted the inequality to an equality by subtracting a slack variable. This variable is now called a surplus variable since it is the amount of carbohydrate in excess of the minimum requirements. All seems well, except the sign of the surplus is negative and the algorithm must have positive signs for the starting variables in the identity matrix. We overcome this by adding an artificial variable to the inequality. This variable is included only to provide a suitable starting variable. Since it is useless other than to get us started, we wish to discard it as soon as possible.

We discard artificial variables rapidly by giving them extremely large coefficients in the objective function. The program rapidly excludes them from the solution and they will never return since they cost so much relative to other variables (remember that this is a minimization problem and we want to keep costs as low as possible).

The results of our handiwork are shown in Fig. 4. Here, the input data is displayed along with the tableaus. Notice first in the objective function data (line 1410) that the surplus variables have a coefficient of zero as expected, but the artificial variables have a coefficient of 100 (extremely expensive items). All coefficients are negative since this is a minimization problem. Also note in the initial tableau that the initial basis consists of the artificial variables (X_{10} , X_{12} and X_{14}) in the columns headed by the -100 values.

The objective function row is considerably changed in tableau 1. Here, as in the ABC Toy problem, we wish to find the most negative coefficient in

$$\begin{aligned} \text{Minimize: } Z &= 0.5X_1 + .7X_2 + 3.75X_3 + 1X_4 + 1.5X_5 + 1.5X_6 + 1.75 + 1.125, \\ \text{subject to:} & \\ 2.4X_1 + 7.1X_2 + 8.4X_3 + 6.2X_4 + .7X_5 + 2.3X_6 + 1.6X_7 &\geq \\ .3X_1 + 9.8X_2 + 2.1X_3 + .2X_4 + 9.4X_5 + 3.7X_6 + 28.1X_7 &\geq 90 \\ 15.8X_1 &+ 11.4X_5 + .9X_6 + 18.0X_7 \geq 300 \end{aligned}$$

Figure 3

Item	Protein	Fat	Carbohydrate	Cost
Wheat bread	2.4	0.3	15.8	0.5
Cheddar cheese	7.1	9.8	0	1.7
Roast chicken	8.4	2.1	0	3.75
Steamed haddock	6.2	0.2	0	1.0
Dried prunes	0.7	0	11.4	1.5
Walnuts	2.3	9.4	0.9	1.5
Gingerbread	1.6	3.7	18.0	1.75
Margarine	0	28.1	0	1.125

Table 2

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the objective function row which will reveal the most promising incoming variable. In this case, variable X_8 (margarine) is the incoming variable. In column 8 there is only one choice for the pivot (90/28.1) and X_{12} is hence the outgoing variable. (This is one of the artificial variables we wish to banish.)

Finally, in Fig. 4, tableau 8 (the last tableau) and the final solution are displayed. (Six other tableaus computed on the way to this solution were omitted to save space.) Observing the objective function row in tableau 8, no further negative signs are seen and the optimal solution is reached. The solution is 18.99 grams of bread, 4.75 grams of fish, and 2.97 grams of margarine. Looks like a fish sandwich! You can question the proportions of items, but the solution does satisfy the constraints.

In the real world, an analyst would go back to the original problem and devise additional constraints. (For example,

we may never want more than 1/2 gram of margarine in any solution.)

The objective function row in the last tableau, now called "shadow prices," reveals the necessary cost reduction for a food item to come into the solution. A person particularly fond of chicken sandwiches (versus fish) could examine the shadow price for chicken (\$2.32). If the price were reduced to \$1.42, chicken would come into the solution. (It would then have a negative coefficient in bottom row.) You may wish to change the cost of chicken in the initial data and explore the resulting solution.

You may wish to explore more alternatives regarding the final solution to the Toy Co. or nutrition problems. Additional solutions are possible. The computer program permits rapid reanalysis of the problem, eliminating the drudgery of hand solution.

Here are some additional problems for interested readers. Explore the

changes in the ABC Toy problem if all available machine hours *must* be used. (Hint: This requirement implies equality constraints and you must add an artificial variable to the formulation to get started.) What happens when you make the following changes to the nutrition problem?

Modify the input data and resolve the problem by reducing the price of chicken by the amount of the shadow price (\$2.33).

Supposing your diet must contain exactly 215 grams of carbohydrates, find the new solution.

Suppose the protein requirement is revised to only 50 grams or more of protein. Can you guess from the current solution if the diet will change? In either case, resolve the problem. ■

Dr. David Clapp is an engineer with a federal agency. He can be reached at 1769 Kingsway Court, Cincinnati, OH 45230.

The Initial Tableau Is:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	
-0.50	-1.70	-3.75	-1.00	-1.50	-1.50	-1.75	-1.13	0.00	-100.00	0.00	-100.00	0.00	-100.00	
2.40	7.10	8.40	6.20	0.70	2.30	1.60	0.00	-1.00	1.00	0.00	0.00	0.00	0.00	75.00
0.30	9.80	2.10	0.20	0.00	9.40	3.70	28.10	0.00	0.00	-1.00	1.00	0.00	0.00	90.00
15.80	0.00	0.00	0.00	11.40	0.90	18.00	0.00	0.00	0.00	0.00	0.00	-1.00	1.00	300.00

Tableau 1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	
2.40	7.10	8.40	6.20	0.70	2.30	1.60	0.00	-1.00	1.00	0.00	0.00	0.00	0.00	75.00
0.30	9.80	2.10	0.20	0.00	9.40	3.70	28.10	0.00	0.00	-1.00	1.00	0.00	0.00	90.00
15.80	0.00	0.00	0.00	11.40	0.90	18.00	0.00	0.00	0.00	0.00	0.00	-1.00	1.00	300.00
-1849.50	-1688.30	-1046.25	-639.00	-1208.50	-1258.50	-2328.25	-2808.88	100.00	0.00	100.00	0.00	100.00	0.00	

The objective function value is -46500

Tableau 2

1	2	3	4	5	6	7	8	9	10	11	12	13	14	
2.40	7.10	8.40	6.20	0.70	2.30	1.60	0.00	-1.00	1.00	0.00	0.00	0.00	0.00	75.00
0.01	0.35	0.07	0.01	0.00	0.33	0.13	1.00	0.00	0.00	-0.04	0.04	0.00	0.00	3.20
15.80	0.00	0.00	0.00	11.40	0.90	18.00	0.00	0.00	0.00	0.00	0.00	-1.00	1.00	300.00
-1819.51	-708.69	-836.33	-619.01	-1208.50	-318.88	-1958.40	0.00	100.00	0.00	0.04	99.96	100.00	0.00	

The objective function value is -37503.6

Tableau 7

1	2	3	4	5	6	7	8	9	10	11	12	13	14	
1.00	0.00	0.00	0.00	0.72	0.06	1.14	0.00	0.00	0.00	0.00	0.00	-0.06	0.06	18.99
0.00	1.00	1.18	0.87	-0.15	0.30	-0.16	0.00	-0.14	0.14	0.00	-0.00	0.02	-0.02	4.15
0.00	0.00	-0.34	-0.30	0.04	0.23	0.18	1.00	0.05	-0.05	-0.04	0.04	-0.01	0.01	1.55
0.00	0.00	2.12	-0.15	1.34	0.70	1.25	0.00	0.18	99.82	0.04	99.96	0.00	100.00	

The objective function value is -18.2915

Tableau 8

1	2	3	4	5	6	7	8	9	10	11	12	13	14	
1.00	-0.00	-0.00	0.00	0.72	0.06	1.14	0.00	0.00	-0.00	-0.00	0.00	-0.06	0.06	18.99
0.00	1.15	1.35	1.00	-0.17	0.35	-0.18	0.00	-0.16	0.16	0.00	-0.00	0.02	-0.02	4.75
0.00	0.34	0.07	0.00	-0.01	0.33	0.12	1.00	0.00	-0.00	-0.04	0.04	0.00	-0.00	2.97
0.00	0.17	2.32	0.00	1.31	0.75	1.23	0.00	0.16	99.84	0.04	99.96	0.01	99.99	

The objective function value is -17.58

The Optimal Tableau Is:

$X(1) = 18.99$

$X(4) = 4.75$

$X(8) = 2.97$

The objective function value is -17.58

Figure 4

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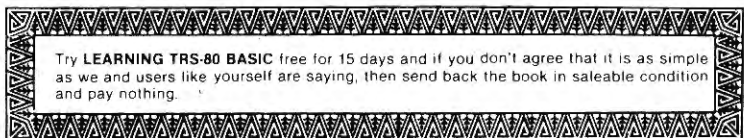
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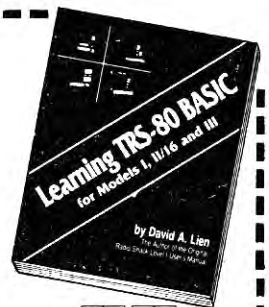
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Model III Relative Files

by Andrew Rucks

The drawbacks of direct access files can be overcome by using relative files accessed by the scatter technique with open addressing.

It's difficult to write application programs using direct-access files for the Model III. Model III Disk Basic offers constructs for creating and accessing random or direct-access files; however, it doesn't permit efficient use of file space unless logical records conform to the size parameter of physical records.

Using the R option with a file-open statement designates a direct-access file. For the Model III and most other microcomputers, direct access means each of the physical records allocated to a file can be accessed independently. For example, the fifth record of a file containing 10 records can be accessed without having to access the first record, second record and so forth. You can determine the number of physical records allocated to a file by examining the #Rec column of the report produced by a DIR command.

Model III Disk Organization and Buffering

Disk Basic running under TRSDOS stores data on disks in fixed-length blocks. These fixed-length blocks, called sectors, are the units of addressable space on a disk. Therefore sector and physical record are synonyms. The size (length) of a sector is expressed as the number of characters (bytes) that can be stored in a sector. On Model III disks the sector size is 256 characters. The combination of sector size, number of sectors per track, and the number of tracks on a disk determine a disk's storage capacity.

For example, the 5¼ inch disks designed for use with Model III systems have 40 tracks, 18 sectors per track, and 256 bytes per sector, and therefore can store 184,326 characters. Actual data storage capacity of a disk is less than the physical capacity of a disk because track 17 of a disk is reserved for the disk's directory and cannot be used for data storage.

The Model III and other microcomputers reserve a portion of random-access memory (RAM) for disk input-output (I/O) operations. These reserved areas are called buffers. A buffer has the same capacity (size) as a sector or physical record. When a disk input operation is performed, a copy of the information stored in a sector is placed in a buffer where it becomes available to an application program. A disk output operation is the reverse of this process. For every disk input operation a complete sector is read into memory and for every disk output operation a complete sector is written onto the disk.

The full sector read/write applies even when you answer V to the "How many files?" query upon entering Disk Basic. The use of variable-length records has no perceivable impact on the manner in which TRSDOS references files. Disk Basic through TRSDOS reads an entire sector; however, when this data is transferred to a buffer, only the first N bytes are placed in the buffer—the remainder are disregarded.

For example, assume that a program is using a variable-length record file

and the file's buffer is fielded for 128 characters. When a disk read operation is performed on the file, a full sector (256 characters) is read from the disk but only the leftmost 128 characters are placed in the file buffer. The remaining 128 characters of the sector are ignored. This remainder cannot be used for data storage because Disk Basic and TRSDOS cannot reference fragments of sectors.

Impact of Fixed Blocks

Fixed-block disk organization is not limited to the Model III; it is also common in other microcomputers, minicomputers and large-scale systems. Operating systems of computers in the mini and large-scale classes perform buffer fielding and data transfer without programmer intervention. These operating systems can write logical records across sector boundaries, thus optimizing disk space utilization. Microcomputers cannot place more than one logical record in a sector without programmer intervention.

Consider writing eight records of 32 characters each in a direct-access file on the Model III compared with the same operation on a typical minicomputer. Storing the eight records on the Model III requires 2,048 characters of disk space (eight records of 256 characters each). For the minicomputer only 256 characters of disk space are required. The Model III consumes eight times more disk space than the minicom-

The Key Box

**Model III
Disk System**

```

100 DIM BU$(8)
"
"
"
1000 OPEN "R",1,"FILE"
1010 FIELD 1, 32 AS BU$(1), 32 AS BU$(2),
32 AS BU$(3), 32 AS BU$(4), 32 AS
BU$(5), 32 AS BU$(6), 32 AS BU$(7),
32 AS BU$(8)

```

Figure 1a

```

100 DIM BU$(5)
"
"
"
1000 OPEN "R",1,"FILE"
1010 FIELD 1, 48 AS BU$(1), 48 AS BU$(2),
48 AS BU$(3), 48 AS BU$(4), 48 AS
BU$(5), 16 AS LOS

```

Figure 1b

of wasted disk space associated with direct-access files. One solution is to avoid the use of direct-access files by relying only on sequential files. Using sequential files improves disk space usage efficiency; however, this technique significantly increases the search time for records and complicates file maintenance procedures. Record search-time inefficiency results from having to read $n-1$ records in order to reach the n th record in a file. In a sequential file maintenance procedure, the original (master file) must be merged with a transaction file (containing changes, deletions or insertions for the master file) to create an update of the master file. The transaction file must be sorted in the same order as the master file.

Relative Files

In relative files the location of a logical record in a file is determined by a value within the record referred to as the record key (e.g., employee ID in a payroll system). The location of a logical record in the file is relative to the

contents of the record. Relative file organization treats a file as a pool of space wherein records can be stored at random or scattered throughout the file.

To create a storage pool, field the buffer areas of direct-access files as elements of an array. The size of the array is the integer portion of the quotient obtained by dividing the number of bytes in each logical record into the buffer size. The treatment of buffers as arrays creates a pool of storage area in much the same way that soft-drink cartons subdivide the space in a soft-drink case.

Figures 1a and 1b show two examples of fielding a file buffer as an array. In Fig. 1a, the logical record length is 32 characters. Therefore, eight logical records can be placed in the buffer and in each sector allocated to the file. Figure 1b illustrates the fielding of a buffer in situations where sector size is not evenly divisible by the logical record length. In Fig. 1b, the logical record length is 48 characters, resulting in five logical records being held in the buffer and a slack or waste area of 16 characters.

puter to store the same amount of information.

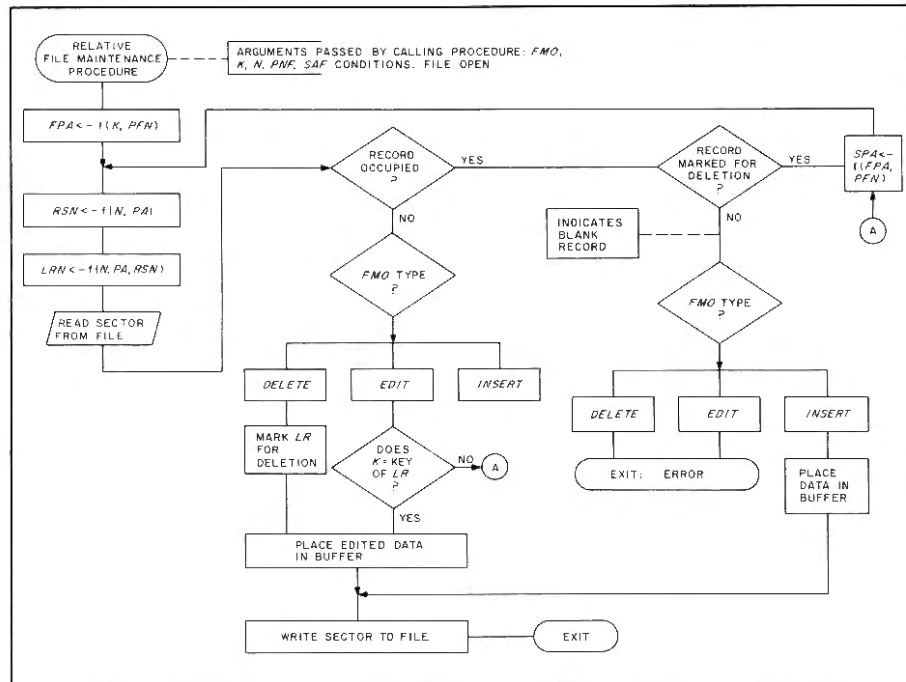
Model III programmers have several options available to solve the problem

Determining Logical Record Location

The actual location of a record in a relative file is determined by a formula known as a hash function. Hash functions produce a set of sector numbers that fall within an allowable range. This range is expressed as $1 \leq S_f \leq S_n$, where 1 is the minimum relative sector number, S_n is the number of sectors allocated to a file and is the largest relative sector number, and S_f is the sector number produced by the hash function.

A good hash function minimizes the probability that the hashing of two independent keys will produce the same relative sector number. The generation of duplicate addresses is termed collision. Since hashing algorithms that totally avoid collisions are rare, you must use a method for resolving these situations.

Open addressing is one of several methods for resolving collisions and offers advantages to the Model III user not provided by alternative methods. Open addressing minimizes the number of disk accesses required to determine if a record is present in a file. Although open addressing involves more computational overhead than other collision-resolution techniques, this overhead is insignificant when compared to the overhead involved in accessing a Model III disk.



Legend:

- FMO = file maintenance operation (delete, edit, insert)
- FPA = first probe address
- K = record key
- LRN = logical record number
- N = number of logical records per sector
- PA = probe address (either FPA or SPA)
- PNF = prime number factor—largest prime number less than the number of logical records per sector times the number of sectors allocated to a file divided by 0.95
- RSN = relative sector number ($1 \leq RSN \leq SAF$)
- SAF = sectors allocated to a file multiplied by 0.95

Fig. 2. File Maintenance Procedure—Scatter Method with Open Addressing

In open addressing a record key is hashed repetitively and the resulting sector number is probed for the appropriate record. This set of sector numbers is referred to as the probe sequence. Members of a probe sequence are generated on an as-needed basis: When the probe of a logical record does not achieve the desired result, the key is hashed again to produce the next member of the probe sequence. An important feature of open addressing is that the formula used to generate a probe sequence always generates the same set of sector numbers for a given record key.

File Maintenance

File maintenance involves three possible actions: placing a new record in a file (insert), changing the contents of a record in a file (edit) and removing a record from a file (delete). Figure 2 shows a flowchart of the procedure for performing file maintenance using the scatter method with open addressing.

Sizing a Relative File

Use a file load factor of approximately 95 percent for this implementation of the relative organization. A

```

200 REM *** First Probe Address Function
210 DEF FNFP (K,P) = K - (INT(K/P)*P) + 1
220 REM   where, K = record key and P = prime number factor

230 REM *** Subsequent Probe Address Function
240 DEF FNSP (PA,K,P) = (PA + (K - (INT(K/P)*P)) -
   (INT (PA + (K - INT(K/P)*P)/P)*P)
250 REM   where, K and P are defined above and PA = probe address

260 REM *** Relative Sector Number Function
270 DEF FNRS(PA,N) = INT (PA - 1/N) + 1
280 REM   where, PA is defined above and N = number of logical records per sector

290 REM *** Logical Record Number Function
300 DEF FNLR(SA,N,PA) = SA*N - (PA - 1)
310 REM   where, SA = relative sector number, and N and PA are defined above
  
```

Program Listing

95-percent file load factor means you should plan to use only about 95 percent of the space allocated to a relative access file. The slack prevents the processing time of a search from significantly increasing as the file becomes full. For example, assume you are creating a relative file with 1,000 logical records of 45 bytes each. Five logical records can be stored in each

is: $SPA = \text{modulo}(PA + \text{modulo}(\text{record key}/P, P), P) + 1$. PA is the previous unsuccessful probe address determined by either the FPA or SPA functions. Record key and P are defined in the FPA function. Probe addresses produced by these algorithms have the characteristic of $1 < = \text{probe address } (PA) < = P$.

Identifying Logical Records

A probe address is a composite of the number of sectors and the number of logical records per sector. It must be reduced to a relative sector number (RSN) and a logical record number (LRN). The RSN identifies the sector that will be read into a file buffer and examined for the desired logical record. The RSN function is: $RSN = \text{integer}((PA - 1) / N) + 1$. PA is the probe address and N is the number of logical records per sector.

The final function required to implement the relative file organization is one to determine the element within the buffer array that contains the logical record. The logical record number (LRN) function is: $LRN = (RSN * N) - (PA - 1)$. RSN, N and PA are the same as defined in previous functions.

Disk Basic Implementation

The program segment presented in the listing is written in Disk Basic. This segment illustrates the define function (DEF FN) construct for each of the functions presented in this article. ■

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“Slack prevents the processing time of a search from significantly increasing as the file becomes full.”

sector ($256/45 = 5$ and a slack area of 31 characters), and 200 sectors are required for data storage. However, because of the file load factor, you should allocate five percent more sectors to the file, thereby making the file 210 sectors long.

Hash Functions

The scatter technique with open addressing requires two hash functions: one to determine the first probe address (FPA) and another to determine all subsequent probe addresses (SPA). The FPA function is: $FPA = \text{modulo}(\text{record key}, P) + 1$. Record key is the value of the record key and P is the largest prime number less than or equal to the number of logical records multiplied by the number of sectors allocated to the file multiplied by the file load factor.

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Apple and Commodore Offer CP/M.

In a recent press conference, the Apple Computer Company stated, "The largest installed base CP/M system in the world today is the Apple II with the Z80 card from Microsoft." In a recent full page ad in the Wall Street Journal, Apple announced CP/M for the Apple III. Commodore, refusing to be left behind, has recently announced their "Emulator" series of computers that support CP/M. There are even rumors that the new Tandy 16 will support a version of CP/M.

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Towards Better Programming

by John T. Blair

Improve your programming technique by applying these straightforward methods—Program Development Language and the Scientific Method.

Professional tools and ideas are always welcome to newcomers to computers and programming. I will present a procedure for solving problems (the scientific method) and Program Development Language (PDL, similar to flowcharting) for program design.

These techniques are not restricted to the TRS-80 or to Basic. They can be applied to a program in any language run on any computer. For programming in Assembly language, these principles are almost mandatory.

I will use these techniques to write a Basic program which will convert an Assembly-language source program to an ASCII file, and an ASCII file back to an Assembly-language source program. Many TRS-80 terminal programs only transmit or receive ASCII files. Consequently, Assembly-language

source programs cannot be sent via these terminal programs unless converted to ASCII files.

Getting Started

Three distinct steps must be performed to get a program from thought to execution.

The first phase is developing the program specifications. You must define requirements and identify possible problem areas. Next comes the program design, where logic flow is developed via a PDL or flowcharts. This is the most important part of writing a program, because a poorly designed program costs extra time and money. Here is where you find out:

Do I want to do this?; Can I do this? (Do I have the time and resources?); and What assumptions have been made

by the person requesting the program?

The second phase is translating ideas from the PDL into the language of the computer.

The last phase consists of running the program, debugging it, and looking for logic flaws.

Each of these independent steps could be handled by a separate person. As hobbyists, most of us must do all three. In an academic environment, most courses emphasize language syntax; the student is expected to learn programming design by default.

Scientific Method

The scientific method is a systematic thought process for solving problems or predicting the correct results of an action. *The Nature of Scientific Thought* states the scientific method in its simplest form as:

Postulate a model based on existing experimental observation or measurement. Check the predictions of the model against further observation or measurements. Adjust or replace the model as required by the new observation or measurement.

How does this relate to programming? The programmer is trying to predict a computer's action when given a sequence of instructions. The scientific method leads to a logical path (flowchart or PDL), a way to predict if the program will yield the desired results. Expanding and redefining the

Initial problem analysis

- Sift through the material or data, to produce a better definition of the given data.
- Define the requirements of the problem. In other words, what are we required to find?

Attempt a general model

- Draw a general system flowchart. Examine the logic.
 - Draw detailed or subordinate flowcharts. All language should be machine independent.
- Write short, descriptive English words to describe functions.
- Test the final model by implementing the coding in the language to be used.

Adjusting the model

- Look for bugs.
- Retest and look for bugs again until complete.

Table 1. Scientific Programming

The Key Box

**Disk Basic
Model I or III
32K RAM
TRSDOS
One Disk Drive**

basic steps of this methodology and applying it to programming, the solution of a problem can be divided into several parts (see Table 1).

This is called "top down design," or structured programming. Be aware of the difference between designing and

writing a program. Designing a program is the development of a smooth flow of ideas and a step-by-step procedure (algorithm) to solve a problem. It is not necessary for the algorithm to run on a computer. The logic flow can be checked by reading the PDL or fol-

lowing the lines in a flowchart. Once the logic has been proved, the design can be translated into a language your computer will understand. Notice that the program design is machine independent! Writing a program is putting instructions in a language the com-

Program Listing

```

10 ' ***** C O N M L S *****
15 '
20 ' CONVERT MACHINE LANGUAGE SOURCE TO AN ASCII DATA FILE
30 ' BY JOHN T. BLAIR WA4CHZ DATE 06/14/80
40 ' LAST REV 11/21/80
50 ' END-OF-FILES BASIC = 0D(H) EDTASM = 0D1A(H)
52 ' PENCIL = 00(H)
60 ' A TAB FOR EDTASM = 09(H)
70 '
80 ' DEFINATION OF VARIABLES USED
90 ' IS = INPUT BUFFER
100 ' IN$ = INPUT FILE
110 ' NS = FILE NAME LESS EXTENSION
120 ' NI$ = DRIVE NUMBER (INPUT)
130 ' NO$ = DRIVE NUMBER (OUTPUT)
140 ' OS = OUTPUT BUFFER
150 ' OUS = OUTPUT FILE
160 ' LN = LINE NUMBER (OUTPUT FILE)
170 ' SS = SPACE STRING
172 ' TS = TEMP OUTPUT LINE
180 '
190 CLEAR 1000: DIM IS(256), OS(256); ' CLEAR STRING SPACE FOR INP
UT & OUTPUT BUFFERS
200 SS=STRING$(10,32)
210 '
220 ' CRT HEADERS
230 '
240 CLS:PRINT " C O N M L S"
250 PRINT:PRINT"THIS PROGRAM WILL CONVERT A MACHINE LANGUAGE SOU
RCE PROGRAM"
260 PRINT"TO AN ASCII FILE OR VISA VERSA. EXTENSIONS ARE N-O-T R
EQUIRED.";
270 PRINT"BUT MUST BE":PRINT "FOR THE INPUT FILESPEC."
280 PRINT" TXT = SOURCE FILE."
290 PRINT" ASC = ASCII FILE."
300 PRINT:PRINT:PRINT"WHICH TYPE OF FILE IS THE INPUT FILE?"
310 PRINT" 1 = M/L SOURCE FILE":PRINT" 2 = ASCII FILE"
320 INPUT"INPUT YOUR OPTION #";O
330 INPUT " SOURCE FILESPEC: ";IN$
340 INPUT " SOURCE DRIVE #";NI$
350 INPUT " DEST DRIVE #";NO$
360 '
370 ' GET FILE NAME FROM FILESPEC
380 '
390 J = INSTR(IN$, "/") : IF J = 0 THEN 400 ELSE 410
400 J=LEN(IN$):GOTO420
410 J=J-1
420 ON O GOTO 500,1220
430 '
440 '*****
450 '***** CONVERT SOURCE FILE TO ASCII FILE *****
460 '*****
470 '
480 ' DISK INITIALIZATION
490 '
500 OS=MID$(IN$,1,J)+"/ASC"+": "+NO$
510 IN$=MID$(IN$,1,J)+"/TXT"+": "+NI$
520 OS=""
530 OPEN "I",1,IN$: ' INPUT FILE
540 OPEN "O",2,OS: ' OUTPUT FILE
550 CLS:PRINT"NEW FILE: ";OS
560 '
570 ' READ 1ST LINE FROM DISK INTO INPUT BUFFER
580 '
590 IS="":LINEINPUT #1,IS
600 GOSUB 970:IF L=0 THEN 820
610 L=LEN(IS):IS=MID$(IS,8,L): ' STRIP OFF FILE NAME
620 OS=""
630 GOSUB 880: ' CONVERT AND ADD LINE NUMBER
640 GOSUB 1050: ' CONVERT TABS
650 PRINT OS: ' PRINT TEXT LINE ON CRT
660 PRINT #2, OS: ' OUTPUT TEXT LINE TO DISK
670 '
680 ' READ REMAINING LINES FROM DISK
690 '
700 IS="":OS="": ' CLEAR INPUT & OUTPUT BUFFERS
710 LINEINPUT #1,IS: ' READ NTH TEXT LINE
720 IF EOF(1) THEN 820
730 GOSUB 970:IF L=0 THEN 820
740 GOSUB 880: ' CONVERT AND ADD LINE NUMBER
750 GOSUB 1050: ' CHECK FOR TABS
760 PRINT OS
770 PRINT #2, OS
780 GOTO 700: ' REPEAT TILL E-O-F
790 '
800 ' CLOSE FILES & ADD END OF TEXT
802 ' THIS ASC FILE IS DIRECTLY READABLE BY PENCIL
810 '
820 OS="":OS=OS+CHR$(13)+CHR$(00): ' ADD EOT CHAR
830 PRINT #2, OS
840 GOTO 1670
850 '
860 ' CONVERT BIT 8 HIGH ASCII TO BIT 8 LOW
870 '
880 FOR I=1 TO 5: ' 5 DIGITS / LINE NUMBER
890 OS=OS+CHR$(ASC(MID$(IS,I,1)) AND 127)
900 NEXT I
910 OS=OS+CHR$(32): ' ADD <SP> APT LINE #
920 IS=MID$(IS,7,L):L=LEN(IS): ' MODIFY INPUT STRING
930 RETURN
940 '
950 ' END-OF-TEXT FINDER
952 '
954 ' THIS SECTION LOOKS FOR A 1A(H) THE EDTASM'S EOT.
960 '
970 J=INSTR(IS,CHR$(26))
980 IF J=0 THEN 1000: ' J = 0 ==> NO EOF THIS READ
990 IS=MID$(IS,1,J-1)
1000 L = LEN(IS)
1010 RETURN
1020 '
1030 ' TAB CONVERTER
1032 '
1034 ' THIS SECTION SCANS EACH LINE LOOKING FOR 09(H) &
1036 ' CONVERTS THEM TO THE APPROPRIATE NUMBER OF <SP>.
1040 '
1050 S=1:TS="": ' SET STARTING POS
1060 J=INSTR(MID$(IS,S,L),CHR$(9)): ' LOCATE A TAB
1070 IF J=0 THEN 1140: ' NO TABS
1080 J1=(INT(J/8)+1)*8: ' CAL NEXT TAB STOP
1090 J2=J1-J: ' # <SP> REQ.
1100 IF J=1 THEN TS=TS+MID$(SS,1,8):GOTO1120
1110 TS=TS+MID$(IS,S,J-1)+MID$(SS,1,J2+1)
1120 S=S+J: ' BUMP START POS PTR.
1130 GOTO 1060
1140 OS=OS+TS+MID$(IS,S,L): ' BUILD OUTPUT LINE
1150 RETURN
1160 '*****
1170 '***** CONVERT ASCII FILE TO SOURCE *****
1180 '*****
1190 '
1200 ' DISK INITIALIZATION
1210 '
1220 IN$=MID$(IN$,1,J)+"/ASC"+NI$
1230 OS=MID$(IN$,1,J)+"/TXT"+": "+NO$
1240 OS="":IS=""
1250 OPEN "I",1,IN$: ' INPUT FILE
1260 OPEN "O",2,OS: ' OUTPUT FILE
1270 CLS:PRINT"NEW FILE: ";OS
1280 '
1290 ' READ 1ST SECTOR FROM DISK INTO BUFFER
1300 '
1310 IS="":OS="": ' CLEAR INPUT & OUTPUT BUFFER
1320 LINEINPUT #1,IS
1330 OS=CHR$(211): ' FILE IDENT CODE (CARRY OVER F
ROW TAPE)
1340 ' INSERT FILE NAME IN OUTPUT BUFFER
1350 '
1360 '
1370 N=6-J: ' # SPACES TO FILL OUT FILE NAME
1380 IF N=0 THEN 1410: ' FILE NAME 6 CHAR LONG
1390 OS=OS+MID$(IN$,1,J)+MID$(SS,1,N)
1400 GOTO 1420
1410 OS=OS+MID$(IN$,1,J): ' ADD NAME TO OUTPUT BUFFER
1420 GOSUB 1720: ' CONVERT AND ADD LINE NUMBER
1430 L=LEN(IS)
1440 IS=MID$(IS,6,L): ' STRIP OFF LINE NUMBER FROM INPU
T BUFFER
1450 OS=OS+IS: ' ADD REMAINDER OF TEXT LINE
1460 PRINT OS
1470 PRINT #2,OS
1480 '
1490 ' READ REMAINING SECTORS FROM DISK
1500 '
1510 IS="":OS="": ' CLEAR INPUT & OUTPUT BUFFERS
1520 LINEINPUT #1,IS: ' GET NTH TEXT LINE
1530 IF EOF(1) THEN 1650
1540 GOSUB 1790
1550 IF L=0 THEN 1650
1560 GOSUB 1720: ' CONVERT AND ADD LINE NUMBER
1570 L=LEN(IS)
1580 OS=OS+MID$(IS,6,L): ' ADD REMAINDER OF TEXT LINE
1590 PRINT OS
1600 PRINT #2,OS
1610 GOTO 1510: ' REPEAT TILL E-O-F
1620 '
1630 ' CLOSE FILES & EXIT
1640 '
1650 OS="":OS=OS+CHR$(26): ' ADD EOT CHAR
1660 PRINT #2, OS
1670 CLOSE ALL
1680 END
1690 '
1700 ' CONVERT BIT 8 LOW ASCII TO BIT 8 HIGH
1710 '
1720 FOR I=1 TO 5:
1730 OS=OS+CHR$(ASC(MID$(IS,I,1)) OR 128)
1740 NEXT I
1750 RETURN
1760 '
1770 ' END-OF-TEXT FINDER
1780 '
1790 J=INSTR(IS,CHR$(13))
1800 IF J=0 THEN 1820: ' J = 0 ==> NO EOF THIS READ
1810 IS=MID$(IS,1,J-1)
1820 L = LEN(IS)
1830 RETURN: ' *** END OF PROG ***

```

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puter can understand.

Solving a Programming Problem

First, read and understand the problem. The hardest part of this is understanding the problem.

Second, restate the problem in your own words, and draw pictures if possible.

Third, identify all given information. Identify any areas where further research is required. Eliminate all extraneous information, and state all assumptions. State all external files or algorithms not explicitly given in the problem.

In many cases the problem will be too large to solve. To reduce the problem size, certain pieces of information may be ignored or taken for granted. These are the assumptions. If when the program is executed the solution yields incorrect results, you can check your assumptions. The particular solution may be applicable to similar problems. While many problems are similar, the results differ depending on the assumptions.

Fourth, identify all the information you are required to find. Identify error handling/trapping ("goofproofing"), find the various intermediate results, and finally, determine what was originally required of the problem.

Many problems have several items which may or may not be order dependent: These are the intermediate results. The final result is the answer to the problem. Error trapping is commonly overlooked. What happens if the user inputs the wrong data? The program should require the operator to reenter data.

Fifth, design the program. Use flowcharts or a PDL in plain English (not machine or language dependent) and describe the function to be performed. Check the logic of the program design.

Sixth, code the design into a particular program language. At this point the program becomes machine dependent unless a higher-level language is used.

Seventh, analyze the results for accuracy. Execute the program to verify results. When running the program in this debugging stage, use sample data. If the results are wrong, check the design again. If the design is good, check the coding.

The most common error is in a loop and is called "off by one." This is when a routine to be repeated X times is executed one more or less. Again run

some sample data. If it is to be repeated 100 times, try setting the counter to five. If the loop is only executed four times, you must increment the counter by one. Conversely if it is executed six times, you must decrement the counter by one.

The best method for determining where an error occurs is to use the "divide and conquer" technique. In machine language use break points, and in a high-level language use print statements. Choose some arbitrary point and insert a print statement or break point, and output the results to this point. If the answers are correct, move further down the program. If they are wrong, move towards the beginning of the program.

Rules for Structured Programming

First, as you design a program start with the overall picture, then write the

"A Programming Development Language (PDL) is a verbal picture of the program function, much like a flowchart."

smaller sections. By dividing a large program into several small modules (subroutines) the task does not seem as overpowering. By keeping it simple, you will not get hung up trying to do too much at once.

Second, use subroutines as small independent modules.

Third, each module should perform only one function. If you want a module to perform a function that has several subfunctions, the subfunctions should be called from the first module. If each module performs only one function, adding or deleting functions to the program is simple. This avoids having two routines do the same thing.

Fourth, each module should have *only* one entry and exit point. This prevents a module from performing more than one function. It also helps the programmer keep track of any flags that have been set.

Fifth, avoid self-modifying coding.

Self-modifying code writes over itself to change instructions. It is more common in Assembly or machine language, and cannot always be avoided.

Sixth, variables should have meaningful names. In a high-level language (Basic) or Assembly language, use a variable name resembling what is stored.

Seventh, initialize and define all variables at the beginning of the program. Many newer languages require that all variables be allocated at the beginning of the program. In Basic it doesn't matter. Each variable should be given an initial value at the beginning of the program, so the computer can allocate storage for it. A remark statement should tell what the variable is used for. Suppose you have an array "grades." It appears that the contents will be a student's grades. But where are the grades for quizzes, mid-term and final exams, and projects located in the array? How will you or anyone else know where to modify the program?

Eighth, assign a variable name to constants. In a high-level program or low-level language this allows the program more flexibility. If the data must be changed, you just alter the value once at the beginning of the program, instead of at each place it is used.

Programming Development Language

A Programming Development Language (PDL) is a verbal picture of the program function, much like a flowchart. A PDL is a set of instructions used to design a program. It is both language and machine independent. This means it is not Fortran, Basic, Cobol, nor does it run on a Z80, 6800, 6502, PDP-11, or IBM computer. Many software professionals are switching from flowcharts to a PDL, for two main reasons: First, too many people write a flowchart after the program is done, producing nothing more than the instructions with a block around them. Second, in a production environment, the programmer does not control flowcharts after sketching them. They are sent to the drafting department to be readied for publication. Design changes rarely catch up to the original documentation.

Repeat...Until

One PDL has the following instructions:

```
Repeat  
    program statements  
Until
```

Until condition

The loop of instructions between the Repeat and Until is repeated until the condition is satisfied. The condition specified is checked at the end of each pass through the loop. When the loop is finished, control moves to the line of code following the Until statement. Use this construction for loops which must repeat at least once.

Example: Design a routine that will read a tape and store the contents in memory until the tape is finished or the buffer is full.

```
Repeat
  Get character from tape
  Store in buffer
  Increment buffer pointer
Until (buffer full) Or (End of tape)
Display finished prompt
```

While...Do

The second set of instructions has the form:

```
While condition Do
  program statement(s)
End While
```

This instruction is similar to the Repeat except that the check Of condition is made before the loop Of is executed. When the condition is satisfied, control passes to the instruction following the End While. If the condition is false initially, the loop will not be executed.

Example: Design a program to read a disk file and store data in buffer until the end of file is found.

```
While Not EOF Do
  Get sector from disk
  Store in buffer
  Increment buffer pointer
End While
```

If...Then...Else

The third set of instructions has the form:

```
If condition
  Then program segment 1
  Else program segment 2
```

This is identical to the If...Then...Else from Basic, Fortran, or Pascal. Only one of the Then or Else program segments is executed. At the completion of the path taken, control transfers to the instruction following the Else clause. The Else clause is usually optional.

Example: Design a program to read a tape until the end of tape is found, the buffer is full, or the read is aborted by the break key.

```
stop = false
While stop = false Do
  Get character from tape
  Store in buffer
  Increment buffer pointer
  If buffer = full
    Then stop = true
  Else If EOT
    Then stop = true
  Else
    Scan keyboard
    If break key closed
      Then stop = true
End While
```

The indentations show the reader what instructions are at the same level. Each successive indentation means that the line is subordinate to the last line. This method is, however, cumbersome.

“Each successive indentation means that the line is subordinate to the last line.”

Case

To overcome this, the Case statement can be used.

```
Case of
  AA: program statement
  BB: program statement
  Others: program statement
End Case
```

In the Case statement only one of the case labels (AA:, BB:, or Others) is executed. Upon completion of a particular case, control passes to the instruction following the End Case.

Example: Repeat the design of example three using the Case statement.

```
stop = false
While stop = false
  Get character from tape
  Case of
    End Of Tape: stop = true
    Buffer full: stop = true
    Others: store character in buffer
      scan keyboard
      If Break key
        Then stop = true
  End Case
End While
```

This instruction clarifies nested If...Then...Else statements. The reader has a more accurate picture of logic at a glance.

Subroutines

Subroutines are identified by a name. In the above example, “store character in buffer” and “scan keyboard” are subroutines. They can be called by name (as above) or by preceding the name with the word Call.

Two schools of thought dictate where subroutines are placed in a program. The first method is to place them at the beginning of a program. Many languages (like Pascal) require this predefinition.

The second school is that they belong at the end of the program, following the concept of top-down design. Controlling modules come first, with subordinate modules following. In some languages (like Basic) the placement makes no difference to the program. But with an interpreter, programs execute faster with subroutines at the front of a program. This is because subroutines are called by line number; the interpreter must scan from the front of the program until the required line number is found.

GOTO

The GOTO label, identical to the Basic GOTO, can be either a number or word. When designing a program this is seldom used. In some cases it is more efficient, but use it sparingly.

This completes the instruction set of most PDLs. The only item remaining is a comment line. This is usually defined as: /* comment */.

In the above examples, English is used liberally to indicate desired functions. This makes reading and comprehending the program very easy, and the program transportable across languages and computers. When implementing the program, these instructions are changed to some corresponding representation in the particular language.

Documentation

This is the last and most important area to cover. Why are documentation and a logical approach so important? Most programs are written based on criteria valid at the time of design. As time passes requirements will change, and you will have to modify the program. If the program is poorly documented, you will not know why you did things the way you did. The documentation helps you sift through the maze of instructions making up the program. In many cases it would be easier to start from scratch and redesign the program.

How is a program documented?

There are three ways of maintaining a program documentation package. The first is the program maintenance package. The program is documented both internally and externally. Internal to the program, use simple structure (no fancy coding).

Use meaningful names and labels, define them at the beginning of the program, and initialize them. Separate variable RAM, I/O and parameter with a blank line. Use names for I/O devices and parameters definitions. Comment liberally. Preface each section with a brief description of its function. Comment as many lines as possible, but don't comment the obvious, by restating the meaning of an instruction. Include a header on each program containing the program's name, creation date, author's name, last revision date, and the name of the person modifying it.

External to the program include the engineering notebook described earlier. Describe the program logic flow and functions using flowcharts or a PDL.

The second way of maintaining a program documentation package is to write a library user's package, for documentation of subroutines. The library user's package should contain the name of the subroutine (creation date and last revision date); the purpose of routine; the computer system required; the language it's written in; the required parameters and how they are passed; the results and how they are passed; the affected registers; and error handling provisions.

This data should be kept at the beginning of each subroutine, algorithm, or module. It should also be kept in a library file, on the computer or on index cards. This way a programmer will not reinvent work someone has already done.

The third way of maintaining a program documentation package is to write a user's manual. The user's manual should include a description of the system configuration required, the amount of memory, number of disks or tape recorders, and so on; a description of the program's function, what it does, and any special functions it can perform; and any warnings or special considerations. Define any external information used. If data is *not* keyed in, include a description of data structure and required I/O. Describe the loading and execution procedure.

Solving a Problem

Let's put these tools to work writing

*“Let's put these tools
to work writing
a program to convert
an Assembly file
to an ASCII file.”*

a program to convert an Assembly file to an ASCII file.

Step one is the initial problem analysis. What do we know about the problem? We know that it is supposed to input an Assembly file, and output an ASCII file. Organize this information.

The Assembly file is the given information and the ASCII file is what the programmer is required to find.

Are there any implied assumptions?

The answer is *probably*. What assumptions were made? The first was the location at which the source file is stored. By my definition, it is on a disk. Great! That leads to two other questions: What does an Assembler source file look like, and what does an ASCII file look like on the disk? Both of these questions require further research.

This research was accomplished us-

ing several tools: Miosys Editor/Assembler to generate the input source file; Basic to generate the output ASCII file; and Apparat's Superzap to examine both the Assembler and a Basic ASCII file. A program, written with the Editor/Assembler (content and executability is not important), was saved to disk. Then a short, meaningless Basic program was written and saved to disk using the ASCII format command, Save "file name", A. Finally, Superzap was loaded, and these two files were examined using its DFS command. The format of the Assembly source file was: D3(H), a program type identifier, is the first byte; next, 6-byte file name in ASCII with bit 8 set low; third, 5-digit ASCII line number with bit 8 set high; next, N number of ASCII characters for the line with a 0D(H) terminator; and finally a 1A(H) End Of Text terminator at the end of the file. The third and fourth steps repeated until the End of Text (EOT = 1A) indicator was found on the last sector.

The format of the Basic ASCII file was: A five-digit ASCII line number with bit 8 set low; N number of ASCII characters for the line with a 0D(H) terminator; and a 1A(H) EOT terminator. This means our program can be considered a black box, with one in-

```

                                     /* CONMLS */

/* This program will convert an Assembly source file          */
/* to an ASCII source file, and save it on disk.              */
/* It can also go the other way, converting an ASCII          */
/* file to an Assembly source file.                            */

Initialize any data required
/* This section will also be responsible for getting          */
/* the source and destination file names.                      */

/* Handle first record of file                                */
Get sector from disk
Call Strip /* strip off file identifier and name              */
Output modified line to new disk file

/* Handle remaining records except the last                   */

While not End Of File Do
  Get sector from disk
  Call Number 2 /* convert line numbers from                  */
                  /* bit 8 high to low                        */
End While

/* EOF character found, handle last case                       */

Call Close /* put end of file marker on file                  */

End Program

```

Table 2. Example PDL

Table 3. Initialization PDL

/*	Initialization Section	*/
	Define all variables	
	Display explanatory text	
	Prompt user for type of input file	
	Open appropriate disk files	
	End Initialization	
	Case Of input file type	
	ASCII : /* Convert to Assembly source	*/
/*	Handle first record of file	*/
	Get sector from disk	
	Call Add /* add file identifier and name	*/
	Call Number 1 /* convert line numbers from bit 8	*/
	/* low to high	*/
	Output modified line to new disk file	
/*	Handle remaining records except the last	*/
	While not End Of File Do	
	Get sector from disk	
	Call Number 1	
	End While	
/*	EOF character found, handle last case	*/
	Close files /* put end of file marker (IAH) on file	*/
	ASSBLY: /* convert to ASCII file	*/
/*	Handle 1st record of file	*/
	Get sector from disk	

Table 3 continues

put and one output. The program appears to be a transfer function: It transforms the input into the desired output.

Step two is to formulate a general model. We have to re-analyze this data and identify the items to be transformed and any particular order required. Once this has been accomplished the model can be built. Most programs have two things in common. At the initial start they all can be represented by:

- Initialization section
- Input data
- Solve problem
- Output results

Next, "solve the problem" is examined. Again most programs have the following in common:

- Process first item
- Process all remaining items, except the last
- Process the last item

Usually there is something different about the first and last data processed. Consequently they must be handled separately.

Stating the changes that have to be

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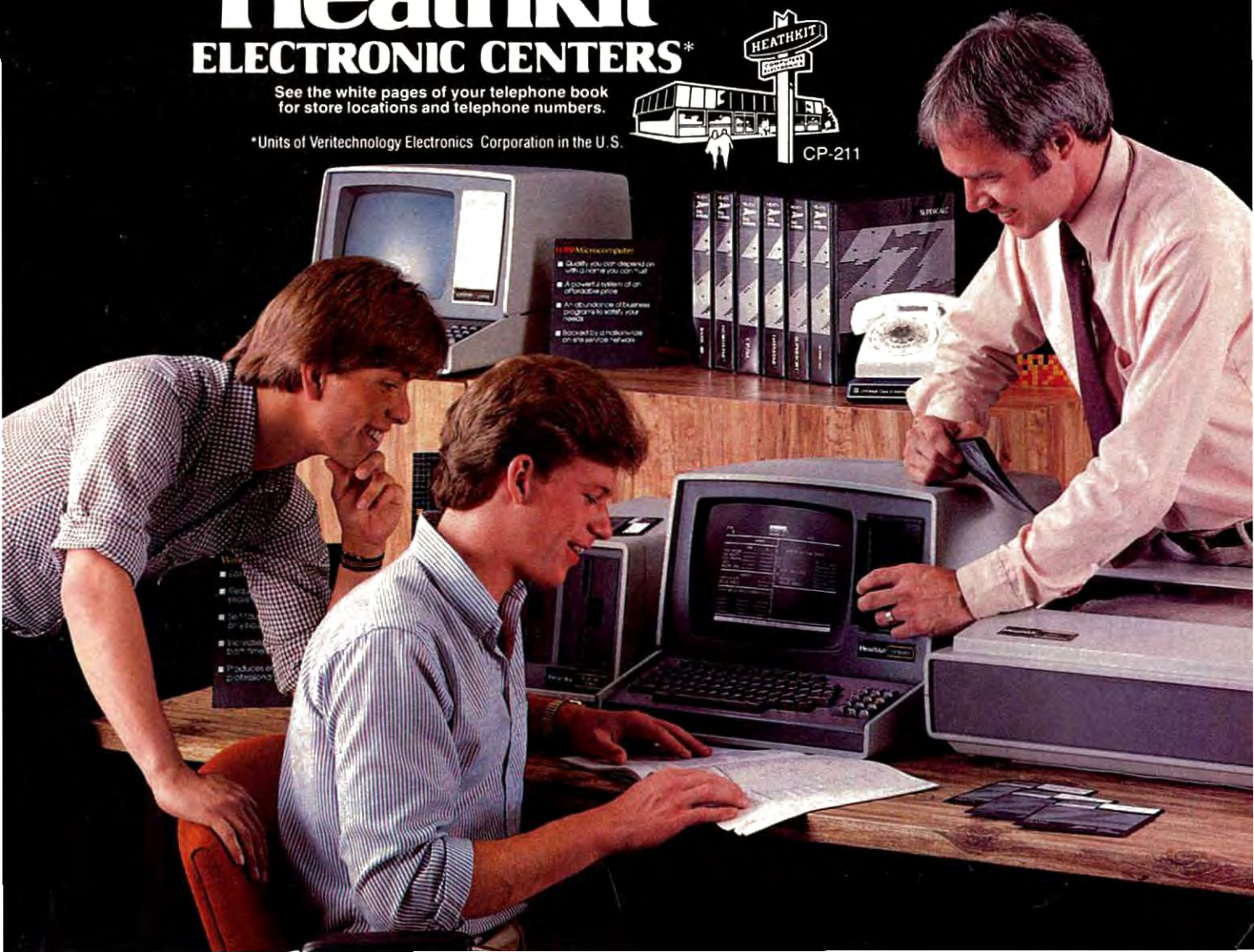


Table 3 continued

```

Call Strip /* Strip off file identifier and name          */
Call Number 2 /* convert line numbers from bit 8        */
                /* high to low                          */
Output modified line to new disk file

/* Handle remaining records except the last             */
While not End Of File Do                                */
    Get sector from disk
    Call Number 2
End While

/* EOF character found, handle last case                */
Close Files /* put end of file marker (ODH) on file     */

End ASSBLY

Others : Error and start again
End Case

```

made to go from an Assembly source to an ASCII file formally, the first change is to delete the file type identifier and the file name. Next, change the bit 8 high ASCII line number to bit 8 low ASCII. There is no need to change the N ASCII characters composing a line of the program.

The PDL for the first crude model would look like Table 2.

Does this PDL look accurate? Can

you find any flaws? If the answers are yes and no respectively, it is time to enhance the program by writing the subordinate sections.

The PDL for the Initialize section would look like Table 3.

Check the model. If there are no errors, begin coding.

At this time the language used is defined (Basic) and coding begins. The final outcome is shown in the Program

“... the student is expected to learn programming design by default.”

Listing. One thing should be brought to your attention again: the *necessity* of documenting a program as it is written. Remember, each section should have a description of what it does.

Finally, execute the program and see if it works. The one in the Program Listing does. If it didn't the necessary changes should be made. If the errors are syntax errors, no correction to the flowcharts or PDL is required. If the program does not work for some reason other than syntax, there is a logic flaw; go back to the PDL and check the logic. If it appears correct, check your program to see that it matches the PDL. ■

John Blair (122 Dumont Ave., Norfolk, VA 23505) is an electrical engineer and amateur radio operator.

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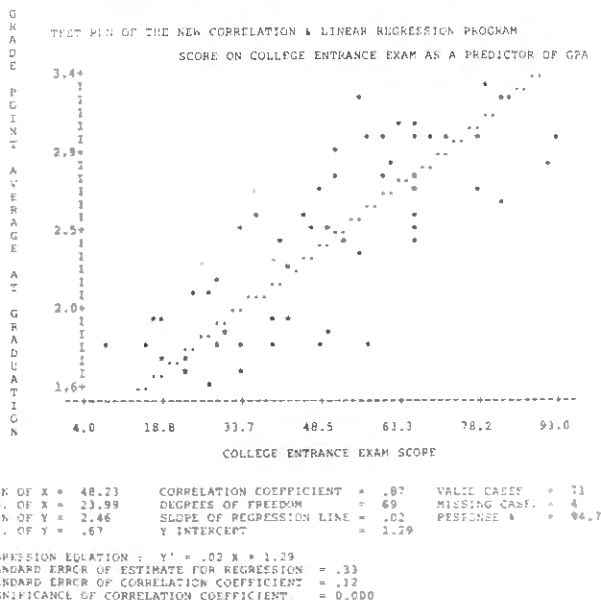
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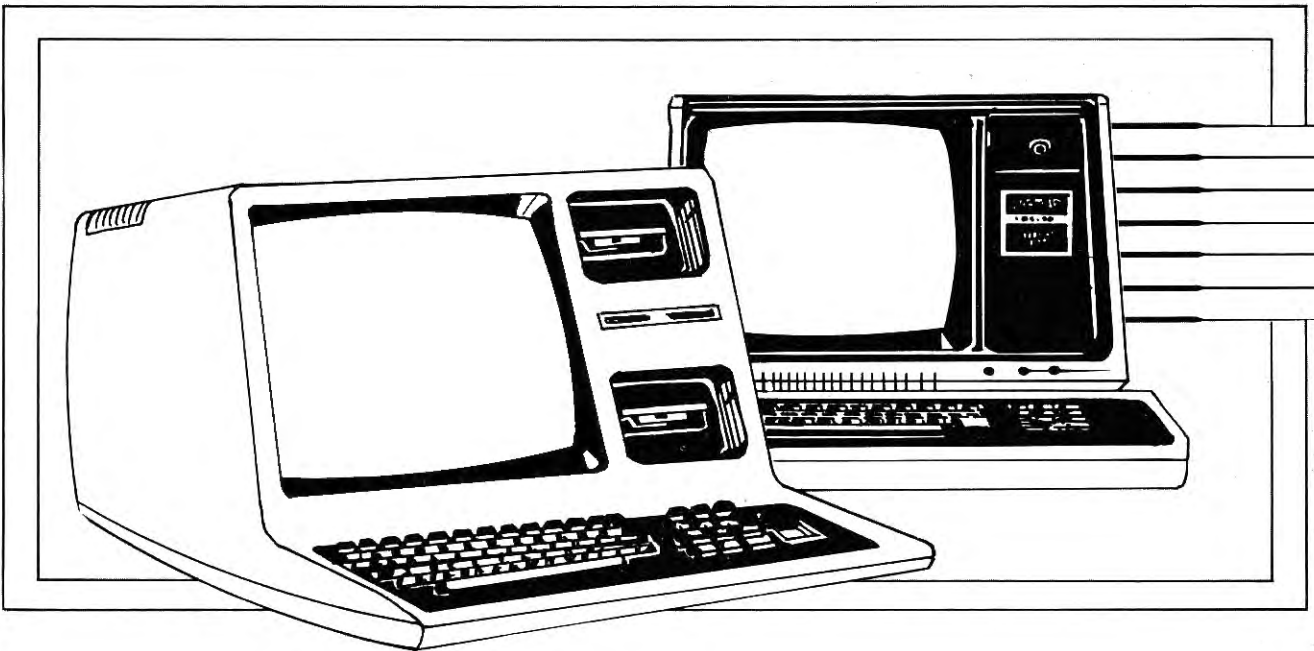
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Part II.

MODEL I/III



NODOS 80

by Thomas Quindry

Who says cassette users can't have some of the features of disk operating systems? It certainly isn't Tom Quindry or 80 Micro.

I've often thought it would be nice to have many of those neat Disk Basic commands and functions on a cassette-based system. There is no reason why CMD-type functions, nine USR functions, a sort routine, renumber capa-

bility, or even other customized commands and functions can't be available in a simple 12K Model I or III system.

I wanted a group of functions in memory that I could just call when needed or command from my Basic

program. I decided to write an operating system for my nondisk 16K Model I.

I set a few goals for this operating system: It would be Model I/III compatible, written in Assembly language, compile to approximately 4K of machine language, reside in low memory, and all functions would be callable either by name or by a CMD-type function. Most Basic programs should run with the remaining 12K. In fact, very few Basic programs require more than 8K except for those using lots of data such as mailing lists, so losing 4K to an operating system was painless.

The question of where to begin such a monumental task is easily answered: *80 Micro*. I had all issues from the first on. I remembered reading articles describing most of the utilities I wanted.

I went through back issues to see what I could find. I felt like a kid in a candy shop with only a dollar to spend—so many possibilities but I could hardly use them all.

I eventually picked 13 articles containing Assembly-language programs and one other explaining the RST functions that I adapted for my operating system. I would have picked more, but I would have exceeded my goal of 4K.

A reference list follows this article. The articles with an asterisk were used to write NODOS 80. Additional magazine references for the same article are addenda from subsequent issues.

CMD"C":	Removes REM, ', and spaces from a Basic program.
CMD"O",A\$(0):	Sorts specified string array. Specify any array.
DEFUSR:	Specify USR address. DEFUSR0-DEFUSR9 are used with USR0-USR9.
MERGE:	Merge two or more Basic programs. Used with Merge *.
RENUM:	Renumber Basic programs. Also can be called using Name.
FIND:	Locate variables in Basic programs.
PACK:	Same as CMD"C" above.
UNIKEY:	Single-key command entry. A toggle command.
DELAY:	Limited debounce routine for Unikey. Disable with Nodelay.
EDT:	Autoedit function. A toggle command.
SNGL:	Single-step through Basic. A toggle command.
DUAL:	Route video output to printer also. Same as Dual Y. Disable with Dual N.
PRDO:	Route printer output to video instead. Disabled with Dual N.
DOPR:	Route video output to printer instead. Disabled with Dual N.
&H, &O, &D:	Hexadecimal, octal, decimal conversion.

Table 1. Synopsis of Commands Available in NODOS 80

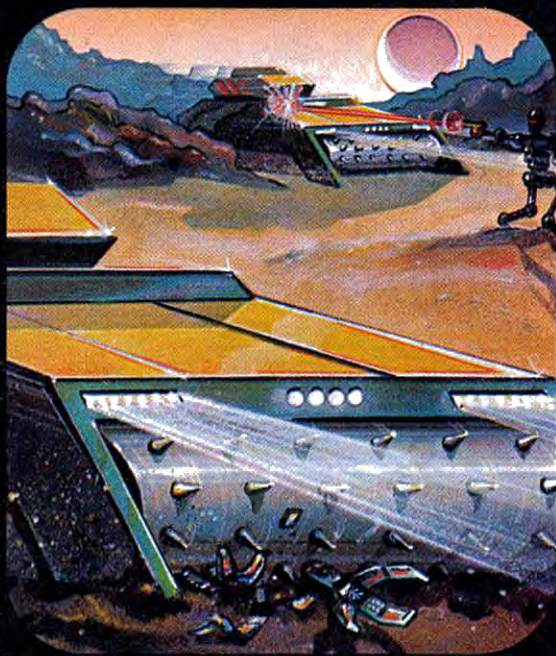
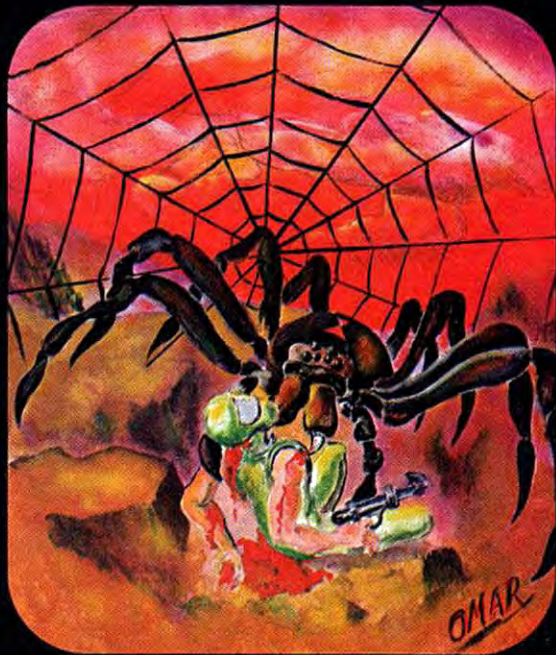
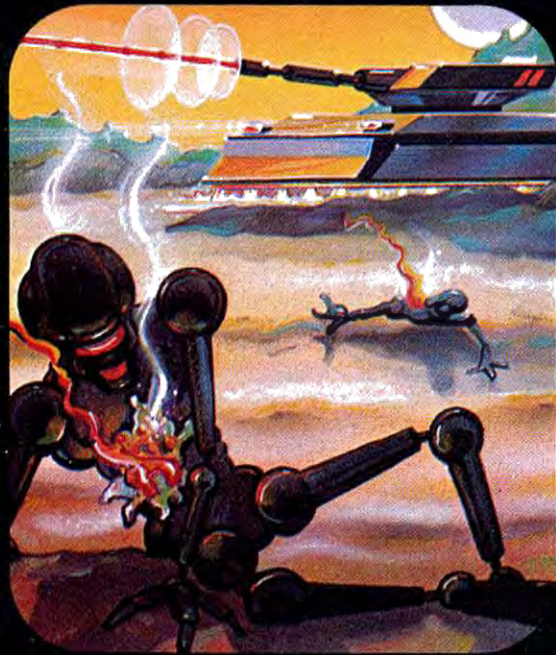
To Activate Key Codes, Press Shift Plus Alphabetical Key

A PRINT@	B ELSE	C CHR\$(	D DATA
E RIGHT\$(	F FOR	G GOTO	H RND(
I INPUT"	J READ	K INKEY\$(	L LEN(
M ASC(	N NEXT	O POKE	P PEEK(
Q LEFT\$(	R RETURN	S GOSUB	T TAB(
U USING	V STRING\$(	W MID\$(	X SET(
Y THEN	Z RESET(

Table 2. Unikey Single-key Entry Commands

The Key Box

**Model I or III
16K RAM
Assembly Language, cassette
Editor/Assembler**



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Program Listing 1

```

00100 ; NODOS80-A EXEC PROGRAM
00110 ; CUSTOM COMMANDS AND ERROR MESSAGES
00120 ; CMD " ", DEFUSR, USR, MERGE, SPECIAL COMMANDS
00130 ; COMPILATION, ADAPTATION OF CODE, AND NEW CODE
00140 ; BY THOMAS L. QUINDRY
00150 ;
00160 ; CUSTOMIZED CMD " " FUNCTION ADAPTED FROM
00170 ; DALE W. RUPERT, 80 MICRO, NOV 81, P292
00180 ORG 4300H
4300 3A7341 00190 PATCH LD A,(4173H) ;CMD
4303 325843 00200 LD (STORE),A
4306 2A7441 00210 LD HL,(4174H)
4309 225943 00220 LD (STORE+1),HL
430C 3A5B41 00230 LD A,(415BH) ;DEFUSR
430F 32C643 00240 LD (STORE3),A
4312 2A5C41 00250 LD HL,(415CH)
4315 22C743 00260 LD (STORE3+1),HL
4318 3AA941 00270 LD A,(41A9H) ;USR
431B 322C44 00280 LD (STORE4),A
431E 2AAA41 00290 LD HL,(41AAH)
4321 222D44 00300 LD (STORE4+1),HL
4324 3EC3 00310 LD A,0C3H ;JUMP COMMAND
4326 327341 00320 LD (4173H),A ;CMD
4329 325B41 00330 LD (415BH),A ;DEFUSR
432C 32A941 00340 LD (41A9H),A ;USR
432F 215B43 00350 LD HL,START
4332 227441 00360 LD (4174H),HL
4335 21DD43 00370 LD HL,START3
4338 225C41 00380 LD (415CH),HL
433B 212F44 00390 LD HL,START4
433E 22AA41 00400 LD (41AAH),HL
4341 060A 00410 LD B,10
4343 214A1E 00420 ERR1 LD HL,1E4AH ;ERROR MESSAGE
4346 22C943 00430 ERR LD (DEFUS),HL
4349 214743 00440 LD HL,ERR+1
434C 34 00450 INC (HL)
434D 34 00460 INC (HL)
434E 10F3 00470 DJNZ ERR1
4350 0614 00480 LD B,20
4352 35 00490 ERR2 DEC (HL)
4353 10FD 00500 DJNZ ERR2
4355 C35644 00510 JP PATCH1
0003 00520 STORE DEFS 3
435B E5 00530 START PUSH HL
435C D5 00540 PUSH DE
435D F5 00550 PUSH AF
435E E5 00560 PUSH HL
435F 21BC43 00570 LD HL,TABLE2
4362 228743 00580 LD (TABLE),HL
4365 E1 00590 POP HL
4366 FE22 00600 CP ;CHECK FORMAT
4368 2047 00610 JR NZ,QUIT
436A D7 00620 RST 16
436B FE41 00630 CP 'A' ;BETWEEN A AND Z?
436D FAB143 00640 JP M,QUIT
4370 FE5A 00650 CP 'Z'
4372 CA7843 00660 JP Z,OK1
4375 F2B143 00670 JP P,QUIT
4378 21B643 00680 OK1 LD HL,TABLE1
437B BE 00690 TEST CP (HL)
437C 2825 00700 JR Z,ADDR1
437E 57 00710 LD D,A
437F 7E 00720 LD A,(HL)
4380 B7 00730 OR A
4381 282E 00740 JR Z,QUIT
4383 7A 00750 LD A,D
4384 23 00760 INC HL
4385 18F4 00770 JR TEST
4387 0000 00780 TABLE DEFWD 0000
4389 11B643 00790 ADDR LD DE,TABLE1 ;FIND CMD " " ADDRESS
438C 3F 00800 CCF
438D ED52 00810 SBC HL,DE
438F 23 00820 INC HL
4390 7D 00830 LD A,L
4391 07 00840 RLCA
4392 2A8743 00850 LD HL,(TABLE)
4395 2B 00860 DEC HL
4396 2B 00870 DEC HL
4397 3C 00880 INC A
4398 3C 00890 INC A
4399 C5 00900 PUSH BC
439A 47 00910 LD B,A
439B 23 00920 INCR INC HL
439C 10FD 00930 DJNZ INCR
439E C1 00940 POP BC
439F 5E 00950 LD E,(HL)
43A0 23 00960 INC HL
43A1 56 00970 LD D,(HL)
43A2 C9 00980 RET
43A3 CD8943 00990 ADDR1 CALL ADDR
43A6 21AC43 01000 LD HL,NEXT1
43A9 E5 01010 PUSH HL
43AA D5 01020 ;ADDRESS IN DE
43AB C9 01030 RET ;JUMP TO "DE" ADDRESS
43AC F1 01040 NEXT1 POP AF
43AD D1 01050 POP DE
43AE E1 01060 POP HL
43AF 23 01070 INC HL
43B0 C9 01080 RET
43B1 F1 01090 QUIT POP AF
43B2 D1 01100 POP DE
43B3 E1 01110 POP HL
43B4 18A2 01120 JR STORE
43B6 43 01130 TABLE1 DEFB 'C' ;PACK
43B7 4F 01140 DEFB 'O' ;SORT
43B8 50 01150 DEFB 'P' ;UNASSIGNED

```

Listing 1 continues

The functions I included in my operating system were CMD“ ”; DEFUSR; nine USR functions; a command interpreter; full error messages; hexadecimal, octal, and decimal conversion routines; a sort routine; single-step Basic, automatic editing; single-key command entry; a line-renumbering program; a program to delete spaces and remarks; a variable lister; dual and route functions for a line printer; and a new sign-on, or ready, message.

I named my operating system NODOS 80, which stands for “no disk operating system.” The 80 is in honor of 80 Micro.

The resulting program is broken down into four listings for a couple of reasons. Though the entire program compiles to approximately 4K of machine-language code, the Assembly-code listing is much longer and cannot all be compiled at once on a 16K computer. Each of the four parts fit within a 16K computer using the Radio Shack Editor/Assembler. Each can be compiled separately, and the four programs can be loaded one after the other in the order given to form the whole system.

Another reason for the split is so readers can customize the program to easily fit their needs. The program is modularly structured so that functions can easily be deleted or added during programming stages. You can use the reference list at the end of the article to find functions you like and want to add.

The only mandatory code is part A and part D following line 18240. Part A contains the executive program. This is the part of the program that recognizes commands. The other three parts have Equates, which only refer back to part A. Starting with line 18240 is the clean-up part of the program. This code determines where the new start of Basic will be. It sets all necessary pointers: the start of Basic pointer, the start of scalar variables, and the start and end of array variables.

Compatibility with the Model III is also maintained by code in this part. One program works on the Model I and Model III. For Model I efficiency, the program starts at 4300H. In the Model III, this starting address is in the middle of the 256-byte input buffer area. Instead of writing a new starting address for the Model III, I kept the same starting address and had the program determine if it is being used on a Model III, and if so, the input buffer is relocated to a safe area and the Basic pointers are advanced to allow for the change. Many functions also have changes from the original program to

maintain the compatibility between these two computers.

If you have no use for a particular function, just eliminate it along with all other code that refers to it. Then change the origin addresses at the start of each part following the one that was changed. The other changes will be in the origin addresses and DEFW commands listed at the bottom of parts B, C, or D.

For instance, you may already have a good renumbering program. The codes for the renumbering function of NODOS 80 take up over 25 percent of the operating-system code. Part C is entirely devoted to renumbering. If you decide you don't want the renumbering function, simply ignore part C. The only change to part D would be to replace the origin address on line 13990 with 4AD3H. If you don't have a printer, the printer functions Dual and Route in lines 14000-14530 and the references to that part of the program in lines 18600-18690 can be eliminated.

If you want to add commands, that is also easy. Take, for instance, the Unikey command, to enable single-key entry commands. In part A, lines 2910-2930, have the words UNIKE, 'Y'+80H, and OUT0. The Unikey command has the last letter set with the seventh bit high (+80H). This tells the program that the end of the word to be compared has been reached. The next two bytes give the address of the Unikey function.

Notice that in part A OUT0 goes to the error-message section instead. The remark PATCH8 is where we want the program to jump to when it interprets the Unikey command. Down in part D, the program that contains Unikey, lines 18500 and 18510, fill the space in line 2930 with the proper address. This is how you add or delete commands. If a command is deleted, the program jumps to an error message as if the command name had not been recognized.

Starting on line 3210 are 31 spaces to add your own coded names and addresses to the command table. Just remember to set the seventh bit high for the last letter of the command. At this time, line 3210 is a zero byte. A zero signals the end of the command table. Be sure to start your commands here, eliminating this zero byte; after you add your last command, be sure to follow the address with a zero byte. You can add your function code anywhere before the clean-up section as long as you adjust the origin statements at the beginning of the parts B, C, or D that are affected.

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Listing 1 continued

43B9	58	01160	DEFB	'X'	;UNASSIGNED
43BA	5A	01170	DEFB	'Z'	;UNASSIGNED
43BB	00	01180	DEFB	0	
43BC	B143	01190	TABLE2	DEFW	QUIT ;PACK
43BE	B143	01200	DEFW	QUIT ;SABUBL	
43C0	B143	01210	DEFW	QUIT ;UNASSIGNED	
43C2	B143	01220	DEFW	QUIT ;UNASSIGNED	
43C4	B143	01230	DEFW	QUIT ;UNASSIGNED	
		01240 ;		DEFUSR FUNCTION	
		01250 ;		THOMAS L. QUINDRY, NEW CODE	
		01260 ;		INCLUDES CODE FROM BASIC ENHANCED AGAIN	
0003		01270	STORE3	DEFS	3
0014		01280	DEFUS	DEFS	20 ;DEFUSR ADDRESS TABLE
43DD	F5	01290	START3	PUSH	AF
43DE	D5	01300		PUSH	DE
43DF	E5	01310		PUSH	HL
43E0	11C643	01320		LD	DE,STORE3
43E3	D5	01330		PUSH	DE
43E4	FEC1	01340		CP	0C1H ;TOKENIZED USR CODE
43E6	206A	01350		JR	NZ,QUIT1
43E8	D7	01360		RST	16
43E9	FED5	01370		CP	0D5H ;TOKENIZED EQUAL SIGN
43EB	2003	01380		JR	NZ,DIGIT1
43ED	3E30	01390		LD	A,30H
43EF	2B	01400		DEC	HL
43F0	CDF843	01410	DIGIT1	CALL	DIGIT
43F3	CD0544	01420		CALL	USR2
43F6	1E20	01430		JR	DEFUS1
43F8	FE30	01440	DIGIT	CP	30H ;BETWEEN 0 AND 9?
43FA	F2FF43	01450		JP	P,OK
43FD	1853	01460		JR	QUIT1
43FF	FE3A	01470	OK	CP	3AH
4401	F25244	01480		JP	P,QUIT1
4404	C9	01490		RET	
4405	D62F	01500	USR2	SUB	2FH
4407	07	01510		RLCA	
4408	221644	01520		LD	(STOR4A),HL
440B	21C743	01530		LD	HL,DEFUS-2
440E	47	01540		LD	B,A
440F	23	01550	INCR1	INC	HL
4410	10FD	01560		DJNZ	INCR1
4412	222544	01570		LD	(STOREH+2),HL
4415	C9	01580		RET	
4416	0000	01590	STOR4A	DEFW	0000
4418	2A1644	01600	DEFUS1	LD	HL,(STOR4A)
441B	D7	01610		RST	16
441C	FED5	01620		CP	0D5H ;EQUAL SIGN
441E	2032	01630		JR	NZ,QUIT1
4420	CD012B	01640		CALL	2B01H ;EVALUATE ASCII TO BINARY
4423	ED53C943	01650	STOREH	LD	(DEFUS),DE
4427	F1	01660	USR1	POP	AF
4428	F1	01670		POP	AF
4429	D1	01680		POP	DE
442A	F1	01690		POP	AF
442B	C9	01700		RET	
		01710 ;			USR FUNCTIONS ADAPTED FROM
		01720 ;			BASIC ENHANCED AGAIN
		01730 ;			MARK GOODWIN, 80 MICRO, NOV 81, P384
0003		01740	STORE4	DEFS	3
442F	F5	01750	START4	PUSH	AF
4430	D5	01760		PUSH	DE
4431	E5	01770		PUSH	HL
4432	112C44	01780		LD	DE,STORE4
4435	D5	01790		PUSH	DE
4436	D7	01800		RST	16
4437	FE28	01810		CP	'(' ;CHECK FORMAT
4439	2003	01820		JR	NZ,DIGIT2
443B	3E30	01830		LD	A,30H
443D	2B	01840		DEC	HL
443E	CDF843	01850	DIGIT2	CALL	DIGIT
4441	CD0544	01860		CALL	USR2
4444	7E	01870		LD	A,(HL)
4445	5F	01880		LD	E,A
4446	23	01890		INC	HL
4447	7E	01900		LD	A,(HL)
4448	57	01910		LD	D,A
4449	ED538E40	01920		LD	(408EH),DE
444D	2A1644	01930		LD	HL,(STOR4A)
4450	18D5	01940		JR	USR1
4452	E1	01950	QUIT1	POP	HL ;ERROR OCCURRED
4453	D1	01960		POP	DE
4454	F1	01970		POP	AF
4455	C9	01980		RET	
		01990 ;			MERGE AND MERGE* COMMANDS ADAPTED FROM
		02000 ;			DALE W. RUPERT, 80 MICRO, NOV 81, P292
4456	215E44	02010	PATCH1	LD	HL,START1
4459	228C41	02020		LD	(418CH),HL ;MERGE COMMAND
445C	181D	02030		JR	PATCH2
445E	7E	02040	START1	LD	A,(HL)
445F	FECF	02050		CP	0CFH ;TOKENIZED *
4461	280A	02060		JR	Z,MERGE2
4463	2AF940	02070	MERGE	LD	HL,(40F9H) ;END OF BASIC
4466	2B	02080		DEC	HL
4467	2B	02090		DEC	HL
4468	22A440	02100		LD	(40A4H),HL ;START OF BASIC
446B	1806	02110		JR	BASIC
446D	2A7944	02120	MERGE2	LD	HL,(BAS)
4470	22A440	02130		LD	(40A4H),HL
4473	01181A	02140	BASIC	LD	BC,1A18H ;MODEL I/III JUMP
4476	C3AE19	02150		JP	19AEH ;TO BASIC
4479	0000	02160	BAS	DEFW	0 ;LOWEST BASIC START
		02170 ;			SPECIAL COMMAND RECOGNITION ADAPTED FROM
		02180 ;			WHITE
		02190 ;			JAKE COMMANDER, 80 MICRO, JULY 80, P94
447B	3EC3	02200	PATCH2	LD	A,0C3H
447D	32A641	02210		LD	(41A6H),A ;ERROR
4480	218944	02220		LD	HL,ENTRY
4483	22A741	02230		LD	(41A7H),HL
4486	C33D47	02240		JP	PATCH3
4489	F5	02250	ENTRY	PUSH	AF

Listing 1 continues

The command tables for CMD“ ” are similar, except that only single-letter commands are used. In this case, TABLE1 corresponds with the addresses in TABLE2 (lines 1130 -1230). Extra unassigned commands P, X, and Z are given. You can change them to suit your needs, or you can use them by putting the correct function addresses in lines 1210, 1220, and 1230, respectively. Notice the one-for-one correspondence between TABLE1 and TABLE2 as given by the remarks.

Table 1 gives a synopsis of all of the functions. The rest of this article gives more detail on how to use them.

CMD“ ” Function

Two commands are available. First, CMD“C” calls the pack function. This function compresses your Basic program in memory by removing all spaces and remark statements. It will remove both the REM and the (')-type remark statement. If a line is entirely a remark statement, the line is deleted.

Second, commands of the form CMD“O”,A\$(0) alphabetically sort the string array specified. You can specify any string array. It is mandatory that the subscript zero array be specified as above.

It is a good idea to dimension every string array to be sorted to exactly the number of elements to be used. If the array is not dimensioned, such as DIM A\$(5), a dimension of 10 is assumed. Unused strings have a null value and are sorted to the beginning of the array elements. For example, if only five strings are defined and the string array is not dimensioned, the sorted array starts with null strings from the 0-5 elements. The array elements that have been defined will start with element 6.

Specified Commands

The DEFUSR command is used to specify the address for the correspondingUSR command. These commands can specify DEFUSR0-DEFUSR9 andUSR0-USR9. The zero is optional. DEFUSER works exactly as it does in Disk Basic. Enter it in the form DEFUSR7 = 32000. USR also works in the same manner as in Disk Basic. Enter it in the form X=USR7(Y) or PRINT USR7(Y) where the value or variable Y can be passed to the called machine-language routine.

Merge lets you CLOAD two or more Basic programs consecutively in memory. The command temporarily hides the program already entered by redefining the start of Basic pointer to the address just above where the program

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resides. After an additional program has been entered, the Merge * command restores the start of Basic pointer to the beginning of the first program. The space between Merge and * is optional. Use the RENUM or Name command to renumber the last program entered so that line numbers do not conflict with previous programs entered. Then use the Merge * command

to restore the start-of-Basic pointer to its original position.

RENUM renumbers your Basic program in memory. The Name command provides the same function. This optional command name is given because it is similar to the renumbering function in Disk Basic.

Four options are available once you are in the renumbering program. "En-

Listing 1 continued

```

448A 7B      02260      LD      A,E
448B FE02    02270      CP      2                ;SYNTAX ERROR?
448D C25545  02280      JP      NZ,OUT1
4490 E5      02290      PUSH   HL
4491 D5      02300      PUSH   DE
4492 2AE640  02310      LD      HL,(40E6H)
4495 7E      02320      LD      A,(HL)
4496 B7      02330      OR      A
4497 2004    02340      JR      NZ,NCHR
4499 23      02350      INC    HL
449A 23      02360      INC    HL
449B 23      02370      INC    HL
449C 23      02380      INC    HL
449D D7      02390      RST    16
449E 11DA44  02400      LD      DE,CMD
44A1 E5      02410      PUSH   HL
44A2 1A      02420      CMPR   A,(DE)          ;COMPARE WITH COMMAND TABLE
44A3 B7      02430      OR      A
44A4 CA5245  02440      JP      Z,OUT0          ;RAN OUT OF WORDS TO COMPARE

44A7 CBBF    02450      RES    7,A              ;GET RID OF HI BIT
44A9 BE      02460      CP      (HL)
44AA 2009    02470      JR      NZ,NEXT
44AC 1A      02480      LD      A,(DE)
44AD CB7F    02490      BIT    7,A
44AF 200F    02500      JR      NZ,DONE
44B1 23      02510      INC    HL
44B2 13      02520      CMPL   INC            DE
44B3 18ED    02530      JR      CMPL
44B5 1A      02540      NEXT   LD      A,(DE)
44B6 CB7F    02550      BIT    7,A
44B8 13      02560      INC    DE
44B9 28FA    02570      JR      Z,NEXT
44BB 13      02580      INC    DE
44BC E1      02590      POP    HL
44BD E5      02600      PUSH   HL
44BE 18F2    02610      JR      CMPL
44C0 F1      02620      DONE   POP    AF          ;FOUND COMMAND
44C1 F1      02630      POP    AF
44C2 F1      02640      POP    AF
44C3 F1      02650      POP    AF
44C4 F1      02660      POP    AF
44C5 E5      02670      PUSH   HL
44C6 21D144  02680      LD      HL,EXIT1
44C9 E5      02690      PUSH   HL          ;PUT "HL" ADDRESS ON STACK
44CA 13      02700      INC    DE
44CB 1A      02710      LD      A,(DE)
44CC 6F      02720      LD      L,A
44CD 13      02730      INC    DE
44CE 1A      02740      LD      A,(DE)
44CF 67      02750      LD      H,A
44D0 E9      02760      JP      (HL)          ;JUMP TO COMMANDED ROUTINE
44D1 AF      02770      EXIT1 XOR    A
44D2 329A40  02780      LD      (409AH),A      ;CLEAR ERROR
44D5 E1      02790      POP    HL
44D6 D7      02800      RST    16
44D7 C31E1D  02810      JP      1D1EH          ;BACK TO PROGRAM
44DA 52      02820      CMD    DEFM 'RENU'            ;COMMAND TABLE
44DE CD      02830      DEFB 'M'+80H          ;END BIT + 80H
44DF 5245    02840      DEFW OUT0             ;START7 (ADDRESS TO GO TO)
44E1 46      02850      DEFM 'FIN'
44E4 C4      02860      DEFB 'D'+80H
44E5 5245    02870      DEFW OUT0             ;FIND
44E7 50      02880      DEFM 'FAC'
44EA CB      02890      DEFB 'K'+80H
44EB 5245    02900      DEFW OUT0             ;PACK
44ED 55      02910      DEFM 'UNIKI'
44F2 D9      02920      DEFB 'Y'+80H
44F3 5245    02930      DEFW OUT0             ;PATCH8
44F5 44      02940      DEFM 'DELA'
44F9 D9      02950      DEFB 'Y'+80H
44FA 5245    02960      DEFW OUT0             ;BOUNCE
44FC 4E      02970      DEFM 'NODELA'
4502 D9      02980      DEFB 'Y'+80H
4503 5245    02990      DEFW OUT0             ;NOBOU
4505 45      03000      DEFM 'ED'
4507 D4      03010      DEFB 'T'+80H
4508 5245    03020      DEFW OUT0             ;PATCHA
450A 53      03030      DEFM 'SNG'
450D CC      03040      DEFB 'L'+80H
450E 5245    03050      DEFW OUT0             ;PATCHB
4510 44      03060      DEFM 'DUAL'
4515 CE      03070      DEFB 'N'+80H
4516 5245    03080      DEFW OUT0             ;DUALOF
4518 44      03090      DEFM 'DUAL'
451D D9      03100      DEFB 'Y'+80H
451E 5245    03110      DEFW OUT0             ;DUALON
4520 44      03120      DEFM 'DUA'
4523 CC      03130      DEFB 'L'+80H
4524 5245    03140      DEFW OUT0             ;DUALON

```

Listing 1 continues

ter start line" and "enter end line" specify which lines you wish to renumber. "Enter new start line" specifies the line number of the first line to be renumbered. "Enter increment" specifies the difference between renumbered lines.

Beware! If you renumber lines in the middle of a program and your increment is too large to keep within the boundaries of lines not renumbered, the program may not run properly. And it may not be easily corrected if GOTOs or GOSUBs refer to those line numbers either before or after renumbering. Also, too large an increment may overflow the 65529 number limit and continue numbering with a lower number. Sometimes using RENUM gives erroneous error messages specifying nonexistent line numbers. Your program is not affected by these messages.

The Find command locates variables used in the Basic program in memory. You can specify up to three letters, including the \$, #, !, and % signs. It doesn't recognize tokenized words, but to some extent it recognizes partial strings up to three letters. It recognizes three-byte combinations and one or two-byte combinations followed by a space. It does not check the variable type, so you must specify the variable exactly as it appears in the text of your program. For example, if you have a DEFINT A command, check for A and not A% if the variable appears in the program as A.

Pack provides the same function as CMD"C". The CMD"C" command was included because it is similar to the Disk Basic compress function. Some may prefer to use the Pack command instead.

Unikey allows single-key entries by hitting the shift key and any alphabetic key or the down arrow. Table 2 gives the coded entry conditions for Unikey. The shift, down-arrow combination enters a user defined command or commands. This command line is pre-defined as RUN<CR>. You can change it to any command or string of commands up to 64 characters by entering shift, clear. You can also enter the carriage return as part of your command. After the command line has been defined, you must enter shift, clear again to put the command in memory for later use. Unikey is a toggle command. Entering the command again disables the function. You can enable and disable it as often as you like.

Delay adds some debounce to the Unikey function. This is not needed in

Listing continued

```

4526 50      03150      DEFM 'PRD'
4529 CP      03160      DEFB 'O'+80H
452A 5245   03170      DEFW OUT0 ;PRDO
452C 44      03180      DEFM 'DOP'
452F D2      03190      DEFB 'R'+80H
4530 5245   03200      DEFW OUT0 ;DOPR
4532 00      03210      DEFB 0
001E        03220      DEFS 30 ;ROOM FOR MORE COMMANDS
4551 00      03230      DEFB 0
4552 D1      03240      POP DE ;GIVE ERROR
4553 D1      03250      POP DE
4554 E1      03260      POP HL
4555 F1      03270      POP AF ;GIVE ERROR MESSAGE
4556 C30F47 03280      JP ERRMES
                                03290 ;
                                03300 ;
                                03310 NF DEFM 'HARRY AND KEY KEAIRNS, 80 MICRO, OCT 81, P340
4559 4E      03320 SN DEFM 'NEXT without FOR'
456A 53      03330 RG DEFM 'Syntax'
4571 52      03340 OD DEFM 'RETURN without GOSUB'
4586 4F      03350 PC DEFM 'Out of DATA'
4592 49      03360 OV DEFM 'Illegal function call'
45A8 4F      03370 OM DEFM 'Overflow'
45B1 4F      03380 UL DEFM 'Out of memory'
45BF 55      03390 BS DEFM 'Undefined line number'
45D5 53      03400 DD DEFM 'Subscript out of range'
45EC 52      03410 DO DEFM 'Redimensioned array'
4600 44      03420 ID DEFM 'Division by zero'
4611 49      03430 TM DEFM 'illegal direct'
4620 54      03440 OS DEFM 'Type mismatch'
462E 4F      03450 LS DEFM 'Out of string space'
4642 53      03460 ST DEFM 'String too long'
4652 53      03470 CN DEFM 'String formula too complex'
466D 43      03480 DEFM 'Can'
4670 27      03490 DEFB 27H ;APOSTROPHE
4671 74      03500 NR DEFM 't continue'
467C 4E      03510 RW DEFM 'No RESUME'
4686 52      03520 UE DEFM 'RESUME without'
4695 55      03530 MO DEFM 'Unprintable'
46A1 4D      03540 PD DEFM 'Missing operand'
46B1 42      03550 L3 DEFM 'BAD file data'
46BF 4E      03560 TABL DEFW 'N/A in NODOS 80 - Disk BASIC only'
46E1 5945   03570 DEFW NF
46E3 6A45   03580 DEFW SN
46E5 7145   03590 DEFW RG
46E7 8645   03600 DEFW OD
46E9 9245   03610 DEFW FC
46EB A845   03620 DEFW OV
46ED B145   03630 DEFW OM
46EF BF45   03640 DEFW UL
46F1 D545   03650 DEFW BS
46F3 EC45   03660 DEFW DD
46F5 0046   03670 DEFW DO
46F7 1146   03680 DEFW ID
46F9 2046   03690 DEFW TM
46FB 2E46   03700 DEFW OS
46FD 4246   03710 DEFW LS
46FF 5246   03720 DEFW ST
4701 6D46   03730 DEFW CN
4703 7C46   03740 DEFW NR
4705 8646   03750 DEFW RW
4707 9546   03760 DEFW UE
4709 A146   03770 DEFW MO
470B B146   03780 DEFW FD
470D BF46   03790 DEFW L3
470F 21E146 03800 ERRMES LD HL,TABL
4712 09      03810 ADD HL,BC
4713 D5      03820 PUSH DE
4714 5E      03830 LD E,(HL)
4715 23      03840 INC HL
4716 56      03850 LD D,(HL)
4717 EB      03860 EX DE,HL
4718 D1      03870 POP DE
4719 CDA728 03880 CALL 28A7H
471C 211D19 03890 LD HL,191DH ;ERROR POINTER
471F E5      03900 PUSH HL
4720 2AEA40 03910 LD HL,(40EAH)
4723 E3      03920 EX (SP),HL
4724 CDA728 03930 CALL 28A7H
4727 E1      03940 POP HL
4728 11FEFF 03950 LD DE,0FFFEH
472B DF      03960 RST 18H
472C CA7406 03970 JP Z,0674H
472F 7C      03980 LD A,H
4730 A5      03990 AND L
4731 3C      04000 INC A
4732 C4A70F 04010 CALL NZ,0FA7H
4735 3ECL    04020 LD A,0CLH
4737 CD8B03 04030 CALL 038BH
473A C31C1A 04040 JP 1ALCH
473D C37344 04050 PATCH3 JP BASIC
02B2        04060 END 02B2H
00000 TOTAL ERRORS

```

Program Listing 2

```

04060 ; NODOS80-B FUNCTIONS
04070 ; HEX/DEC/BINARY, READY MESSAGE,
04080 ; VARIABLE LISTER, PACKER
04090 ;
04100 ; HEX/OCTAL/DECIMAL CONVERSION FROM
04110 ; CONSTANT ALTERNATIVES
04120 ; EVAN C. HAND, SR., 80 MICRO, MAR 81, P225
473D 04130 ORG 473DH
473D 3A9441 04140 PATCH3 LD A,(4194H) ;& FUNCTION

```

Listing continues

Listing 2 continued

```

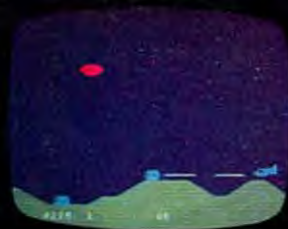
4740 325747 04150 LD (STORE5),A
4743 2A9541 04160 LD HL,(4195H)
4746 225847 04170 LD (STORE5+1),HL
4749 3EC3 04180 LD A,0C3H
474B 329441 04190 LD (4194H),A
474E 215A47 04200 LD HL,START5
4751 229541 04210 LD (4195H),HL
4754 C3AF47 04220 JP PATCH4
0003 04230 STORE5 DEFS 3
475A D7 04240 START5 RST 16
475B 110000 04250 LD DE,0
475E FE48 04260 CP 'H'
4760 2815 04270 JR Z,HEX
4762 FE4F 04280 CP '0'
4764 282F 04290 JR Z,OCT
4766 FE44 04300 CP 'D'
4768 C25747 04310 JP WZ,STORE5
476B CD5E1E 04320 DEC CALL 1E5EH ;ASCII TO BINARY
476E EB 04330 EX DE,HL
476F CD9A0A 04340 LDINT CALL 0A9AH ;INTEGER LOAD
4772 EB 04350 EX DE,HL
4773 C9 04360 RET
4774 C3B207 04370 OVERR JP 07B2H ;OVERFLOW ERROR
4777 D7 04380 HEX RST 16
4778 EB 04390 EX DE,HL
4779 300C 04400 JR NC,ALPHA
477B E60F 04410 AND 0FH
477D 0604 04420 SHIFT LD B,04H
477F CDA947 04430 CALL SHFLFT
4782 B5 04440 OR L
4783 6F 04450 LD L,A
4784 EB 04460 EX DE,HL
4785 18F0 04470 JR HEX
4787 28E6 04480 ALPHA JR Z,LDINT
4789 FE41 04490 CP 'A' ;BETWEEN A AND P?
478B 38E2 04500 JR C,LDINT
478D FE47 04510 CP 'G'
478F 30DE 04520 JR NC,LDINT
4791 D637 04530 SUB 37H
4793 18E8 04540 JR SHIFT
4795 D7 04550 OCT RST 16
4796 EB 04560 EX DE,HL
4797 30D6 04570 JR NC,LDINT
4799 FE38 04580 CP '8'
479B 30D7 04590 JR NC,OVERR
479D 0603 04600 LD B,03
479F CDA947 04610 CALL SHFLFT
47A2 E60F 04620 AND 0FH
47A4 B5 04630 OR L
47A5 6F 04640 LD L,A
47A6 EB 04650 EX DE,HL
47A7 18EC 04660 JR OCT
47A9 29 04670 SHFLFT ADD HL,HL
47AA 38C8 04680 JR C,OVERR
47AC 10FB 04690 DJNZ SHFLFT
47AE C9 04700 RET
04710 ; NODOS 80 MESSAGE FROM
04720 ; NEVER READY
04730 ; RON BALEWSKI, 80 MICRO, JULY 81, P199
47AF 21BD47 04740 PATCH4 LD HL,START6
47B2 22AD41 04750 LD (41ADH),HL
47B5 3EC3 04760 LD A,0C3H
47B7 32AC41 04770 LD (41ACH),A
47BA C3D34A 04780 JP PATCH7
47BD CDF881 04790 START6 CALL 01F8H ;SIMILAR TO ROM
47C0 CDF920 04800 CALL 20F9H
47C3 21CD47 04810 LD HL,MESS ;SUBSTITUTE MESSAGE
47C6 CDA728 04820 CALL 28A7H
47C9 E1 04830 POP HL
47CA C32B1A 04840 JP 1A2BH ;RETURN TO ROM
47CD 4E 04850 MESS DEFB 'NODOS 80 READY'
47DB 0D 04860 DEFB 0DH
47DC 00 04870 DEFB 0
04880 ; FIND VARIABLES IN BASIC ADAPTED FROM
04890 ; LOST IN BASIC
04900 ; MARK C. PAXTON, 80 MICRO, JAN 82, P304
0000 04910 BEGWS DEFS 0
0002 04920 SVLINE DEFS 2
0004 04930 FIELD DEFS 4
0003 04940 HLDPLD DEFS 3
47E6 4E 04950 PRGMID DEFM 'NODOS 80 Locator - Variable = '
4803 0D 04960 DEFB 0DH
4804 4C 04970 DEFM 'Line(s)'
480B 0D00 04980 DEFW 000DH
480D 20 04990 MSG1 DEFM ' ,12 SPACES
4819 0D 05000 DEFB 0DH
481A 4E 05010 DEFM 'No Basic Program in Memory'
4834 0D00 05020 DEFW 000DH
4836 3E5A 05030 VALCHR LD A,'Z'
4838 BE 05040 CP (HL)
4839 FA6240 05050 JP M,NONVAL
483C 3E2F 05060 LD A,2FH
483E BE 05070 CP (HL)
483F F26248 05080 JP P,NONVAL
4842 3E39 05090 LD A,'9'
4844 BE 05100 CP (HL)
4845 F24E48 05110 JP P,VALID
4848 3E40 05120 LD A,'8'
484A BE 05130 CP (HL)
484B FA4E48 05140 JP M,VALID
484E 3E01 05150 VALID LD A,1
4850 C9 05160 RET
4851 7E 05170 SPCCHR LD A,(HL)
4852 FE24 05180 CP 'S'
4854 28F8 05190 JR Z,VALID
4856 FE23 05200 CP '#'
4858 28F4 05210 JR Z,VALID
485A FE21 05220 CP 't'
485C 28F0 05230 JR Z,VALID
485E FE25 05240 CP '%'
4860 28EC 05250 JR Z,VALID
4862 AF 05260 NONVAL XOR A
4863 C9 05270 RET
4864 C1 05280 FIND POP BC
4865 E1 05290 POP HL ;GET HL
4866 E5 05300 PUSH HL ;RECTIFY STACK
4867 C5 05310 PUSH BC
4868 D5 05320 PUSH DE
4869 E5 05330 PUSH HL ;SAVE HL
486A 21DD47 05340 LD HL,BEGWS
486D 11DE47 05350 LD DE,BEGWS+1
4870 010800 05360 LD BC,8
4873 3600 05370 LD (HL),00
4875 EDB0 05380 LDIR
4877 E1 05390 POP HL
4878 D7 05400 RST 10H
4879 11DF47 05410 LD DE,FIELD
487C 0603 05420 LD B,3
487E 7E 05430 TRANS LD A,(HL)
487F B7 05440 OR A
4880 2805 05450 JR Z,CONT
4882 12 05460 LD (DE),A
4883 13 05470 INC DE
4884 23 05480 INC HL
4885 10F7 05490 DJNZ TRANS
4887 CDC901 05500 CONT CALL 01C9H
488A 21E647 05510 LD HL,PRGMID
488D CDA728 05520 CALL 28A7H
4890 CD9548 05530 CALL CHECK1
4893 181C 05540 JR CONT2
4895 ED4BA440 05550 CHECK1 LD BC,(40A4H)
4899 2AF940 05560 LD HL,(40F9H)
489C 2B 05570 DEC HL
489D 2B 05580 DEC HL
489E B7 05590 OR A
489F ED42 05600 SBC HL,BC
48A1 C0 05610 RET NZ
48A2 21113C 05620 LD HL,3C11H
48A5 222040 05630 LD (4020H),HL
48A8 210D48 05640 LD HL,MSG1
48AB CDA728 05650 CALL 28A7H

```

Listing 2 continues



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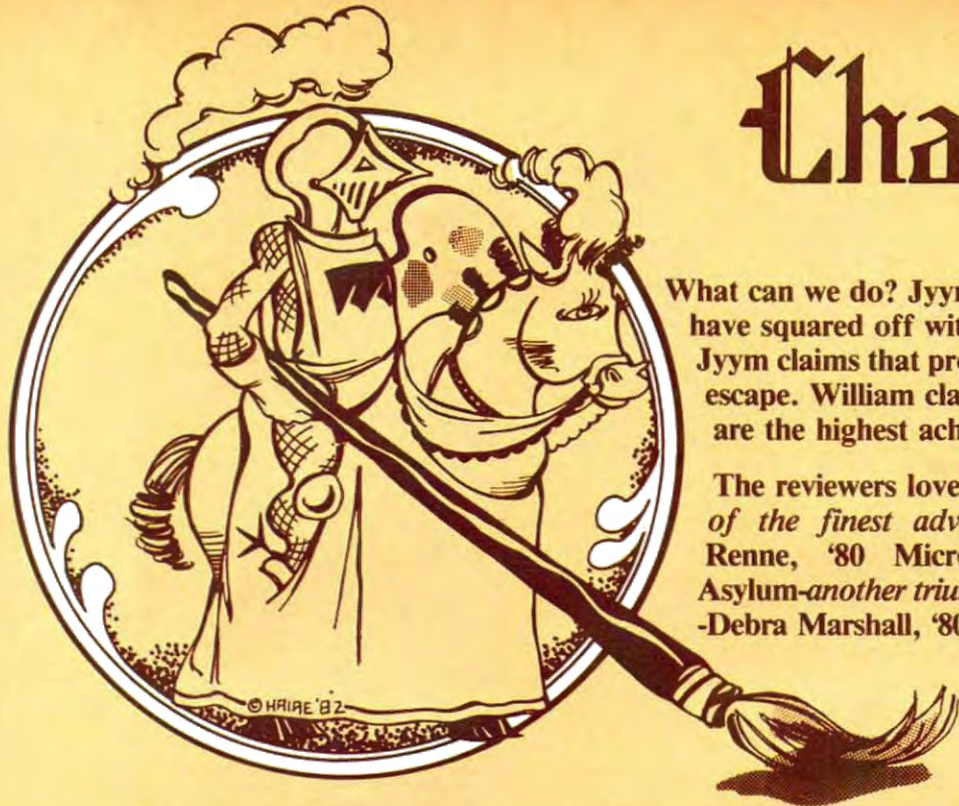
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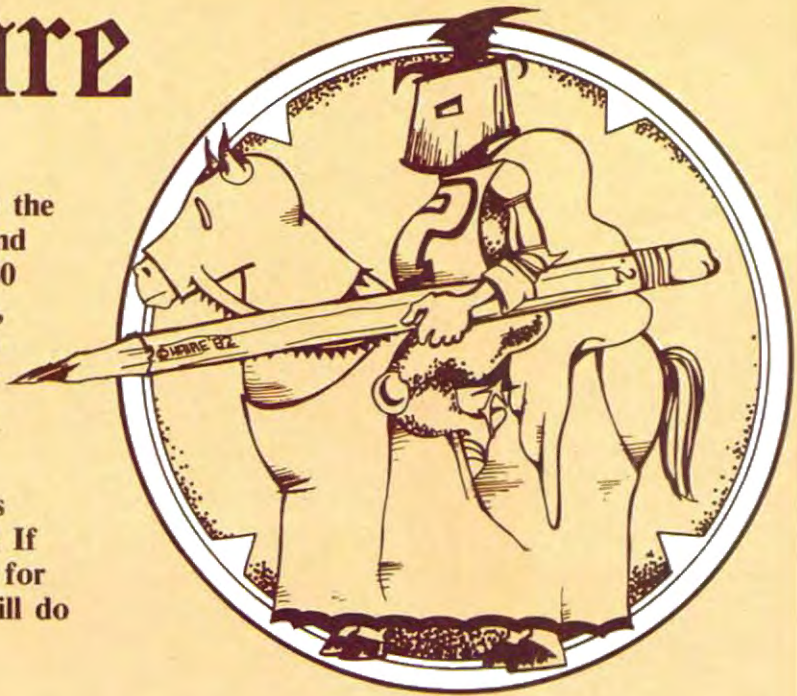
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Listing 2 continued

48AE	C37344	05660	JP	BASIC	4938	CD5148	06410	CALL	SPCCHR
48B1	E5	05670	PUSH	HL	493B	FE01	06420	CP	1
48B2	111E3C	05680	LD	DE,3C1EH	493D	2004	06430	JR	NZ,CHECK
48B5	ED532040	05690	LD	(4020H),DE	493F	7E	06440	LD	A,(HL)
48B9	21DF47	05700	LD	HL,FIELD	4940	32E547	06450	LD	(HLDFLD+2),A
48BC	CDA728	05710	CALL	28A7H	4943	3ADF47	06460	LD	A,(FIELD)
48BF	11403C	05720	LD	DE,3C48H	4946	DD21E347	06470	LD	IX,HLDFLD
48C2	ED532040	05730	LD	(4020H),DE	494A	DDBE00	06480	CP	(IX)
48C6	C1	05740	POP	BC	494D	2037	06490	JR	NZ,EXIT
48C7	2AA440	05750	LD	HL,(40A4H)	494F	3AE047	06500	LD	A,(FIELD+1)
48CA	23	05760	INC	HL	4952	DDBE01	06510	CP	(IX+1)
48CB	0B	05770	DEC	BC	4955	202F	06520	JR	NZ,EXIT
48CC	23	05780	INC	HL	4957	3AE147	06530	LD	A,(FIELD+2)
48CD	0B	05790	DEC	BC	495A	DDBE02	06540	CP	(IX+2)
48CE	7E	05800	LD	A,(HL)	495D	2027	06550	JR	NZ,EXIT
48CF	32DD47	05810	LD	(SVLINE),A	495F	E5	06560	DISPLN	PUSH HL
48D2	23	05820	INC	HL	4960	C5	06570	PUSH	BC
48D3	0B	05830	DEC	BC	4961	2ADD47	06580	LD	HL,(SVLINE)
48D4	7E	05840	LD	A,(HL)	4964	CD9A0A	06590	CALL	0A9AH
48D5	32DE47	05850	LD	(SVLINE+1),A	4967	AF	06600	XOR	A
48D8	23	05860	INC	HL	4968	CD3410	06610	CALL	1034H
48D9	0B	05870	DEC	BC	496B	B6	06620	OR	(HL)
48DA	AF	05880	XOR	A	496C	CDD90F	06630	CALL	0FD9H
48DB	32E347	05890	LD	(HLDFLD),A	496F	ED5B2040	06640	LD	DE,(4020H)
48DE	32E447	05900	LD	(HLDFLD+1),A	4973	213041	06650	LD	HL,4130H
48E1	32E547	05910	LD	(HLDFLD+2),A	4976	010600	06660	LD	BC,6
48E4	BE	05920	CP	(HL)	4979	EDB0	06670	LDIR	
48E5	2009	05930	JR	NZ,EXAM01	497B	13	06680	INC	DE
48E7	23	05940	INC	HL	497C	13	06690	INC	DE
48E8	0B	05950	DEC	BC	497D	ED532040	06700	LD	(4020H),DE
48E9	78	05960	LD	A,B	4981	CD9B1D	06710	CALL	1D9BH
48EA	B1	05970	OR	C	4984	C1	06720	POP	BC
48EB	CA8E49	05980	JP	Z,ENDPRG	4985	E1	06730	POP	HL
48EE	18DA	05990	JR	SAVELN	4986	AF	06740	EXIT	XOR A
48F0	CD3648	06000	CALL	VALCHR	4987	BE	06750	CP	(HL)
48F3	FE01	06010	CP	1	4988	CAE748	06760	JP	Z,BMPSAV
48F5	2809	06020	JR	Z,EXAM02	498B	C3F748	06770	JP	BMPRTN
48F7	23	06030	INC	HL	498E	21403F	06780	ENDPRG	LD HL,3F40H
48F8	0B	06040	DEC	BC	4991	222040	06790	LD	(4020H),HL
48F9	78	06050	LD	A,B	4994	C37344	06800	JP	BASIC
48FA	B1	06060	OR	C			06810	;	PACKER ADAPTED FROM
48FB	CA8E49	06070	JP	Z,ENDPRG			;		THE MEMORY EXPANDER
48FE	18DA	06080	JR	EXAMIN			;		TIM KENEALY, 80 MICRO, SEPT 81, P174
4900	7E	06090	LD	A,(HL)			;		USE CMD"C" OR PACK COMMAND
4901	32E347	06100	LD	(HLDFLD),A	4997	318842	06850	PACK	LD SP,4280H
4904	23	06110	INC	HL	499A	CD901	06860	CALL	01C9H
4905	0B	06120	DEC	BC	499D	21A24A	06870	LD	HL,TITLE
4906	78	06130	LD	A,B	49A0	CDA728	06880	CALL	28A7H
4907	B1	06140	OR	C	49A3	CD9548	06890	CALL	CHECK1
4908	CABE49	06150	JP	Z,ENDPRG	49A6	21B24A	06900	LD	HL,MSSG
490B	AF	06160	XOR	A	49A9	CDA728	06910	CALL	28A7H
490C	BE	06170	CP	(HL)	49AC	2AA440	06920	LD	HL,(40A4H)
490D	2834	06180	JR	Z,CHECK	49AF	22CF4A	06930	LD	(BUFF1),HL
490F	CD3648	06190	CALL	VALCHR	49B2	7E	06940	LD	A,(HL)
4912	FE01	06200	CP	1	49B3	32D14A	06950	LD	(BUFF2),A
4914	260D	06210	JR	Z,EXAM03	49B6	23	06960	INC	HL
4916	CD5148	06220	CALL	SPCCHR	49B7	7E	06970	LD	A,(HL)
4919	FE01	06230	CP	1	49B8	32D24A	06980	LD	(BUFF2+1),A
491B	2026	06240	JR	NZ,CHECK	49BB	2B	06990	DEC	HL
491D	7E	06250	LD	A,(HL)	49BC	ED5BA740	07000	COPY	LD DE,(40A7H)
491E	32E447	06260	LD	(HLDFLD+1),A	49C0	010400	07010	LD	BC,4
4921	1820	06270	JR	CHECK	49C3	EDB0	07020	LDIR	
4923	7E	06280	LD	A,(HL)	49C5	7E	07030	MORE	LD A,(HL)
4924	32E447	06290	LD	(HLDFLD+1),A	49C6	12	07040	LD	(DE),A
4927	23	06300	INC	HL	49C7	B7	07050	OR	A
4928	0B	06310	DEC	BC	49C8	2804	07060	JR	Z,DONE1
4929	78	06320	LD	A,B	49CA	23	07070	INC	HL
492A	B1	06330	OR	C	49CB	13	07080	INC	DE
492B	2861	06340	JR	Z,ENDPRG	49CC	18F7	07090	JR	MORE
492D	AF	06350	XOR	A	49CE	010000	07100	DONE1	LD BC,0
492E	BE	06360	CP	(HL)	49D1	2AA740	07110	LD	HL,(40A7H)
492F	2812	06370	JR	Z,CHECK	49D4	23	07120	INC	HL
4931	CD3648	06380	CALL	VALCHR	49D5	23	07130	INC	HL
4934	FE01	06390	CP	1	49D6	23	07140	INC	HL
4936	2007	06400	JR	Z,SAVCHK	49D7	23	07150	INC	HL
					49D8	7E	07160	LD	A,(HL)

Listing 2 continues

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Listing 2 continued

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49D9 FE3A 07170 CP 3AH
49DB 2006 07180 JR NZ,DONE2
49DD 3E20 07190 LD A,20H ;REMOVE COLON
49DF 77 07200 LD (HL),A
49E0 23 07210 INC HL ;CHECKS REM (')
49E1 7E 07220 LD A,(HL)
49E2 2B 07230 DEC HL
49E3 FE93 07240 CP 147
49E5 CA8A4A 07250 JP Z,ALLREM
49E8 7E 07260 LD A,(HL)
49E9 FE88 07270 CP 136
49EB 2816 07280 JR Z,DATA
49ED FE3A 07290 CP 3AH
49EF 2817 07300 JR Z,COLON
49F1 FE22 07310 CP 22H
49F3 2822 07320 JR Z,QUOTE
49F5 FE20 07330 CP 20H
49F7 282C 07340 JR Z,SPACE
49F9 FE93 07350 CP 147
49FB 284C 07360 JR Z,REM
49FD B7 07370 OR A
49FE 2852 07380 JR Z,FINISH
4A00 23 07390 INC HL
4A01 18E5 07400 JR CHECK3
4A03 0E01 07410 LD C,1
4A05 23 07420 INC HL
4A06 18E0 07430 JR CHECK3
4A08 79 07440 COLON LD A,C
4A09 FE01 07450 CP 1
4A0B 2007 07460 JR NZ,NODATA
4A0D 78 07470 LD A,B
4A0E FE01 07480 CP 1
4A10 2002 07490 JR Z,NODATA
4A12 0E00 07500 LD C,0
4A14 23 07510 NODATA INC HL
4A15 18D1 07520 JR CHECK3
4A17 78 07530 QUOTE LD A,B
4A18 FE01 07540 CP 1
4A1A 2804 07550 JR Z,SECOND
4A1C 0601 07560 LD B,1
4A1E 1802 07570 JR CONT3
4A20 0600 07580 SECOND LD B,0
4A22 23 07590 CONT3 INC HL
4A23 18C3 07600 JR CHECK3
4A25 78 07610 SPACE LD A,B
4A26 FE01 07620 CP 1
4A28 2003 07630 JR NZ,OUT
4A2A 23 07640 INDATA INC HL
4A2B 18BB 07650 JR CHECK3
4A2D 79 07660 OUT LD A,C
4A2E FE01 07670 CP 1
4A30 28F8 07680 JR Z,INDATA
4A32 E5 07690 PUSH HL
4A33 E5 07700 PUSH HL
4A34 DDE1 07710 POP IX
4A36 DD7E00 07720 LOOP LD A,(IX)
4A39 B7 07730 OR A
4A3A 280A 07740 JR Z,DONE3
4A3C DD7E01 07750 LD A,(IX+1)
4A3F DD7700 07760 LD (IX),A
4A42 DD23 07770 INC IX
4A44 18F0 07780 JR LOOP
4A46 E1 07790 DONE3 POP HL
4A47 189F 07800 JR CHECK3
4A49 2B 07810 REM DEC HL
4A4A 7E 07820 LD A,(HL)
4A4B FE3A 07830 CP 3AH
4A4D 28FA 07840 JR Z,REM
4A4F 23 07850 INC HL
4A50 3600 07860 LD (HL),0
4A52 ED5BCF4A 07870 FINISH LD DE,(BUFF1)
4A56 2AA740 07880 LD HL,(40A7H)
4A59 010400 07890 LD BC,4
4A5C EDB0 07900 LDIR
4A5E 7E 07910 MORE2 LD A,(HL)

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4A5F 12 07920 LD (DE),A
4A60 B7 07930 OR A
4A61 2804 07940 JR Z,FINIS
4A63 23 07950 INC HL
4A64 13 07960 INC DE
4A65 18F7 07970 JR MORE2
4A67 13 07980 FINIS INC DE
4A68 2ACF4A 07990 LD HL,(BUFF1)
4A6B 73 08000 LD (HL),E
4A6C 23 08010 INC HL
4A6D 72 08020 LD (HL),D
4A6E 2AD14A 08030 ETC LD HL,(BUFF2)
4A71 23 08040 INC HL
4A72 7E 08050 LD A,(HL)
4A73 B7 08060 OR A
4A74 281A 08070 JR Z,PRGEND
4A76 ED53CF4A 08080 LD (BUFF1),DE
4A7A 2AD14A 08090 LD HL,(BUFF2)
4A7D 7E 08100 LD A,(HL)
4A7E 32D14A 08110 LD (BUFF2),A
4A81 23 08120 INC HL
4A82 7E 08130 LD A,(HL)
4A83 32D24A 08140 LD (BUFF2+1),A
4A86 2B 08150 DEC HL
4A87 C3BC49 08160 JP COPY
4A8A ED5BCF4A 08170 ALLREM LD DE,(BUFF1)
4A8E 18DE 08180 JR ETC
4A90 AF 08190 PRGEND XOR A
4A91 12 08200 LD (DE),A
4A92 13 08210 INC DE
4A93 12 08220 LD (DE),A
4A94 13 08230 INC DE
4A95 8B 08240 EX DE,HL
4A96 22F940 08250 LD (40F9H),HL
4A99 22FB40 08260 LD (40FBH),HL
4A9C 22FD40 08270 LD (40FDH),HL
4A9F C37344 08280 JP BASIC
4AA2 4E 08290 TITLE DEFM 'NODOS 80 Packer'
4AB1 00 08300 DEFB 0
4AB2 0D 08310 MSSG DEFB 0DH
4AB3 44 08320 DEFM 'Deleting Spaces and Remarks'
4ACE 00 08330 DEFB 0
4ACF 0000 08340 BUFF1 DEFW 0
4AD1 0000 08350 BUFF2 DEFW 0
4AD3 C37344 08360 PATCH7 JP BASIC
4473 08370 BASIC EQU 4473H ;BASIC JUMP FROM PROG A
43BC 08380 ORG 43BCH
43BC 9749 08390 DEFW PACK ;SET COMMAND ADDRESSES
44E5 08400 ORG 44E5H
44E5 6448 08410 DEFW FIND
44EB 08420 ORG 44EBH
44EB 9749 08430 DEFW PACK
02B2 08440 END 02B2H ;BACK TO SYSTEM PROMPT
00000 TOTAL ERRORS

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Program Listing 3

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                                08450 ; NODOS80-C RENUMBER
                                08460 ;
                                08470 ; SPEEDY RENUMBERER
                                08480 ; ROBERT J. DOWD, 80 MICRO, MAR 81, P256
                                08490 ; USE EITHER NAME OR RENUM COMMAND
4AD3 08500 ORG 4AD3H
4AD3 3EC3 08510 PATCH7 LD A,0C3H
4AD5 328E41 08520 LD (418EH),A ;NAME COMMAND
4AD8 21F54A 08530 LD HL,START7
4ADB 228F41 08540 LD (418FH),HL
4ADE C37C4F 08550 JP PATCHC
4AE1 4E 08560 RENUM DEFM 'NODOS 80 Renumber'

```

Listing 3 continues

Telewriter-64™

the Color Computer Word Processor

- **3 display formats: 51/64/85 columns × 24 lines**
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- **Easy hyphenation**
- **Drives any printer**
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- **Menu-driven disk and cassette I/O**
- **No hardware modifications required**

THE ORIGINAL

Simply stated, Telewriter is the most powerful word processor you can buy for the TRS-80 Color Computer. The original Telewriter has received rave reviews in every major Color Computer and TRS-80 magazine, as well as enthusiastic praise from thousands of satisfied owners. And rightly so.

The standard Color Computer display of 32 characters by 16 lines without lower case is simply inadequate for serious word processing. The checkerboard letters and tiny lines give you no feel for how your writing looks or reads. Telewriter gives the Color Computer a 51 column by 24 line screen display with *true lower case characters*. So a Telewriter screen looks like a printed page, with a good chunk of text on screen at one time. In fact, more on screen text than you'd get with Apple II, Atari, T1, Vic or TRS-80 Model III.

On top of that, the sophisticated Telewriter full-screen editor is so simple to use, it makes writing fun. With single-letter mnemonic commands, and menu-driven I/O and formatting, Telewriter surpasses all others for user friendliness and pure power.

Telewriter's chain printing feature means that the size of your text is never limited by the amount of memory you have, and Telewriter's advanced cassette handler gives you a powerful word processor without the major additional cost of a disk.

...one of the best programs for the Color Computer I have seen...

— Color Computer News, Jan. 1982

TELEWRITER-64

But now we've added more power to Telewriter. Not just bells and whistles, but major features that give you total control over your writing. We call this new supercharged version Telewriter-64. For two reasons.

64K COMPATIBLE

Telewriter-64 runs fully in any Color Computer — 16K, 32K, or 64K, with or without Extended Basic, with disk or cassette or both. It automatically configures itself to take optimum advantage of all available memory. That means that when you upgrade your memory, the Telewriter-64 text buffer grows accordingly. In a 64K cassette based system, for example, you get about 40K of memory to store text. So you don't need disk or FLEX to put all your 64K to work immediately.

64 COLUMNS (AND 85!)

Besides the original 51 column screen, Telewriter-64 now gives you 2 additional high-density displays: 64 × 24 and 85 × 24!! Both high density modes provide all the standard Telewriter editing capabilities, and you can switch instantly to any of the 3 formats with a single control key command. The 51 × 24 display is clear and crisp on the screen. The two high density modes are more crowded and less easily readable, but they are perfect for showing you the exact layout of your printed page, *all on the screen at one time*. Compare this with cumbersome "windows" that show you only fragments at a time and don't even allow editing.

RIGHT JUSTIFICATION & HYPHENATION

One outstanding advantage of the full-width screen display is that you can now set the screen width to match the width of your printed page, so that "what you see is what you get." This makes exact alignment of columns possible and it makes hyphenation simple.

Since short lines are the reason for the large spaces often found in standard right justified text, and since hyphenation is the most effective way to eliminate short lines, Telewriter-64 can now promise you some of the best looking right justification you can get on the Color Computer.

FEATURES & SPECIFICATIONS:

Printing and formatting: Drives any printer (LPV7/VIII, DMP-100/200, Epson, Okidata, Centronics, NEC, C. Itoh, Smith-Corona, Terminus, etc).

Embedded control codes give full dynamic access to intelligent printer features like: underlining, subscript, superscript, variable font and type size, dot-graphics, etc.

Dynamic (embedded) format controls for: top, bottom, and left margins; line length, lines per page, line spacing, new page, change page numbering, conditional new page, enable/disable justification.

Menu-driven control of these parameters, as well as: pause at page bottom, page numbering, baud rate (so you can run your printer at top speed), and Epson font. "Typewriter" feature sends typed lines directly to your printer, and Direct mode sends control codes right from the keyboard. Special Epson driver simplifies use with MX-80.

Supports single and multi-line headers and automatic centering. Print or save all or any section of the text buffer. Chain print any number of files from cassette or disk.

File and I/O Features: ASCII format files — create and edit BASIC, Assembly, Pascal, and C programs, Smart Terminal files (for uploading or downloading), even text files from other word processors. Compatible with spelling checkers (like Spell 'n Fix).

Cassette verify command for sure saves. Cassette auto-retry means you type a load command only once no matter where you are in the tape.

Read in, save, partial save, and append files with disk and/or cassette. For disk: print directory with free space to screen or printer, kill and rename files, set default drive. Easily customized to the number of drives in the system.

Editing features: Fast, full-screen editor with wordwrap, block copy, block move, block delete, line delete, global search and replace (or delete), wild card search, fast auto-repeat cursor, fast scrolling, cursor up, down, right, left, begin line, end line, top of text, bottom of text; page forward, page backward, align text, tabs, choice of buff or green background, complete error protection, line counter, word counter, space left, current file name, default drive in effect, set line length on screen.

Insert or delete text anywhere on the screen without changing "modes." This fast "free-form" editor provides maximum ease of use. Everything you do appears immediately on the screen in front of you. Commands require only a single key or a single key plus CLEAR.

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— The RAINBOW, Jan. 1982

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Telewriter-64 costs \$49.95 on cassette, \$59.95 on disk, and comes complete with over 70 pages of well-written documentation. (The step-by-step tutorial will have your writing with Telewriter-64 in a matter of minutes.) To order, send check or money order to:

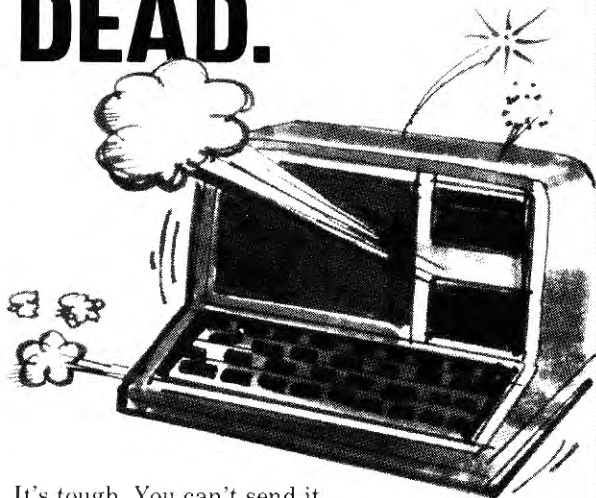
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Or check your local software store. If you have questions, or would like to order by Visa or Mastercard, call us at (714) 755-1258 (weekdays, 8AM-4PM PST). Dealer inquiries invited.

(Add \$2 for shipping. Californians add 6% state tax. Allow 2 weeks for personal checks. Send self-addressed stamped envelope for Telewriter reviews from CCN, RAINBOW, 80-Micro, 80-U.S. Telewriter owners: send SASE or call for information on upgrading to Telewriter-64. Telewriter-compatible spelling checker (Spell 'n Fix) and Smart Terminal program (Colorcom/E) also available. Call or write for more information.)

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Listing 3 continued

4AF2 00	08570	DEFB	0
4AF3 0000	08580	DEFW	0
4AF5 2AB140	08590	ARRAY	LD HL, (40B1H)
4AF8 25	08600	START7	LD H
4AF9 22F34A	08610	DEC	H
4AFC 24	08620	LD	(ARRAY), HL
4AFD CDC901	08630	INC	H
4B00 21E14A	08640	CALL	01C9H
4B03 CDA728	08650	LD	HL, RENUM
4B06 CD9548	08660	CALL	28A7H
4B09 AF	08670	CALL	CHECK1
4B0A 0616	08680	XOR	A
4B0C 21E44E	08690	LD	B, 22
4B0F 77	08700	LD	HL, INDEX
4B10 23	08710	LD	(HL), A
4B11 10FC	08720	INC	HL
4B13 2F	08730	LOOP1	LD HL
4B14 32EC4E	08740	DJNZ	LOOP1
4B17 32ED4E	08750	CPL	LD
4B1A 21F24E	08760	LD	(ELINE), A
4B1D ED5BA440	08770	LD	(ELINE+1), A
4B21 73	08780	LD	HL, NXTLPT
4B22 23	08790	LD	DE, (40A4H)
4B23 72	08800	LD	(HL), E
4B24 2AF34A	08810	INC	HL
4B27 22E44E	08820	LD	(HL), D
4B2A 3E0A	08830	LD	HL, (ARRAY)
4B2C 32EE4E	08840	LD	(INDEX), HL
4B2F 3E0A	08850	LD	A, 10
4B31 32F04E	08860	LD	(SLINE), A
4B34 2AF940	08870	LD	A, 10
4B37 2B	08880	LD	(INCR3), A
4B38 2B	08890	LD	HL, (40F9H)
4B39 22F84E	08900	DEC	HL
4B3C CD504E	08910	DEC	HL
4B3F 2AF24E	08920	LD	(PEND), HL
4B42 E5	08930	CALL	OPTION
4B43 ED5BF04E	08940	LD	HL, (NXTLPT)
4B47 CD994C	08950	PUSH	HL
4B4A D2E14B	08960	LD	DE, (PEND)
4B4D E1	08970	CALL	COMPAR
4B4E E5	08980	LD	NC, PASS2
4B4F 23	08990	POP	HL
4B50 23	09000	PUSH	HL
4B51 22F64E	09010	LD	HL, (CURLPT), HL
4B54 E1	09020	LD	HL
4B55 0604	09030	LD	B, 4
4B57 DD21F24E	09040	LD	IX, NXTLPT
4B5B 7E	09050	LD	A, (HL)
4B5C DD7700	09060	LD	(IX+0), A
4B5F 23	09070	LD	HL
4B60 DD23	09080	INC	HL
4B62 10F7	09090	INC	IX
4B64 3AE94E	09100	LOOP2	LD HL, (GOFLAG)
4B67 B7	09110	OR	A
4B68 200E	09120	JR	NZ, CKEND
4B6A 2AF44E	09130	LD	HL, (CURLIN)
4B6D ED5BEA4E	09140	LD	DE, (BLINE)
4B71 CD994C	09150	CALL	COMPAR
4B74 2810	09160	JR	Z, SAVEM
4B76 38C7	09170	JR	C, BEGIN5
4B78 2AF44E	09180	LD	HL, (CURLIN)
4B7B ED5BEC4E	09190	LD	DE, (ELINE)
4B7F CD994C	09200	CALL	COMPAR
4B82 2802	09210	JR	Z, SAVEM
4B84 305B	09220	JR	NC, PASS2
4B86 AF	09230	XOR	A
4B87 2F	09240	CPL	A
4B88 32E94E	09250	LD	(GOFLAG), A
4B8B 2AEE4E	09260	LD	HL, (SLINE)
4B8E 11FAFF	09270	LD	DE, 65530
4B91 CD994C	09280	CALL	COMPAR
4B94 3806	09290	JR	C, LINEOK
4B96 CD614C	09300	CALL	ERROR1
4B99 C36E4C	09310	JP	BASIC1
4B9C 2AE44E	09320	LD	HL, (INDEX)
4B9F E5	09330	PUSH	HL
4BA0 DDE1	09340	POP	IX
4BA2 2AF44E	09350	LD	HL, (CURLIN)
4BA5 DD7400	09360	LD	(IX+0), H
4BA8 DD2B	09370	DEC	IX
4BAA DD7500	09380	LD	(IX+0), L
4BAD DD2B	09390	DEC	IX
4BAF 2ABE4E	09400	LD	HL, (SLINE)
4BB2 DD7400	09410	LD	(IX+0), H
4BB5 DD2B	09420	DEC	IX
4BB7 DD7500	09430	LD	(IX+0), L
4BBA DD2B	09440	DEC	IX
4BBC DD22E44E	09450	LD	(INDEX), IX
4BC0 2AE64E	09460	LD	HL, (LINECT)
4BC3 23	09470	INC	HL
4BC4 22E64E	09480	LD	(LINECT), HL
4BC7 2AF64E	09490	LD	HL, (CURLPT)
4BCA E5	09500	PUSH	HL
4BCB DDE1	09510	POP	IX
4BCD 2ABE4E	09520	LD	HL, (SLINE)
4BD0 DD7500	09530	LD	(IX+0), L
4BD3 DD7401	09540	LD	(IX+1), H
4BD6 ED5BF04E	09550	LD	DE, (INCR3)
4BDA 19	09560	ADD	HL, DE
4BDB 22EE4E	09570	LD	(SLINE), HL
4BDE C33F4B	09580	JP	BEGIN5
4BE1 2AE64E	09590	LD	HL, (LINECT)
4BE4 7C	09600	LD	A, H
4BE5 B5	09610	OR	L
4BE6 CA684C	09620	JP	Z, ERROR2
4BE9 2AA440	09630	LD	HL, (40A4H)
4BEC 22F24E	09640	LD	(NXTLPT), HL
4BEF AF	09650	XOR	A

Listing 3 continues

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4BF0	32E84E	09660	LD	(ONFLAG),A
4BF3	110300	09670	LD	DE,3
4BF6	19	09680	ADD	HL,DE
4BF7	23	09690	GETBYT	INC
4BF8	7E	09700	LD	A,(HL)
4BF9	B7	09710	OR	A
4BFA	200C	09720	JR	NZ,COLON1
4BFC	23	09730	INC	HL
4BFD	ED5BF84E	09740	LD	DE,(PEND)
4C01	CD994C	09750	CALL	COMPAR
4C04	20E6	09760	JR	NZ,PASS22
4C06	1848	09770	JR	FIN
4C08	FE3A	09780	COLON1	CP
4C0A	2006	09790	JR	NZ,COMMA
4C0C	AF	09800	XOR	A
4C0D	32E84E	09810	LD	(ONFLAG),A
4C10	18E5	09820	JR	GETBYT
4C12	FE2C	09830	COMMA	CP
4C14	200A	09840	JR	NZ,CHEKON
4C16	3AE84E	09850	LD	A,(ONFLAG)
4C19	B7	09860	OR	A
4C1A	28DB	09870	JR	Z,GETBYT
4C1C	3E8D	09880	LD	A,141
4C1E	1020	09890	JR	GOPORT
4C20	FEA1	09900	CHEKON	CF
4C22	2006	09910	JR	NZ,KEYWRD
4C24	2F	09920	CPL	
4C25	32E84E	09930	LD	(ONFLAG),A
4C28	18CD	09940	JR	GETBYT
4C2A	FE8D	09950	KEYWRD	CP
4C2C	2812	09960	JR	Z,GOPORT
4C2E	FE91	09970	CP	145
4C30	280E	09980	JR	Z,GOPORT
4C32	FECA	09990	CP	202
4C34	280A	10000	JR	Z,GOPORT
4C36	FE95	10010	CP	149
4C38	20BD	10020	JR	NZ,GETBYT
4C3A	08	10030	EX	AF,AF'
4C3B	AF	10040	XOR	A
4C3C	32E84E	10050	LD	(ONFLAG),A
4C3F	08	10060	EX	AF,AF'
4C40	CD0B4D	10070	GOPORT	CALL
4C43	B7	10080	OR	A
4C44	CC7D4C	10090	CALL	Z,ERROR3
4C47	CB4F	10100	BIT	1,A
4C49	20AD	10110	JR	NZ,GETBYT+1
4C4B	CDB44D	10120	CALL	INSERT
4C4E	10A8	10130	JR	GETBYT+1
4C50	2AF84E	10140	FIN	LD
4C53	23	10150	INC	HL
4C54	23	10160	INC	HL
4C55	22F940	10170	LD	(40F9H),HL
4C58	21FA4E	10180	LD	HL,FINI
4C5B	CDA728	10190	CALL	28A7H
4C5E	C36E4C	10200	JP	BASIC1
4C61	21044F	10210	ERROR1	LD
4C64	CDA728	10220	CALL	HL,EMSG1
4C67	C9	10230	RET	28A7H
4C68	21164F	10240	ERROR2	LD
4C6B	CDA728	10250	CALL	HL,EMSG2
4C6E	CD641B	10260	BASIC1	CALL
4C71	AF	10270	XOR	A
4C72	329A40	10280	LD	(409AH),A
4C75	2AF940	10290	LD	HL,(40F9H)
4C78	2B	10300	DEC	HL
4C79	2B	10310	DEC	HL
4C7A	C31E1D	10320	JP	1D1EH
4C7D	E5	10330	ERROR3	PUSH
4C7E	21294F	10340	LD	HL,EMSG3
4C81	CDA728	10350	CALL	28A7H
4C84	CD8C4C	10360	CALL	ERRET
4C87	21F84B	10370	LD	HL,GETBYT+1
4C8A	E3	10380	EX	(SP),HL
4C8B	C9	10390	RET	
4C8C	2AF24E	10400	ERRET	LD
4C8F	23	10410	INC	HL
4C90	23	10420	INC	HL
4C91	5E	10430	LD	E,(HL)
4C92	23	10440	INC	HL
4C93	56	10450	LD	D,(HL)
4C94	EB	10460	EX	DE,HL
4C95	CDA70F	10470	CALL	0FA7H
4C98	C9	10480	RET	
4C99	C5	10490	COMPAR	PUSH
4C9A	D5	10500	PUSH	DE
4C9B	E5	10510	PUSH	HL
4C9C	FE	10520	PUSH	AF
4C9D	45	10530	LD	B,L
4C9E	4B	10540	LD	C,E
4C9F	6C	10550	LD	L,H
4CA0	5A	10560	LD	E,D
4CA1	AF	10570	XOR	A
4CA2	67	10580	LD	H,A
4CA3	57	10590	LD	D,A
4CA4	ED52	10600	SBC	HL,DE
4CA6	2805	10610	JR	Z,MSBEQU
4CA8	F2C04C	10620	JP	P,HLGRTR
4CAB	180C	10630	JR	HLLESS
4CAD	68	10640	MSBEQU	LD
4CAE	59	10650	LD	L,B
4CAF	AF	10660	XOR	A
4CB0	67	10670	LD	H,A
4CB1	57	10680	LD	D,A
4CB2	ED52	10690	SBC	HL,DE
4CB4	2810	10700	JR	Z,EQUAL
4CB6	F2C04C	10710	JP	P,HLGRTR
4CB9	F1	10720	HLLESS	POP
4CBA	47	10730	LD	AF
4CBB	F6FF	10740	OR	B,A
4CBD	37	10750	SCF	0FFH

Listing 3 continues

4CBE 1809	10760	JR	EXITPT	4CF0 2806	11100	JR	Z,SKIPIT
4CC0 F1	10770	HLGRTR	POP	4CF2 F1	11110	POP	AF
4CC1 47	10780	LD	B,A	4CP3 CB15	11120	RL	L
4CC2 F6FF	10790	OR	0FFH	4CP5 CB14	11130	RL	H
4CC4 1803	10800	JR	EXITPT	4CF7 D1	11140	POP	DE
4CC6 F1	10810	EQUAL	POP	4CF8 E7	11150	SKIPIT	OR
4CC7 47	10820	LD	B,A	4CF9 79	11160	LD	A,C
4CC8 AF	10830	XOR	A	4CPA C1	11170	POP	BC
4CC9 78	10840	EXITPT	LD	4CPB C9	11180	RET	
4CCA E1	10850	POP	HL	4CPC ED62	11190	ZEROIT	SBC
4CCB D1	10860	POP	DE	4CFE 18F8	11200	JR	HL,HL
4CCC C1	10870	POP	BC	4D00 F1	11210	CHKCRY	POP
4CCD C9	10880	RET	BC	4D01 3003	11220	JR	NC,CHKCRL
4CCE CD994C	10890	HLDESB	CALL	4D03 B7	11230	OR	A
4CD1 D8	10900	RET	COMPAR	4D04 1802	11240	JR	CHKCRL+2
4CD2 C5	10910	PUSH	C	4D06 13	11250	CHKCRL	INC
4CD3 4F	10920	LD	BC	4D07 37	11260	SCF	DE
4CD4 2826	10930	JR	C,A	4D08 F5	11270	PUSH	AF
4CD6 0600	10940	LD	Z,ZEROIT	4D09 18DF	11280	JR	CLEAR-1
4CD8 CB7C	10950	BIT	B,0	4D0B 23	11290	LOOKUP	INC
4CDA 280F	10960	JR	7,H	4D0C E5	11300	POP	HL
4CDC D5	10970	PUSH	Z,CLEAR	4D0D F5	11310	PUSH	HL
4CDD B7	10980	OR	DE	4D0E CD5A1E	11320	CALL	AF
4CDE CB1C	10990	RR	A	4D11 7A	11330	LD	1E5AH
4CE0 CB1D	11000	RR	H	4D12 B3	11340	OR	A,D
4CE2 F5	11010	PUSH	L	4D13 CA9F4D	11350	JP	Z
4CE3 B7	11020	OR	AF	4D16 F1	11360	POP	E,POSERR
4CE4 CB1A	11030	RR	A	4D17 2AEA4E	11370	LD	AF
4CE6 CB1B	11040	RR	D	4D1A CD994C	11380	CALL	HL,(BLINE)
4CE8 3816	11050	JR	E	4D1D 2810	11390	JR	COMPAR
4CEA 04	11060	INC	C,CHKCRY	4D1F 300A	11400	JR	Z,FINDIT
4CEB B7	11070	CLEAR	B	4D21 2AEC4E	11410	LD	NC,RETURN
4CEC ED52	11080	SBC	A	4D24 CD994C	11420	CALL	HL,(BLINE)
4CEE CB40	11090	BIT	HL,DE	4D27 2806	11430	JR	COMPAR
			0,B				Z,FINDIT

Listing 3 continues

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- "Base Conversions," James Yowell Yelvington, *80 Micro*, Sept. 81, p. 186.
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- "*Full Error," Harry and Ken Keairns, *80 Micro*, Oct. 81, p. 340.
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- "The Sentry," Jim Rastin, *80 Micro*, Dec. 81, p. 242.
- "USR Usery," David H. Freese, Jr., *80 Micro*, Dec. 81, p. 248.
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- "The Sargon Saver—Part II," Thomas L. Quindry, *80 Micro*, Dec. 81, p. 348.
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- "Error Code Expanded," Roger C. Alford, *80 Micro*, Feb. 82., p. 260.
- "As the Screen Scrolls," M. Keller, *80 Micro*, Feb.82, p. 264.
- "Varispeed," Bruce Evans, *80 Micro*, Mar. 82, p. 336.
- "Bam," Jeff Byrkit, *80 Micro*, April 82, p. 167.
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- "*Unikey," Rowland Archer, Jr., *80 Micro*, Sept. 80, p. 76.
- "Slow Scroll," Peter A. Lewis, *80 Micro*, Sept. 80, p. 202.
- "*Get Serious," Roger L. Pape, *80 Micro*, Oct. 80, p. 93.
- "*Variable Scroll," William L. Colsher, *80 Micro*, Oct. 80, p. 134.
- "Resurrect It," Thomas L. Quindry, *80 Micro*, Nov. 80, p. 206.
- "Basic Line Compressor (Assembly Line)," William Barden, Jr., *80 Micro*, Jan. 81, p. 23.
- "Zbug... Super Debug Monitor," Lt. John B. Harrell, *80 Micro*, Jan. 81, p. 131.
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- "Horizontal Scroll (Soft Bits)," Roger Fuller, *80 Micro*, June/July 82, p. 40.
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- "Horizontal Scrolling," G. M. Foley, *80 Micro*, June/July 82, p. 318.
- *Signifies article was used for NODOS 80 source material.

DOES STRING COMPRESSION HAVE YOU TIED UP IN KNOTS?

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TRASHMAN is a machine language utility for the TRS-80 Models I and III. It was written by Glenn Tesler, the author of FASTER, and can reduce BASIC's string compression time by 95% (see table below).



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When a BASIC program changes a string (words, names, descriptions), it moves it to a new place in memory, and leaves a hole in the old place. Eventually, all available memory gets used up and BASIC has to push the strings together to free up some space. This takes time. Lots of time. The computer stops running for seconds or minutes, and you may even think it's "crashed". The keyboard won't work, and until all the strings have been collected, you just have to sit and wait. Then things run for a while, until string compression is needed again. And again.

If you're using your computer for business, that wastes your money. If you're using it personally, it wastes your time.

WHAT'S THE SOLUTION?

As soon as you start using TRASHMAN, those delays almost disappear. It uses less than 600 bytes of memory, plus 2 bytes for each active string. It works with other machine language programs and with all major operating systems. It's easy to use, comes with complete instructions, and can be copied to your own disks.

WHAT'S THE CATCH?

If a BASIC program uses only a few strings, very little time is wasted in string compression, and TRASHMAN won't be helpful. But, if hundreds of strings, including large string arrays, are used, TRASHMAN is just what you need.

Ask your software dealer for TRASHMAN, or order directly on our toll-free number. The price is just \$39.95 (plus sales tax in California).

# STRINGS	SECONDS DELAY		PERCENT IMPROVEMENT
	NORMAL	TRASHMAN	
250	11.8	0.7	94
500	45.8	1.6	96.5
1000	179.6	3.5	98
2000	713.2	7.8	98.9

(All timings done on TRS-80 Model I. Model III 15% faster, but pct. improvements identical. Listing of timing program available on request.)

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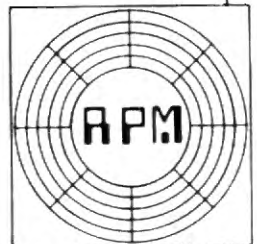
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4D29 3004	11440		JR	NC,FINDIT		4DC9 DD23	12200		INC	IX
4D2B E1	11450	RETURN	POP	HL		4DCB 10F5	12210		DJNZ	INSRT2
4D2C C3AB4D	11460		JP	NOERR		4DCD F5	12220	INSRT3	PUSH	AF
4D2F ED4BE64E	11470	FINDIT	LD	BC,(LINECT)		4DCE 7E	12230		LD	A,(HL)
4D33 DD2AF34A	11480		LD	IX,(ARRAY)		4DCF FE30	12240		CP	'0'
4D37 DD6600	11490	LOOKLP	LD	H,(IX+0)		4DD1 FAEF4D	12250		JP	M,INSRT5
4D3A DD2B	11500		DEC	IX		4DD4 FE3A	12260		CP	','
4D3C DD6E00	11510		LD	L,(IX+0)		4DD6 F2EF4D	12270		JP	P,INSRT5
4D3F DD2B	11520		DEC	IX		4DD9 F1	12280	INSRT6	POP	AF
4D41 CD994C	11530		CALL	COMPAR		4DDA 77	12290		LD	(HL),A
4D44 280C	11540		JR	Z,GOTMAT		4DDB DD23	12300		INC	IX
4D46 DD2B	11550		DEC	IX		4DDD 23	12310		INC	HL
4D48 DD2B	11560		DEC	IX		4DDE DD7E00	12320		LD	A,(IX+0)
4D4A 0B	11570		DEC	BC		4DE1 105A	12330		DJNZ	INSRT3
4D4B 70	11580		LD	A,B		4DE3 7E	12340	INSRT4	LD	A,(HL)
4D4C B1	11590		OR	C		4DE4 FE30	12350		CP	'0'
4D4D 20E8	11600		JR	NZ,LOOKLP		4DE6 F0	12360		RET	M
4D4F C3AE4D	11610		JP	ERROR5		4DE7 FE3A	12370		CP	','
4D52 DD6600	11620	GOTMAT	LD	H,(IX+0)		4DE9 F0	12380		RET	P
4D55 DD2B	11630		DEC	IX		4DEA CD124E	12390		CALL	COMPRS
4D57 DD6E00	11640		LD	L,(IX+0)		4DED 10F4	12400		JR	INSRT4
4D5A AF	11650		XOR	A		4DEF CDF44D	12410	INSRT5	CALL	EXPAND
4D5B 32E94E	11660		LD	(GOFLAG),A		4DF2 18E5	12420		JR	INSRT6
4D5E FD21774F	11670		LD	IY,ASCIIN		4DF4 E5	12430	EXPAND	PUSH	HL
4D62 DD216D4F	11680		LD	IX,POWERS		4DF5 08	12440		EX	AF,AF'
4D66 0605	11690		LD	B,5		4DF6 D9	12450		EXX	
4D68 DD5E00	11700	LOOKL2	LD	E,(IX+0)		4DF7 D1	12460		POP	DE
4D6B DD5601	11710		LD	D,(IX+1)		4DF8 2AF84E	12470		LD	HL,(PEND)
4D6E 3E00	11720		LD	A,0		4DFB 23	12480		INC	HL
4D70 0E30	11730		LD	C,'0'		4DFC E5	12490		PUSH	HL
4D72 CDCE4C	11740	LOOKL3	CALL	HLDESB		4DFD 22F84E	12500		LD	(PEND),HL
4D75 3021	11750		JR	NC,INCRA		4E00 23	12510		INC	HL
4D77 B7	11760		OR	A		4E01 E5	12520		PUSH	HL
4D78 2011	11770		JR	Z,BLNKIT		4E02 CDCE4C	12530		CALL	HLDESB
4D7A 01	11780		ADD	A,C		4E05 E5	12540		PUSH	HL
4D7B 32E94E	11790		LD	(GOFLAG),A		4E06 C1	12550		POP	BC
4D7E FD7700	11800	LOOKL4	LD	(IY+0),A		4E07 D1	12560		POP	DE
4D81 FD23	11810		INC	IY		4E08 E1	12570		POP	HL
4D83 DD23	11820		INC	IX		4E09 EDB8	12580		LDDR	
4D85 DD23	11830		INC	IX		4E0B AF	12590		XOR	A
4D87 10DF	11840		DJNZ	LOOKL2		4E0C CD314E	12600		CALL	FIXPTS
4D89 1010	11850		JR	ALLDON		4E0F 08	12610		EX	AF,AF'
4D8B 3AE94E	11860	BLNKIT	LD	A,(GOFLAG)		4E10 D9	12620		EXX	
4D8E B7	11870		OR	A		4E11 C9	12630		RET	
4D8F 2004	11880		JR	NZ,BLNK1		4E12 E5	12640	COMPRS	PUSH	HL
4D91 3520	11890		LD	A,' '		4E13 08	12650		EX	AF,AF'
4D93 18E9	11900		JR	LOOKL4		4E14 D9	12660		EXX	
4D95 79	11910	BLNK1	LD	A,C		4E15 D1	12670		POP	DE
4D96 18E6	11920		JR	LOOKL4		4E16 2AF84E	12680		LD	HL,(PEND)
4D98 3C	11930	INCRA	INC	A		4E19 2B	12690		DEC	HL
4D99 18D7	11940		JR	LOOKL3		4E1A 22F84E	12700		LD	(PEND),HL
4D9B 3E01	11950	ALLDON	LD	A,1		4E1D 23	12710		INC	HL
4D9D E1	11960		POP	HL		4E1E 23	12720		INC	HL
4D9E C9	11970		RET			4E1F CDCE4C	12730		CALL	HLDESB
4D9F F1	11980	POSERR	POP	AF		4E22 E5	12740		PUSH	HL
4DA0 E1	11990		POP	HL		4E23 C1	12750		POP	BC
4DA1 FECA	12000		CP	202		4E24 D5	12760		PUSH	DE
4DA3 2006	12010		JR	Z,NOERR		4E25 E1	12770		POP	HL
4DA5 FE95	12020		CP	149		4E26 23	12780		INC	HL
4DA7 2002	12030		JR	Z,NOERR		4E27 EDB0	12790		LDIR	
4DA9 AF	12040		XOR	A		4E29 AF	12800		XOR	A
4DAA C9	12050		RET			4E2A 2F	12810		CPL	
4DAB 3E02	12060	NOERR	LD	A,2		4E2B CD314E	12820		CALL	FIXPTS
4DAD C9	12070		RET			4E2E 08	12830		EX	AF,AF'
4DAE 215B4F	12080	ERROR5	LD	HL,MSG5		4E2F D9	12840		EXX	
4DB1 C3014C	12090		JP	ERROR3+4		4E30 C9	12850		RET	
4DB4 7E	12100	INSERT	LD	A,(HL)		4E31 2AF24E	12860	FIXPTS	LD	HL,(NXTLPT)
4DB5 FE20	12110		CP	' '		4E34 5E	12870	FIXPT1	LD	E,(HL)
4DB7 2003	12120		JR	NZ,INSRT1		4E35 23	12880		INC	HL
4DB9 23	12130		INC	HL		4E36 56	12890		LD	D,(HL)
4DBA 18F8	12140		JR	INSERT		4E37 B7	12900		OR	A
4DBC 0605	12150	INSRT1	LD	B,5		4E38 2013	12910		JR	Z,ADDON
4DBE DD21774F	12160		LD	IX,ASCIIN		4E3A 1B	12920		DEC	DE
4DC2 DD7E00	12170	INSRT2	LD	A,(IX+0)		4E3B 72	12930	FIXPT2	LD	(HL),D
4DC5 FE20	12180		CP	' '		4E3C 2B	12940		DEC	HL
4DC7 2004	12190		JR	NZ,INSRT3		4E3D 73	12950		LD	(HL),E

Listing 3 continued

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4E3E D5      12960    PUSH    DE
4E3F C1      12970    POP     BC
4E40 EB      12980    EX      DE,HL
4E41 ED5BF84E 12990    LD      DE,(PEND)
4E45 CD994C  13000    CALL   COMPAR
4E48 D0      13010    RET     NC
4E49 C5      13020    PUSH   BC
4E4A E1      13030    POP     HL
4E4B 18E7    13040    JR      FIXPT1
4E4D 13      13050    ADDON  INC
4E4E 18EB    13060    JR      FIXPT2
4E50 DD21924E 13070    OPTION LD      IX,AMSG1
4E54 FD21EA4E 13080    LD      IX,BLINE
4E58 0604    13090    LD      B,4
4E5A C5      13100    LOOPOP PUSH   BC
4E5B DD6E00  13110    LD      L,(IX+0)
4E5E DD6601  13120    LD      H,(IX+1)
4E61 CDA728  13130    CALL   28A7H
4E64 2AA740  13140    LD      HL,(40A7H)
4E67 2B      13150    DEC    HL
4E68 2B      13160    DEC    HL
4E69 CDD905  13170    CALL   05D9H
4E6C AF      13180    XOR    A
4E6D B0      13190    OR     B
4E6E 280D    13200    JR      Z,NEXTOP
4E70 CD5A1E  13210    CALL   1E5AH
4E73 7A      13220    LD      A,D
4E74 B3      13230    OR     E
4E75 2812    13240    JR      Z,ERROR4
4E77 FD7300  13250    LD      (IX+0),E
4E7A FD7201  13260    LD      (IX+1),D
4E7D DD23    13270    NEXTOP INC    IX
4E7F DD23    13280    INC    IX
4E81 FD23    13290    INC    IY
4E83 FD23    13300    INC    IY
4E85 C1      13310    POP     BC
4E86 10D2    13320    DJNZ   LOOPOP
4E88 C9      13330    RET
4E89 21444F  13340    ERROR4 LD      HL,EMSG4
4E8C CDA728  13350    CALL   28A7H
4E8F C1      13360    POP     BC
4E90 18C8    13370    JR      LOOPOP
4E92 9A4E    13380    MSG1   DEFW   MSG1
4E94 AD4E    13390    DEFW   MSG2
4E96 BD4E    13400    DEFW   MSG3
4E98 D34E    13410    DEFW   MSG4
4E9A 0D      13420    MSG1   DEFB   0DH
4E9B 45      13430    DEFB   'Enter start line '
4EAC 00      13440    DEFB   0
4EAD 45      13450    MSG2   DEFB   'Enter end line '
4EB0 00      13460    DEFB   0
4EBD 45      13470    MSG3   DEFB   'Enter new start line '
4ED2 00      13480    DEFB   0
4ED3 45      13490    MSG4   DEFB   'Enter increment '
4EE3 00      13500    DEFB   0
4EE4 0000    13510    INDEX  DEFW   0
4EE6 0000    13520    LINECT DEFW   0
4EE8 00      13530    ONFLAG DEFB   0
4EE9 00      13540    GOFLAG DEFB   0
4EEA 0000    13550    BLINE  DEFW   0
4EEC 0000    13560    ELINE  DEFW   0
4EEE 0000    13570    SLINE  DEFW   0
4EF0 0000    13580    INCR3  DEFW   0
4EF2 0000    13590    NXTLPT DEFW   0
4EF4 0000    13600    CURLIN DEFW   0
4EF6 0000    13610    CURLPT DEFW   0
4EF8 0000    13620    PEND   DEFW   0
4EFA 0D      13630    FINI   DEFB   0DH
4EFB 46      13640    DEFB   'finished'
4F03 00      13650    DEFB   0
4F04 0D      13660    MSG1   DEFB   0DH
4F05 4C      13670    DEFB   'Line # too large'
4F15 00      13680    DEFB   0
4F16 0D      13690    MSG2   DEFB   0DH
4F17 52      13700    DEFB   'range value error'
4F28 00      13710    DEFB   0

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4F29 0D      13720    MSG3   DEFB   0DH
4F2A 47      13730    DEFB   'GOTO/GOSUB missing line #'
4F43 00      13740    DEFB   0
4F44 50      13750    MSG4   DEFB   'Parameter not numeric'
4F59 0D      13760    DEFB   0DH
4F5A 00      13770    DEFB   0
4F5B 0D      13780    MSG5   DEFB   0DH
4F5C 55      13790    DEFB   'Undefined line #'
4F6C 00      13800    DEFB   0
4F6D 1027    13810    POWERS DEFB   10000
4F6F E803    13820    DEFW   1000
4F71 6400    13830    DEFW   100
4F73 0A00    13840    DEFW   10
4F75 0100    13850    DEFW   1
0005        13860    ASCIIN DEFS   5
4F7C C37344  13870    PATCHC JP      BASIC
4473        13880    BASIC  EQU    4473H
4895        13890    CHECK1 EQU    4895H
440F        13900    ORG    44DFH ;SET COMMAND ADDRESS
440F F54A    13910    DEFW   START7
02B2        13920    END    02B2H
00000 TOTAL ERRORS

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Program Listing 4

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13930 ;          NODOS80-D      FUNCTIONS
13940 ;          DUAL, ROUTE, SINGLE KEY ENTRY, DEBOUNCE
13950 ;          SORT, AUTO EDIT, SINGLE STEP BASIC
13960 ;
13970 ;          DUAL AND ROUTE
13980 ;          THOMAS L. QUINDRY, NEW CODE
4F7C        13990    ORG    4F7CH
4F7C 2A1E40  14000    PATCHC LD      HL,(401EH) ;VIDEO DCB
4F7F 22B24F  14010    LD      (VIDEO+1),HL
4F82 2A2640  14020    LD      HL,(4026H) ;PRINTER DCB
4F85 22D54F  14030    LD      (LPRINT),HL
4F88 C31D53  14040    JP      CLENUF
4F8B CD994F  14050    DUALON CALL   DUALOF
4F8E CDA64F  14060    CALL   PRSTAT
4F91 C0      14070    RET     NZ
4F92 21AE4F  14080    LD      HL,DUAL
4F95 221E40  14090    LD      (401EH),HL
4F98 C9      14100    RET
4F99 2AB24F  14110    DUALOF LD      HL,(VIDEO+1)
4F9C 221E40  14120    LD      (401EH),HL
4F9F 2AD54F  14130    LD      HL,(LPRINT)
4FA2 222640  14140    LD      (4026H),HL
4FA5 C9      14150    RET
4FA6 3AE837  14160    PRSTAT LD      A,(37E8H) ;PRINTER STATUS
4FA9 E6F0    14170    AND    0F0H
4FAB FE30    14180    CP     30H
4FAD C9      14190    RET
4FAE CDB44F  14200    DUAL   CALL   LPR ;OUTPUT TO PRINTER AND VIDEO
4FB1 C30000  14210    VIDEO  JP      0000
4FB4 F5      14220    LPR    PUSH   AF ;LINEPRINTER FILTER
4FB5 D5      14230    DEFW   DE
4FB6 79      14240    LD      A,C
4FB7 FE0E    14250    CP     14
4FB9 280D    14260    JR      Z,NOPRT
4FBB FE0F    14270    CP     15
4FBD 2809    14280    JR      Z,NOPRT
4FBF FE7F    14290    CP     127
4FC1 3802    14300    JR      C,PRT
4FC3 3E20    14310    LD      A,20H
4FC5 CD3B00  14320    PRT    CALL   003BH
4FC8 D1      14330    NOPRT  POP     DE
4FC9 F1      14340    POP    AF
4FCA C9      14350    RET
4FCB CD994F  14360    PRDO   CALL   DUALOF ;ROUTE PRINTER TO DISPLAY

```

Listing 4 continues

Listing 4 continued

```

4FCE 21E54F 14370 LD HL,VID
4FD1 222640 14380 LD (4026H),HL
4FD4 C9 14390 RET
4FD5 0000 14400 LPRINT DEFWD 0000
4FD7 CD994F 14410 DOPR CALL DUALOF ;ROUTE DISPLAY TO PRINTER
4FDA CDA64F 14420 CALL PRSTAT
4FDD C0 14430 RET NZ
4FDE 21B44F 14440 LD HL,LPR
4FEL 221E40 14450 LD (401EH),HL
4FE4 C9 14460 RET
4FE5 F5 14470 VID PUSH AF ;VIDEO ROUTINE
4FE6 D5 14480 PUSH DE
4FE7 79 14490 LD A,C
4FE8 CD3300 14500 CALL 0033H
4FEB D1 14510 POP DE
4FEC F1 14520 POP AF
4FED C9 14530 RET
14540 ; SINGLE KEY COMMAND ENTRY ADAPTED FROM
14550 ; UNIKEY
14560 ; ROWLAND ARCHER JR, 80 MICRO, SEPT 80, P76
4FEE 2A1640 14570 PATCH8 LD HL,(4016H) ;KEYBOARD DCB
4FF1 E5 14580 PUSH HL
4FF2 2A0C51 14590 LD HL,(KEYDR1+1)
4FF5 221640 14600 LD (4016H),HL
4FF8 E1 14610 POP HL
4FF9 220C51 14620 LD (KEYDR1+1),HL
4FFC 22AF51 14630 LD (KEYDR2+1),HL
4FFF C37344 14640 JP BASIC
5002 3ECD 14650 BOUNCE LD A,0CDH ;GET DELAY
5004 320851 14660 LD (DEBOU1),A
5007 32AB51 14670 LD (DEBOU2),A
500A 211E50 14680 LD HL,DELAY
500D 220951 14690 LD (DEBOU1+1),HL
5010 22AC51 14700 LD (DEBOU2+1),HL
5013 C9 14710 RET
5014 211801 14720 NOBOU LD HL,0118H ;NO DELAY
5017 220851 14730 LD (DEBOU1),HL
501A 22AB51 14740 LD (DEBOU2),HL
501D C9 14750 RET
501E C5 14760 DELAY PUSH BC
501F 010002 14770 LD BC,0200H
5022 C1 14780 POP BC
5023 C9 14790 RET
5024 00 14800 KEEPER DEFBD 0 ;SAVE KEYBOARD ENTRY
5025 52 14810 USTR DEFMD 'RUN'
5028 0D 14820 DEFBD 0DH
5029 00 14830 DEFBD 0
003B 14840 REST DEFSD 59
5065 00 14850 DEFBD 0
5066 00 14860 OSFLAG DEFBD 0
5067 0000 14870 OSPTR DEFWD 0
5069 50 14880 LA DEFMD 'PRINT0'
506F 00 14890 DEFBD 0
5070 45 14900 LB DEFMD 'ELSE'
5074 00 14910 DEFBD 0
5075 43 14920 LC DEFMD 'CHR$( '
507A 00 14930 DEFBD 0
507B 44 14940 LD DEFMD 'DATA'
507F 00 14950 DEFBD 0
5080 52 14960 LE DEFMD 'RIGHT$( '
5087 00 14970 DEFBD 0
5088 46 14980 LF DEFMD 'FOR'
508B 00 14990 DEFBD 0
508C 47 15000 LG DEFMD 'GOTO'
5090 00 15010 DEFBD 0
5091 52 15020 LH DEFMD 'RND('
5095 00 15030 DEFBD 0
5096 49 15040 LI DEFMD 'INPUT'
509C 00 15050 DEFBD 0
509D 52 15060 LJ DEFMD 'READ'
50A1 00 15070 DEFBD 0
50A2 49 15080 LK DEFMD 'INKEY$( '
50A8 00 15090 DEFBD 0
50A9 4C 15100 LL DEFMD 'LEN('
50AD 00 15110 DEFBD 0
50AE 41 15120 LM DEFMD 'ASC('
50B2 00 15130 DEFBD 0
50B3 4E 15140 LN DEFMD 'NEXT'
50B7 00 15150 DEFBD 0
50B8 50 15160 LO DEFMD 'POKE'
50BC 00 15170 DEFBD 0
50BD 50 15180 LP DEFMD 'PEEK('
50C2 00 15190 DEFBD 0
50C3 4C 15200 LQ DEFMD 'LEFT$( '
50C9 00 15210 DEFBD 0
50CA 52 15220 LR DEFMD 'RETURN'
50D0 00 15230 DEFBD 0
50D1 47 15240 LSL DEFMD 'GOSUB'
50D6 00 15250 DEFBD 0
50D7 54 15260 LT DEFMD 'TAB('
50DB 00 15270 DEFBD 0
50DC 55 15280 LU DEFMD 'USING'
50E1 00 15290 DEFBD 0
50E2 53 15300 LV DEFMD 'STRING$( '
50EA 00 15310 DEFBD 0
50EB 4D 15320 LW DEFMD 'MID$( '
50F0 00 15330 DEFBD 0
50F1 53 15340 LX DEFMD 'SET('
50F5 00 15350 DEFBD 0
50F6 54 15360 LY DEFMD 'THEN'
50FA 00 15370 DEFBD 0
50FB 52 15380 LZ DEFMD 'RESET('
5101 00 15390 DEFBD 0
5102 3A6650 15400 ONESTR LD A,(OSFLAG)
5105 B7 15410 OR A
5106 2078 15420 JR NZ,SUBST
5108 1801 15430 DEBOUL JR KEYDR1
510A 00 15440 NOP
510B CD0251 15450 KEYDR1 CALL ONESTR
510E 322450 15460 LD (KEEPER),A
5111 3A4038 15470 LD A,(3840H) ;CHECK FOR DOWN ARROW
5114 FE10 15480 CP 16
5116 3A2450 15490 LD A,(KEEPER)
5119 2804 15500 JR Z,ARROW
511B B7 15510 OR A
511C C8 15520 RET Z
511D 180B 15530 JR ARROW1
511F 3A4038 15540 ARROW LD A,(3840H)
5122 B7 15550 OR A
5123 20FA 15560 JR NZ,ARROW ;MUST RELEASE
5125 3E1A 15570 LD A,1AH
5127 322450 15580 LD (KEEPER),A
512A 3A0038 15590 ARROW1 LD A,(3880H)
512D B7 15600 OR A
512E 3A2450 15610 LD A,(KEEPER)
5131 C8 15620 RET Z
5132 3A4038 15630 LD A,(3840H)
5135 FE02 15640 CP 2
5137 2858 15650 JR Z,DEFINE
5139 3A2450 15660 LD A,(KEEPER) ;DOWN ARROW
513C FE1A 15670 CP 1AH
513E 2815 15680 JR Z,SUBMOD
5140 3A2450 15690 LD A,(KEEPER)
5143 CBAF 15700 RES 5,A
5145 FE29 15710 CP 41
5147 3A2450 15720 LD A,(KEEPER)
514A D8 15730 RET C
514B CBAF 15740 RES 5,A
514D FE5B 15750 CP 5BH
514F 3A2450 15760 LD A,(KEEPER)
5152 3801 15770 JR C,SUBMOD
5154 C9 15780 RET
5155 E5 15790 SUBMOD PUSH HL
5156 3A2450 15800 LD A,(KEEPER)
5159 FE1A 15810 CP 1AH ;DOWN ARROW
515B 2005 15820 JR NZ,KEYWR
515D 212550 15830 LD HL,USTR
5160 1815 15840 JR SRCHDN
5162 216950 15850 KEYWR LD HL,LA
5165 3A2450 15860 LD A,(KEEPER)
5168 CBAF 15870 RES 5,A
516A D641 15880 SUB 41H

```

Listing 4 continues

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Listing 4 continued

```

516C B7 15890 OR A
516D 2808 15900 JR Z,SRCHDN
516F 47 15910 LD B,A
5170 7E 15920 NXTC LD A,(HL)
5171 23 15930 INC HL
5172 B7 15940 OR A
5173 20FB 15950 JR NZ,NXTC
5175 10F9 15960 DJNZ NXTC
5177 226750 15970 SRCHDN LD (OSPTR),HL
517A 3E01 15980 SETMD LD A,1
517C 326650 15990 LD (OSFLAG),A
517F E1 16000 POP HL
5180 E5 16010 SUBST PUSH HL
5181 2A6750 16020 LD HL,(OSPTR)
5184 7E 16030 LD A,(HL)
5185 B7 16040 OR A
5186 2003 16050 JR NZ,NOTEND
5188 326650 16060 LD (OSFLAG),A
518B 23 16070 NOTEND INC HL
518C 226750 16080 LD (OSPTR),HL
518F E1 16090 POP HL
5190 C9 16100 RET
5191 3A8038 16110 DEFINE LD A,(3880H) ;SHIFT KEY
5194 B7 16120 OR A
5195 3A2450 16130 LD A,(KEEPER)
5198 2002 16140 JR NZ,DEF
519A B7 16150 OR A
519B C9 16160 RET
519C C5 16170 DEF PUSH BC
519D E5 16180 PUSH HL
519E 21E451 16190 LD HL,STRDF
51A1 CDD851 16200 CALL PUTSTR
51A4 212550 16210 LD HL,USTR
51A7 0640 16220 LD B,64
51A9 E5 16230 GETC PUSH HL
51AA C5 16240 PUSH BC
51AB 1801 16250 DEBOU2 JR KEYDR2
51AD 08 16260 NOP
51AE CD0000 16270 KEYDR2 CALL 0000H
51B1 C1 16280 POP BC
51B2 E1 16290 POP HL
51B3 B7 16300 OR A
51B4 28F3 16310 JR Z,GETC
51B6 322450 16320 LD (KEEPER),A
51B9 3A4038 16330 LD A,(3840H)
51BC FE02 16340 CP 2
51BE 2006 16350 JR NZ,NTENDF
51C0 3A8038 16360 LD A,(3880H)
51C3 B7 16370 OR A
51C4 200A 16380 JR NZ,ENDDEF
51C6 3A2450 16390 NTENDF LD A,(KEEPER)
51C9 77 16400 LD (HL),A
51CA 23 16410 INC HL
51CB CD3A03 16420 CALL 033AH
51CE 10D9 16430 DJNZ GETC
51D0 AF 16440 ENDDF XOR A
51D1 77 16450 LD (HL),A
51D2 21F551 16460 LD HL,ENDMSG
51D5 CDD851 16470 CALL PUTSTR
51D8 E1 16480 POP HL
51D9 C1 16490 POP BC
51DA C9 16500 RET
51DB 7E 16510 PUTSTR LD A,(HL)
51DC B7 16520 OR A
51DD C8 16530 RET Z
51DE CD3A03 16540 CALL 033AH
51E1 23 16550 INC HL
51E2 18F7 16560 JR PUTSTR
51E4 0D 16570 STRDF DEFB 0DH
51E5 44 16580 DEFB 'Define String:'
51F3 0D 16590 DEFB 0DH
51F4 08 16600 DEFB 0
51F5 0D 16610 ENDMMSG DEFB 0DH
51F6 45 16620 DEFB 'End Definition'
5204 0D 16630 DEFB 0DH
5205 08 16640 DEFB 0
16650 ; SORT ARRAY STRING ADAPTED FROM
16660 ; BUBBLE SORT, THE ASSEMBLY LINE
16670 ; WILLIAM BARDEN JR, 80 MICRO, APR 81, P53
16680 ; SORT ARRAY STARTING WITH ZERO ELEMENT
16690 ; COMMAND IS OF THE FORM CMD*O*,AS(0)
16700 ; ARRAY MUST BE DIMENSIONED
5206 C1 16710 SABUBL POP BC
5207 F1 16720 POP AF
5208 D1 16730 POP DE
5209 E1 16740 POP HL
520A E5 16750 PUSH HL
520B D5 16760 PUSH DE
520C F5 16770 PUSH AF
520D D7 16780 RST 16
520E D7 16790 RST 16
520F FE22 16800 CP '*' ;CHECK FORMAT
5211 2003 16810 JR Z,SAB01A
5213 C3A024 16820 SABERR JF 24A0H
5216 D7 16830 SAB01A RST 16
5217 FE2C 16840 CP ','
5219 20F8 16850 JR NZ,SABERR
521B E5 16860 PUSH HL
521C D7 16870 STRING RST 16 ;MUST BE (0)
521D FE3A 16880 CP ':'
521F CA1352 16890 JF Z,SABERR
5222 B7 16900 OR A
5223 CA1352 16910 JF Z,SABERR
5226 FE24 16920 CP '$'
5228 20F2 16930 JR NZ,STRING
522A D7 16940 RST 16
522B CF 16950 RST 8
522C 28 16960 DEFB '('
522D CF 16970 RST 8
522E 30 16980 DEFB '@'
522F CF 16990 RST 8

```

Listing 4 continues

the Model III. Nodelay removes this function.

EDT is another toggle command, allowing an autoedit function. Using the shift, enter keys puts you in the edit mode for the line after that already in the current line pointer in RAM. The proper way to use the autoedit function is to specify EDT, then use the Edit command of Basic for the first line to be edited. Consecutive lines are automatically put in the edit mode with the shift, enter combination. Entering the EDT command a second time disables the autoedit function. As with Unikey, you can enable or disable the autoedit function as often as you like.

*“The proper way
to use the autoedit
function is to
specify EDT,
then use the
End command of Basic
for the
first line to be edited.”*

SNGL is a toggle command like Unikey and EDT. Entering the command allows you to single-step through Basic. You must enter the shift key to continue operation. A small delay occurs before you invoke the next Basic command. You can enable or disable this function as often as you like.

Dual or Dual Y routes anything output through the Print command to a printer as well as the video. This command isn't invoked if the printer is not ready. This avoids locking up computers without printers. Dual N disables the command. You can use these commands within a Basic program by taking certain precautions. The Pack utility removes the space between Dual Y and Dual N, and the command is not recognized. If the printer is busy when you invoke the Dual command, it won't recognize the command. When the Dual or Dual Y commands are not recognized, the command disables all route functions.

The PRDO command routes LPRINT commands to the video instead. This is especially useful when you don't have a printer or prefer the text to be printed to video such as when debugging a program. If you don't

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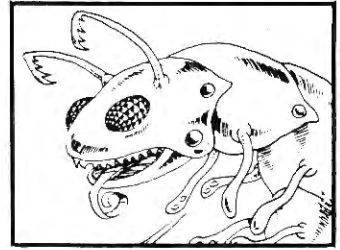
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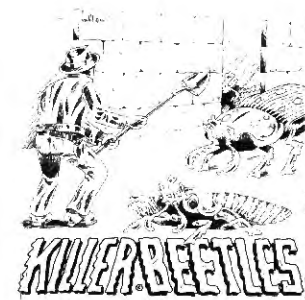


Insect Frenzy - Page 5

Volume 4

All The News That's Fit To ZAP!

Users vote no to the same OLD ARCADE GAMES



(DV 1982) Blurry eyed users have turned to **DISPLAYED VIDEO** to answer their need for new and exciting arcade games. In response, **DISPLAYED VIDEO** has announced eight new programs for the TRS-80* Models I-III. These arcade type games feature sound, graphics, joystick compatibility and are written in machine language for maximum speed! Both disk and tape versions allow the user to save high scores, a feature not usually found on cassette based games. Maze enthusiasts seem to like Ghost Hunter and Killer

Beetles, while gun slingers look toward Insect Frenzy, Jungle Raiders, Space Shootout, Alien Cresta and Battle Stations for excitement. A Game that does not fall into these categories is Hoppy. It features wild drivers, sinking turtles, and hungry alligators. These programs are distributed exclusively by **DISPLAYED VIDEO** and written by Dubois and McNamara. Pricing for these programs is \$15.95 for tape and \$19.95 for disk. Reliable sources inside the company indicate Killer Gorilla will be available by the time you read this.

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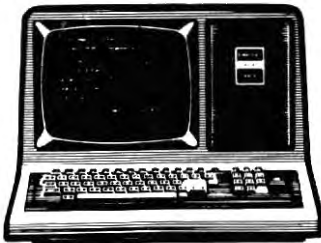
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Listing 4 continued

```

5230 29      17000      DEFB  ' )
5231 E1      17010      POP  HL
5232 D7      17020      RST  16
5233 CD0D26  17030      CALL 260DH
5236 E5      17040      PUSH HL
5237 D5      17050      PUSH DE
5238 DDE1    17060      POP  IX
523A DDE5    17070      PUSH IX
523C DD4EFE  17080      LD   C,(IX+254)
523F DD46FP  17090      LD   B,(IX+255)
5242 0B      17100      DEC  BC
5243 FD210000 17110     LD   IX,0
5247 C5      17120     SAB020 PUSH BC
5248 DD7E00  17130     LD   A,(IX)
524B B7      17140     OR   A
524C 2857    17150     JR   Z,SAB070
524E DD7E03  17160     LD   A,(IX+3)
5251 DD4600  17170     LD   B,(IX)
5254 90      17180     SUB  B
5255 ED44    17190     NEG
5257 4F      17200     LD   C,A
5258 FA5E52  17210     JP   M,SAB030
525B DD4603  17220     LD   B,(IX+3)
525E DD6E01  17230     SAB030 LD   L,(IX+1)
5261 DD6E02  17240     LD   H,(IX+2)
5264 DD5E04  17250     LD   E,(IX+4)
5267 DD5605  17260     LD   D,(IX+5)
526A E5      17270     PUSH HL
526B D5      17280     PUSH DE
526C DD7E03  17290     LD   A,(IX+3)
526F B7      17300     OR   A
5270 2004    17310     JR   NZ,SAB040
5272 D1      17320     POP  DE
5273 E1      17330     POP  HL
5274 1013    17340     JR   SAB060
5276 1A      17350     SAB040 LD   A,(DE)
5277 96      17360     SUB  (HL)
5278 ED44    17370     NEG
527A 2005    17380     JR   NZ,SAB050
527C 13      17390     INC  DE
527D 23      17400     INC  HL
527E 10F6    17410     DJNZ SAB040
5280 79      17420     LD   A,C
5281 D1      17430     SAB050 POP  DE
5282 E1      17440     POP  HL
5283 B7      17450     OR   A
5284 281F    17460     JR   Z,SAB070
5286 FAA552  17470     JP   M,SAB070
5289 DD7504    17480     SAB060 LD   (IX+4),L
528C DD7405    17490     LD   (IX+5),H
528F DD7301    17500     LD   (IX+1),E
5292 DD7202    17510     LD   (IX+2),D
5295 DD7E00    17520     LD   A,(IX)
5298 DD4603    17530     LD   B,(IX+3)
529B DD7703    17540     LD   (IX+3),A
529E DD7000    17550     LD   (IX),B
52A1 PD214000 17560     LD   IX,40H
52A5 C1      17570     SAB070 POP  BC
52A6 DD23    17580     SAB080 INC  IX
52A8 DD23    17590     INC  IX
52AA DD23    17600     INC  IX
52AC 0B      17610     DEC  BC
52AD 78      17620     LD   A,B
52AE B1      17630     OR   C
52AF 2096    17640     JR   NZ,SAB020
52B1 PDE5    17650     PUSH IY
52B3 F1      17660     POP  AF
52B4 DDE1    17670     POP  IX
52B6 2002    17680     JR   NZ,SAB090
52B8 1800    17690     JR   SAB010
52BA E1      17700     SAB090 POP  HL
52BB F1      17710     POP  AF
52BC D1      17720     POP  DE
52BD C1      17730     POP  BC
52BE C9      17740     RET
17750 ; AUTO EDIT
17760 ; DAN ROLLINS, 80 MICRO, FEB 81, P144
17770 ; <SHIFT><ENTER> TO ACTIVATE
52BF 3AAP41  17780     PATCHA LD   A,(41APH)
52C2 F5      17790     PUSH AF
52C3 2AB041  17800     LD   HL,(41B0H)
52C6 E5      17810     PUSH HL
52C7 3ADE52  17820     LD   A,(STOREA)
52CA 32AF41  17830     LD   (41APH),A
52CD 2ADP52  17840     LD   HL,(STOREA+1)
52D0 22B041  17850     LD   (41B0H),HL
52D3 E1      17860     POP  HL
52D4 F1      17870     POP  AF
52D5 32DE52  17880     LD   (STOREA),A
52D8 22DF52  17890     LD   (STOREA+1),HL
52DB C37344  17900     JP   BASIC
52DE C3E152  17910     STOREA JP   ATOEDT
52E1 3A8038  17920     ATOEDT LD   A,(3800H)
52E4 B7      17930     OR   A
52E5 28F7    17940     JR   Z,STOREA
52E7 ED5BEC40 17950     LD   DE,(40ECH)
52EB 13      17960     INC  DE
52EC CD2C1B  17970     CALL 1B2CH
52EF C5      17980     PUSH BC
52F0 E1      17990     POP  HL
52F1 23      18000     INC  HL
52F2 23      18010     INC  HL
52F3 CD3F1B  18020     CALL 1B3FH
52F6 C3662E  18030     JP   2E66H
18040 ; SINGLE STEP, 80 APPLICATIONS
18050 ; DENNIS KITSZ, 80 MICRO, AUG 80, P28
18060 ; SINGLE STEP THROUGH A BASIC PROGRAM
52F9 2A0440  18070     PATCHB LD   HL,(4004H)
52FC E5      18080     PUSH HL
52FD 2A1B53  18090     LD   HL,(STOREB+1)

```

Listing 4 continues

Listing 4 continued

5300	220440	18100	LD	(4004H),HL					
5303	E1	18110	POP	HL					
5304	221B53	18120	LD	(STOREB+1),HL					
5307	C37344	18130	JP	BASIC					
530A	F5	18140	STARTB	PUSH	AF				
530B	C5	18150	PUSH	BC					
530C	3A8038	18160	LOOPB	LD	A,(3880H)				
530F	A7	18170	AND	A					
5310	28FA	18180	JR	Z,LOOPB					
5312	010010	18190	LD	BC,1000H				;DELAY	
5315	CD6000	18200	CALL	0060H					
5318	C1	18210	POP	BC					
5319	F1	18220	POP	AF					
531A	C30A53	18230	STOREB	JP	STARTB				
		18240	;	CLEAN UP					
		18250	;	SET POINTERS FOR BASIC					
		18260	;						
531D	214653	18270	CLENUM	LD	HL,CLEND				
5320	3A2501	18280	LD	A,(0125H)					
5323	FE49	18290	CP	49H				;CHECK IF MODEL III	
5325	2004	18300	JR	NZ,CLEN1					
5327	22A740	18310	LD	(40A7H),HL				;BUFFER POINTER	
532A	24	18320	INC	H					
532B	3600	18330	CLEN1	LD	(HL),0				
532D	23	18340	INC	HL					
532E	22A440	18350	LD	(40A4H),HL				;BASIC START	
5331	227944	18360	LD	(BAS),HI					
5334	3600	18370	LD	(HL),0					
5336	23	18380	INC	HL					
5337	3600	18390	LD	(HL),0					
5339	23	18400	INC	HL					
533A	22F940	18410	LD	(40F9H),HL					
533D	22FB40	18420	LD	(40FBH),HL					
5340	22FD40	18430	LD	(40FDH),HL					
5343	C37344	18440	JP	BASIC					
5346	00	18450	CLEND	DEFB	0				
4473		18460	BASIC	EQU	4473H				
4479		18470	BAS	EQU	4479H				
43BE		18480	ORG	43BEH				;SET COMMAND ADDRESSES	
43BE	0652	18490	DEFW	SABUBL					
44F3		18500	ORG	44F3H					
44F3	EE4F	18510	DEFW	PATCH8					
44FA		18520	ORG	44FAH					
44FA	0250	18530	DEFW	BOUNCE					
4503		18540	ORG	4503H					
4503	1450	18550	DEFW	NOBOU					
4508		18560	ORG	4508H					
4508	BF52	18570	DEFW	PATCHA					
450E		18580	ORG	450EH					
450E	F952	18590	DEFW	PATCHB					
4516		18600	ORG	4516H					
4516	994F	18610	DEFW	DUALOP					
451E		18620	ORG	451EH					
451E	8B4F	18630	DEFW	DUALON					
4524		18640	ORG	4524H					
4524	8B4F	18650	DEFW	DUALON					
452A		18660	ORG	452AH					
452A	CB4F	18670	DEFW	PRDO					
4530		18680	ORG	4530H					
4530	D74F	18690	DEFW	DOPR					
4300		18700	END	4300H					

have a printer you may want to keep the Dual command as a function. You would also have to eliminate this command as part of that set. PRDO is a very useful function and is well worth the memory used by all the route functions. The Dual N command turns off this function. The same precautions apply as for the Dual commands.

The DOPR command routes Print commands to a printer. As with PRDO, Dual N turns off this function and the same precautions apply. Only one command, Dual, PRDO, or DOPR, is enabled at a time—the last command entered.

Hex, octal, and decimal conversion is accomplished by the &H, &O, and &D commands, respectively. For example, executing PRINT &D255, PRINT &HFF, or PRINT &0377 return the value 255 to video. The &D function is especially useful for converting integers above 32767 to their signed value. For example, PRINT PEEK (&D40000) is equivalent to PRINT PEEK(-25536) and lets you avoid computing the negative value. The largest values allowed for the three functions are &HFFFF, &017777, and &D65529.

Well, there you have it! Many of the commands work in a slightly different fashion than intended by the original author. The Unikey function required extensive modification to work with the Model III as well as the Model I. The DEFUSR and USR functions are very loose derivatives of the program presented by the original author of the

concept.

I applaud the original authors for their work. With this program, you will get a compilation of utility programs that I wish I had earlier on in my

computing experience. ■

Tom Quindry, a Defense Department employee, lives at 6237 Windward Drive, Burke, VA 22015.

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Storm Tracker

by Charles C. Williams

Forecast the landfall coordinates of an oncoming tropical storm or hurricane to see how much danger the storm poses to you.

This computer program forecasts landfall coordinates of an oncoming tropical storm or hurricane. The program supplements the hurricane watches and warnings issued by the weather bureau and gives you a clearer picture of just how much danger the storm poses to you.

You enter the coordinates of the storm, longitude and $\ln(\log_e)$ latitude (the weather service furnishes these), as

```
1001 DATA 90.0, 3.295837
1002 DATA 90.5, 3.295837
1003 DATA 91.0, 3.277145
1004 DATA 91.2, 3.269569
1005 DATA 91.5, 3.265759
1006 DATA 92.0, 3.265759
1007 DATA 92.5, 3.265759
1008 DATA 93.5, 3.258097
1009 DATA 94.3, 3.254243
1010 DATA 95.4, 3.242592
1011 DATA 96.0, 3.218876
1012 DATA 96.6, 3.194583
1013 DATA 98.0, 3.178054
1014 DATA 97.5, 3.182212
1015 DATA 98.2, 3.161247
1016 DATA 98.5, 3.157000
1017 RETURN
1018 GOTO 1018
```

Fig. 1. Data for Anita

The Key Box
Models I and III
16K RAM
Cassette or Disk Basic

data into the program. The program computes a least-squares formula for the longitude and latitude and the latitude for a given longitude, and plots the curve points included in the computation and the predictive curve based on the input data.

The input value for M controls the depth of the data scan. When you are tracking a storm with the computer using the weather advisory's coordinates, you enter the longitude and $\ln(\log_e)$ latitude data sets in reverse order. In the data stack the first data are on the bottom and the latest data at the

top. For example, you would enter your data as follows:

```
995 Fifth data set
996 Fourth data set
997 Third data set
998 Second data set
999 First data set
```

The computer scans the data from the top down, line by line. Your value for M tells the computer how many data sets to read. When it reads M sets, it goes about its other chores.

With the data entered in reverse, and with a constant value for M (e.g., three), you can see that on the third day your computer will read the third, second, and first data sets. On the fourth day it will read the fourth, third, and second data sets. On the fifth day the data scan involves the fifth, fourth, and

Program Listing

```
100 CLS:N=0:X=0:Y=0
101 PRINTTAB(12)":::HURRICANE TRACKING SYSTEM:::"
102 PRINTTAB(12)"***** ALLEN *****"
103 PRINTTAB(12)"LONGITUDE 'X'..LOG LATITUDE 'Y'"
104 PRINTTAB(12)" M = NUMBER OF (X,Y) DATA SETS "
105 PRINTTAB(12)" CHARLES C WILLIAMS "
106 PRINTTAB(12)" COPYRIGHT 1980 "
107 INPUT "M=";M
108 CLS
109 READ X,Y
110 O=O+X
111 P=P+(X*X)
112 Q=Q+(X*Y)
113 S=S+Y
114 T=T+(Y*Y)
115 N=N+1
116 IFN=MTHEN117 ELSE109
117 U=((Q*M)-(O*S))/(M*M)
118 V=((P*M)-(O*O))/(M*M)
119 W=((T*M)-(S*S))/(M*M)
120 B=U/V
121 A=((S/N)-(B*O/N))
```

Listing continues


```

122 J=SQR(ABS(V)):K=SQR(ABS(W))
123 R=U/(J*K)
124 PRINTTAB(12)"CORRELATION COEFFICIENT (R) =" ;R
125 PRINT
126 PRINTTAB(12)"          *** D ***          "
127 PRINTTAB(12)"...VALUE(1)...PLOT(2)...CURVE(3)..."
128 INPUT "D=" ;D
129 IF D=1 THEN 132
130 IF D=2 THEN 135
131 IF D=3 THEN 144
132 INPUT "X=" ;X
133 PRINT,"LONGITUDE=" ;X ;"          " ;"LATITUDE=" ;EXP(A+(B*X))
134 GOTO 132
135 RESTORE:GOSUB 153
136 FOR N=1TOM
137 READ X, Y
138 Z=EXP(Y)
139 F=407-4*X
140 G= 91-3*Z
141 SET (F,G)
142 NEXT N
143 GOTO 184
144 RESTORE:GOSUB 153
145 FORX=98T072 STEP-1
146 Z=EXP(A+(B*X))
147 F=407-(4*X)
148 G= 91-(3*Z)
149 IF(G<=1)OR(G>=47)THEN 152 ELSE 150
150 SET (F,G)
151 NEXT X
152 GOTO 184
153 CLS:N=0:X=0
154 FOR Y=0T044 STEP 2
155 C=(30-(N))
156 PRINT C"- "
157 N=N+1:IF N>=15 THEN 159 ELSE 154
158 NEXT Y
159 N=0:X=0:Y=0
160 FOR X=7T0119 STEP 8
161 Y=44
162 SET (X,Y)
163 NEXT X
164 N=0
165 FOR X=7T0119 STEP 8
166 C=(100-(2*N))
167 PRINT C;
168 N=N+1
169 NEXT X
170 PRINT@ 23,"NO";
171 PRINT@ 77,"GV";
172 PRINT@136,"CC";
173 PRINT@166,"TM";
174 PRINT@265,"BV";
175 PRINT@299,"MI";
176 PRINT@422,"HV";
177 PRINT@455,"TP";
178 PRINT@542,"*Y";
179 PRINT@651,"VC";
180 PRINT@662,"CP";
181 PRINT@766,"SD";
182 PRINT@817,"KG";
183 RETURN
184 GOTO 184
1001 DATA 87.0,3.091043
1002 DATA 87.9,3.109061
1003 DATA 89.0,3.109061
1004 DATA 89.6,3.113515
1005 DATA 90.8,3.157000
1006 DATA 91.4,3.169686
1007 DATA 92.0,3.178054
1008 DATA 92.8,3.194583
1009 DATA 93.1,3.194583
1010 DATA 93.8,3.210844
1011 DATA 94.4,3.222868
1012 DATA 95.2,3.230804
1013 DATA 95.5,3.226844
1014 DATA 96.1,3.230804
1015 DATA 96.5,3.238679
1016 DATA 96.7,3.246491
1017 DATA 96.9,3.254243
1018 DATA 97.4,3.259569
1019 DATA 98.1,3.292126
1020 DATA 99.0,3.306887
1021 END

```

Fig. 2. Data for Henri

```

1001 DATA 93.0,3.068053
1002 DATA 94.0,3.044522
1003 DATA 94.0,3.020425
1004 DATA 94.3,2.995732
1005 DATA 94.0,3.020425
1006 DATA 95.0,3.044522
1007 DATA 95.2,3.058707
1008 DATA 95.8,3.058707
1009 DATA 95.7,3.077312
1010 DATA 96.2,3.063391
1011 DATA 95.5,3.068053
1012 DATA 95.0,3.044522
1013 DATA 94.5,3.068053
1014 DATA 94.5,3.068053
1015 DATA 94.0,3.044522
1016 DATA 93.5,3.044522
1017 DATA 93.0,3.044522
1018 DATA 92.5,3.044522
1019 DATA 93.0,3.091042
1020 DATA 92.5,3.091042
1021 DATA 92.5,3.091042
1022 DATA 92.0,3.113515
1023 DATA 89.5,3.238678
1024 DATA 89.0,3.238678
1025 DATA 88.0,3.258097
1026 DATA 87.5,3.269569
1027 END

```

third sets. This gives you a moving scan with M data-set depth. You may vary the depth of the scan by changing the value for M. A large M gives a more generalized analysis. A smaller M makes the analysis more sensitive to path change.

After you enter a value for M, the computer asks for the selector value D. If you press 1 the computer then asks for a value of x, the longitude coordinate. The value for x is the longitude of the possible landfall area. For the western Gulf a value of 97 is suitable. The computer then determines a latitude value using the data you have input. This gives you the coordinates of the landfall based on the measurements made at that point in time.

Each point you determine is like a hit on a target. If the storm is well organized and consistent, you will have a tight group of points and a good idea of where the storm will landfall. If the storm is disorganized and erratic your group of points could spread all over. Even so each landfall point you determine is the best guess that can be made at that point in time and for the data input to the computer.

If you enter a value of 2 for D the computer plots the points that have been included by the value for M. If you enter a value of 3 for D the computer plots a total curve based on the input measurements.

The program also computes R, a measure of the correlation between the computer analysis and the actual data. R measures the goodness of fit and gives you an idea of how accurate your measurements are.

The Program Listing contains the complete program including data from hurricane Allen. Figures 1 and 2 contain the data for hurricanes Anita and Henri. If you want to analyze these hurricanes replace the data from lines 1001 and on in the program listing with the data from the figure for the hurricane you are interested in.

The computer analysis of Allen was hard to believe. At longitude 89, a little past Yucatan, the predictions had an 85 percent probability. By longitude 91 they had reached 90 percent probability. By longitude 94 the probability was 98 percent and rising. The latitude predicted at longitude 91.4 (25.8) was within .1 degree of the actual landfall coordinate (25.9) longitude 96.9. ■

Charles Williams can be reached at Number 14, 5320 Auden, Houston, TX 77005.

6502 to Z80, Bit by Bit

by David S. Peckett

If you've ever wanted to convert those 6502 Assembly-language programs to run on a Z80 computer, here's a piece on how it's done.

One of the delights of working with computers is learning a particular system's programming language. To have any hope of adapting programs written for other systems, you must have a nodding acquaintance with other languages.

Even a widely used high-level language like Basic has as many dialects as there are computer types. Fortunately, if you know Level II Basic, you can usually read, say, Applesoft programs. That's one of the reasons for having high-level languages.

When you get down to the level of Assembly-language, things are not so easy. A thorough knowledge of the

Z80 assembler is not much help when that special 6502 listing seems to be just what you need. The only way you can use it is to understand 6502 Assembly code well enough to work back to the program's algorithm. Then you can recode it for a Z80, and then debug it.

This article gives an easy way out. It describes a Level II Basic program that can translate 6502 assembler into equivalent Z80 code. If you only work in Basic, the program will be of no use; however, if you are a machine-code freak it could be a great help to you.

To keep things to a manageable size, the program translates a general 6502 listing to a general Z80 listing. Hardware-dependent sections are only translated as Assembly code—they are not altered to suit the architecture of the target computer.

For example, an Apple program may write directly to display memory; the translation would not automatically write to the TRS-80 display area. Similarly, you must make your own decisions about such items as where to put the stack.

Translation Approach

Before going into the detail of how

the translation is handled, let's review the architectures of the 6502 and the Z80. Remember, a computer's architecture is reflected in its Assembly language. An understanding of one is essential to understand the other.

Figure 1 shows the 6502's basic configuration. The micro has a single 8-bit accumulator and a status register. It also has two 8-bit index registers (X and Y). Often interchangeable, these can be used for temporary data storage, as loop counters, and as indices for the micro's numerous addressing modes.

The 6502 also has an 8-bit stack pointer (SP) pointing to a stack permanently located on page 1 of memory, and a conventional 16-bit program counter (PC).

The Z80's architecture is shown in Fig. 2. The micro is more complex than the 6502 and has two sets of working registers. It can use either set at any time, but not together.

Each set has an 8-bit accumulator (A), with its associated flag register (F), and six general-purpose 8-bit reg-

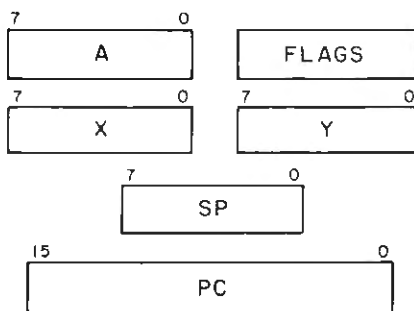


Fig. 1. 6502 Architecture

The Key Box

**Basic Level II
Model I
16K RAM
An editor/assembler**

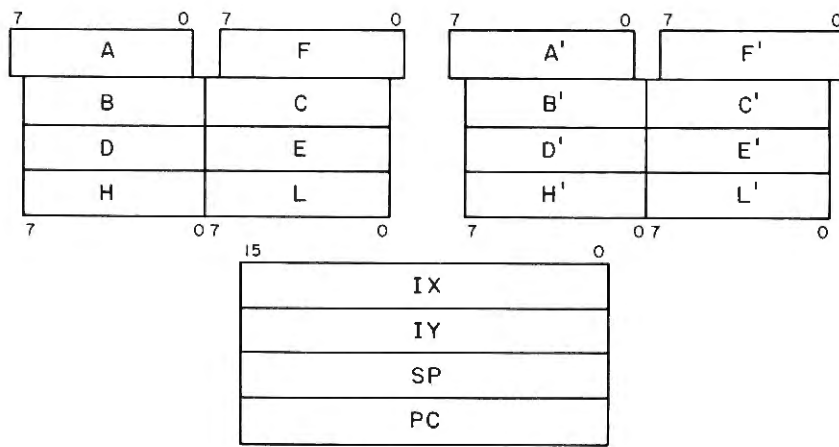


Fig. 2. Basic Z80 Architecture

isters (B-E,H,L). These six registers can be concatenated into three 16-bit registers (BC, DE, and HI), to perform limited 16-bit arithmetic or to give pointers to anywhere in memory.

The Z80 also has a 16-bit stack pointer (SP), which means the stack can be anywhere in memory, and a 16-bit program counter (PC). The two 16-bit index registers (IX and IY) are redundant in this translation program.

Both microprocessors have an eight-bit accumulator which performs most

arithmetic and both offer the same fundamental operations. The flags show the results of the operations, and both micros have equivalent carry, zero, and sign flags. Program counter operation is similar in the two micros, and the 6502's eight-bit SP is a subset of the Z80's 16-bit stack pointer.

Major Differences

Perhaps the most important difference between the two micros is in their approach to addressing memory.

The 6502 has a wide selection of indexed, indirect, and compound addressing modes, including the more obvious immediate and absolute modes. The Z80 has only immediate and indirect operations—the latter use register HL as a pointer—and an indexing mode totally unlike the 6502.

The two sets of flags work differently. The 6502 sets them whenever it loads or manipulates A, X, or Y; the Z80 alters flags only after an arithmetic or logical operation. In subtraction and comparison operations, the 6502 sets its carry flag to show there was no borrow, while the Z80 clears the flag to show the same state. To add to the confusion, both micros treat their carry flags identically during addition.

Despite the differences, a Z80 can model a 6502 quite well. The grey areas (like the overflow flag) are unimportant. In fact, SED, OLD, BRK and BIT are the only four 6502 operations that the Z80 cannot copy.

Translation Approach

The program uses the Z80's registers to emulate those in the 6502. The accumulators, flag registers, stack pointers, and program counters are

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equivalent and present no real problems. C and E in the Z80 model X and Y in the 6502. By keeping B and D at zero, we can reproduce the 6502's addressing modes.

The fundamental approach is to replace a single line of 6502 code with functionally equivalent Z80 code; any labels or comments are preserved.

With operations like ADC or LDA this is straightforward, but some operations, such as CLV, are more complex.

Handling only one 6502 instruction at a time is not an ideal approach but was necessary to fit the program into 16K. With more RAM, it is not too difficult to generate a more intelligent program that could translate the sense

6502 Instruction Categories

Untranslatable:
BIT, BRK, CLD, SED

Single-Line, No Operand:
CLI, DEX, DEY, INX, INY, NOP, PHA, PHP, RTS, SEC, SEI

Single-Line, with Operand:
BCC, BCS, BEQ, BMI, BNE, BPL, BVC, BVS, JSR

Standard Format:
ADC, AND, ASL, CMP, DEC, EOR, INC, JMP, LSR, ORA, ROL, ROR, STA, STX, STY

Irregular:
CLC, CLV, CPX, CPY, LDA, LDX, LDY, PLA, PLP, RTI, SBC, TAX, TAY, TSX, TXA, TXS, TYA

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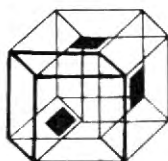
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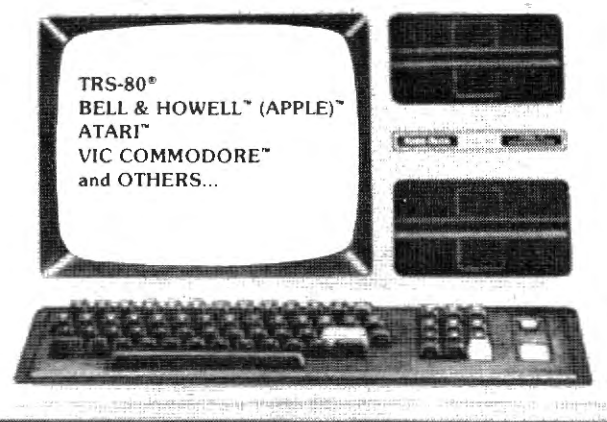
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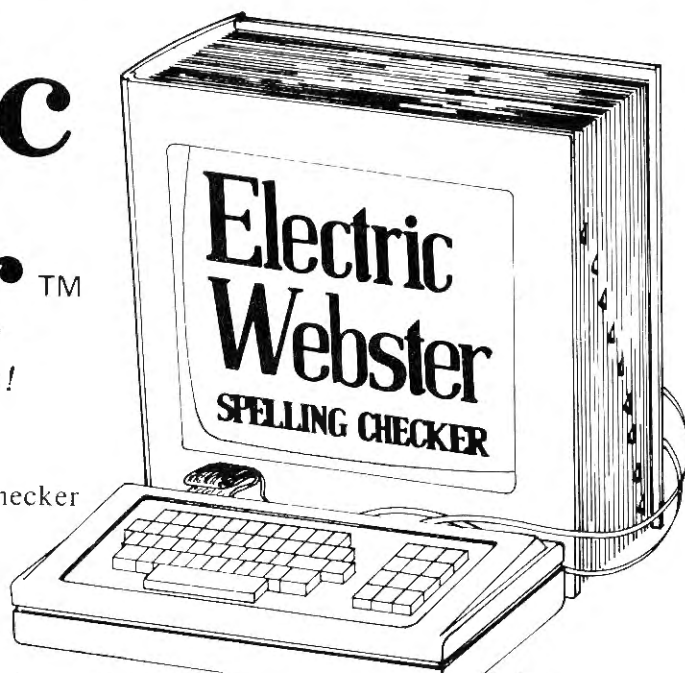
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of (small) blocks of 6502 assembler into Z80. Larger source programs than the 16K program's 1,500 byte buffer allows could also be handled.

Translation causes a growth in code size, so a translated program takes about three times as much RAM as the original and runs about one third slower. Neither penalty is significant.

Translating 6502 Operations

The fundamental problem is how to translate the 6502 operations. There is no room for all the details here, but the micro's instruction set can be divided into five general categories (see Table 1).

Untranslatable instructions are self-explanatory. The single-line commands replace a single 6502 operation with a single line of Z80 code. Single-line, no operand functions use implied addressing, while single-line with operand use a relative or absolute address. For example, the 6502 instructions DEY and BNE LOOP translate exactly as DEC E and JR NZ,LOOP.

The standard multi-line translations define a group in which the basic operation can be translated by a single line or modified by other lines controlling

flags and the addressing mode. For example, EOR TEST becomes:

```
LD HL, TEST
XOR (HL)
```

These first three groups of translatable instructions can be handled by a simple look-up table approach, but the instructions in the last category do not

Program Listing 1

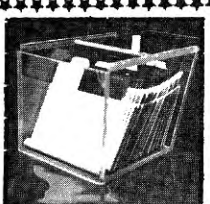
```
10 ' 6502 TO Z80 TRANSLATION PROGRAM
20 '(C) 1981, D S PECKETT
30 CLEAR 1000:DEFINT A-Z
40 DIM IN$(4),LN$(8),OD(57),TA$(8,4),TC(8),TV$(38)
500 'TOP-LEVEL SEGMENT FOR 6502-Z80 TRANSLATION
510 CLS: PRINT@272,"INITIALIZING SYSTEM";:GOSUB1000
520 GOSUB1500:'INPUT DATA
530 GOSUB3000:'PARSE A LINE
540 GOSUB5000:'TRANSLATE
550 IF F4 THEN 580:'END?
560 GOSUB2500:'SAVE TO TAPE
570 GOTO 530:'BACK FOR MORE
580 GOSUB9000:'TAIL END
590 PRINT@960,"TRANSLATION COMPLETE; REMOVE TAPE"
600 XS="":INPUT "DO YOU WANT TO DO ANOTHER TRANSLATION";X$:X$=LE
FT$(X$,1)
610 IF X$="N" END
620 X$="Y" THEN 520 ELSE GOTO 600
1000 'SYSTEM INITIALIZATION
1010 OC$="ADCANDASLBCCBCSBEQBITBMBIBNEBPLBRKBVCBVSCLCLDCLICLVCMPC
PXCPYDECDEXDEYENDEORINCINXINYJMPJSRLDALDXLDYLSRNOPOPAPHAPHPPLAP
LPROLRRORTIRTSSBCSECSSEISEISTASTXSTYTXATYATYTXATXSTYA":'6502 OPC
ODES
1020 FOR I=1 TO 57:READ X:OD(I)=X:NEXTI:'TRANSLATION CODES
1030 T$=CHR$(9):T1$="":C$=CHR$(13)
1040 FOR I=1 TO 35:READ X$:TV$(I)=X$:NEXTI:'TRANSLATION VECTOR
1050 'FILL TRANSLATION ARRAY

1060 FOR I=1 TO 8:READ TC(I):FOR J=1 TO TC(I):READ X$:TA$(I,J)=X
$:NEXT J,I
1070 FOR I=32584 TO 32762:READ X:POKE I,X:NEXTI:'LOAD M/CODE
1080 POKE 16526,72:POKE 16527,127
1090 RETURN
1500 'INPUT DATA
1510 'READ IN LISTING TO BE TRANSLATED
1520 CLS
1530 PRINT "LOAD CASSETTE WITH 6502 PROGRAM INTO CASSETTE DRIVE
- HIT ANY KEY WHEN READY"
1540 IF INKEY$="" THEN 1540
1550 A=USR(32588):'LOAD SOURCE CODE
1560 IF A=32588 PRINT "BAD TAPE - TRY AGAIN":GOTO 1530
1570 IF A=0 THEN PRINT"INPUT BUFFER FULL. ANY KEY TO CONTINUE TR
ANSLATION"ELSE GOTO 1590
1580 IF INKEY$="" THEN 1580
1590 L9=0:INPUT"START LINE NUMBER FOR OUTPUT";L9:L9=L9-10
1600 P9=30720:'POINTER FOR READING TEXT
1610 FD=0:FE=0:FF=0:FG=0:'ADD. MODE FLAGS
1620 'SET UP OUTPUT TAPE
1630 PRINT"LOAD CASSETTE WITH BLANK TAPE AND SET TO RECORD"
1640 X$="" :INPUT"NAME OF OUTPUT FILE";X$:X$=X$+" "
1650 X=VARPTR(X$)+1:POKE 32765,PEEK(VARPTR(X)):POKE 32766,PEEK(V
ARPTR(X)+1):'SET ADDRESS OF TITLE
1660 A=USR(32691):'LOAD HEADER
1670 LN=2:GOSUB2000
1680 OP$=LN$(1)+T1$+"LD B,0"+C$+LN$(2)+T1$+"LD D,0"+C$: 'INIT
IALIZE REGISTERS
1690 GOSUB2500:RETURN
2000 'GENERATE LINE NUMBERS
2010 FOR IL=1 TO LN:L9=L9+10:L9$=STR$(L9):LN$(IL)=RIGHT$("0000"+
RIGHT$(L9$,LEN(L9$)-1)+"",6):NEXT
2020 RETURN
2500 'OUTPUT TRANSLATION
2510 PRINT OP$;
2520 X=VARPTR(OP$):POKE 32765,PEEK(VARPTR(X)):POKE 32766,PEEK(VA
RPTR(X)+1):'OP$ ADDRESS
2530 A=USR(32720):'RECORD TRANS.
2540 RETURN
3000 'PARSE A LINE
3010 F1=0:F2=0:F3=0:IN$(1)="" :IN$(2)="" :IN$(3)="" :IN$(4)="" :INI
TIALIZE VARIABLES
3020 IF CHR$(PEEK(P9))="" THEN 3200:'COMMENT LINE?
3030 F9=0:I9U1
3040 X$=CHR$(PEEK(P9)): 'READ A CHAR
3050 IF X$=C$ P9=P9+1:GOTO 3120:'FINISH ON CR
3060 IF X$="" THEN F3=-1:'COMMENT FLAG
3070 IF (X$="" OR X$=T$) AND NOT F9 AND NOT F3 AND I9<4 THEN I9
```

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Listing 1 continues

have a regular pattern. Each opcode in this group must be handled individually. It's possible to rationalize in the case of closely related instructions like CPX and CPY, but that is all. As examples of translations of opcodes in this group, TAX becomes:

```
LD C,A
INC C ;THESE 2 LINES..
DEC C ;.SET THE FLAGS
```

while CPY #SAB is translated as:

```
LD D,A ;SAVE A
LD A,E ;A=Y
CP 0AB
CCF ;CY FLAG TO 6502 MODE
LD A,D ;RESTORE A
LD D,B ;D=0 AGAIN
```

These two examples illustrate the translation program's approach to controlling the flags. The INC, DEC in the first case sets the flags, and the second example's CCF keeps the Z80 carry flag in the state the 6502 would put it.

Translating 6502 Addressing Modes

There is no point in translating 6502 operations unless 6502 addressing modes can also be translated. The ab-

Listing 1 continued

```
=I9+1:P9=-1:P9=P9+1:GOTO 3040:'DELIMITER?
3080 IF (X$=" " OR X$=T$) AND P9 THEN P9=P9+1:GOTO 3040:'SAME DE
LIMITER?
3090 P9=0:'RESET FLAG
3100 IN$(I9)=IN$(I9)+X$:'READ A CHAR
3110 P9=P9+1:GOTO 3040:'NEXT
3120 'IN$(1-4) FILLED
3130 IF X(IN$(3),1)=";" AND IN$(4)="" IN$(4)=IN$(3):IN$(3)=""':C
ORRECT COMMENT FIELD
3140 'FILL RETURN STRINGS
3150 LB$=IN$(1)+T1$:O1$=IN$(2):O2$=IN$(3):CT$=T1$+IN$(4)
3160 GOSUB3500:IF F2 RETURN:'CHECK FOR ERRORS
3170 GOSUB4000:IF F2 RETURN:'FIND OPCODE
3180 GOSUB4500:RETURN:'CHECK ADDRESS MODE
3200 'COMMENT LINE
3210 CT$=""':F1=-1
3220 X$=CHR$(PEEK(P9)):P9=P9+1:CT$=CT$+X$
3230 IF X$=C$ THEN RETURN ELSE GOTO 3220
3500 'CHECK FOR OBVIOUS SYNTAX ERRORS
3510 'LABEL FIELD
3520 IF LB$=T1$ THEN 3550
3530 IF LEN(LB$)>10 F2=-1:RETURN:'LABEL WRONG
3540 L=ASC(LEFT$(LB$,1)): IF NOT(LB$=T1$ OR (L>64ANDL<91)) F2=-1
:RETURN:'START OK?
3550 'OPERATION FIELD
3560 IF LEN(O1$)<>3 F2=-1:RETURN:'3 CHAR IN OP?
3570 L=ASC(LEFT$(O1$,1)):IF L<65 OR L>84 F2=-1:RETURN:'A-T START
?
3580 'COMMENT FIELD
3590 IF CT$=T1$ RETURN
3600 IF MID$(CT$,5,1)<>";" F2=-1:'NO ";" AT START
3610 RETURN
4000 'GET OPCODE
4010 IA=1:IB=57:FH=0
4020 IF FH OR IA>IB THEN 4060:'FINISHED?
4030 IM=(IA+IB)/2:AM$=MID$(OC$,IM*3-2,3)
4040 IF AM$=O1$ THEN FH=-1 ELSE IF AM$>O1$ THEN IB=IM-1 ELSE IA=
```

Listing 1 continues

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solute and immediate modes are easy, as is the pure indirect mode; unfortunately, only JMP (Q) uses the indirect mode.

We also have to deal with the 6502's indexed, indirect-indexed and indexed-indirect modes; at the cost of a few lines of code, it is possible to imitate them all with a Z80.

The technique is to load register HL with the operand label (for example, Total from LDA (TOTAL,X)). This is followed by a CALL to one of four possible subroutines to modify HL to the intended address. Four subroutines (XIXX, IXIY, IXIND, and INDIX) emulate ABS,X, ABS,Y, (IND,X), and (IND),Y respectively. An example of this technique, EOR (STORE),Y, translates as:

```
LD    HL,STORE
CALL  INDIX
XOR  (HL)
```

where:

```
INDIX EX  AF,AF' ;SAVE A AND F
LD    A,(HL) ;LOW BYTE...
INC  HL
LD    H,(HL) ;HIGH BYTE...
LD    L,A ;HL IS NOW POINTER
ADD  HL,DE ;ADD OFFSET
EX   AF,AF' ;RESTORE
RET
```

When the 6502 program is translated, those subroutines actually called by the translation are added to the output.

Using the Translator

First, prepare the 6502 source code on tape. Use an editor/assembler to write the 6502 program in standard format, including line numbers, and save the program on tape in standard TRS-80 format. The translator accepts code in the standard 6502 assembler format as defined in Zaks' *Programming the 6502*; in addition, all comment fields must start with a semi-colon. Do not include assembler pseudo-operations; since they vary from assembler to assembler, the translator does not attempt to handle them—they will be flagged as errors.

Reboot your computer and set memory size to 30720. You can then load the translation program and read the source tape into the 1,500-byte buffer. If the source program is in the wrong format, or is too long, you will get a warning message. In the latter case you will have to split the program into smaller parts. Even if the buffer overflows, you can run the translator immediately on what has been loaded.

Once the source code is in the buffer,

Listing 1 continued

```
IM+1
4050 GOTO 4020
4060 IF IA>IB THEN F2=-1:RETURN:'UNIDENTIFIED OPCODE
4070 IC=OD(IM):RETURN:'GET CODE
4500 'IDENTIFY ADDRESS MODE
4510 LN=LEN(O2$)
4520 IF O2$="" MA=1:RETURN:'IMPLIED
4530 IF O2$="A" MA=2:RETURN:'ACCUM
4540 L=ASC(LEFT$(O2$,1)):R=ASC(RIGHT$(O2$,1)):1ST & LAST CHARS
4550 IF L<65 OR L>90 THEN 4620:'NOT ABS OR INDEXED
4560 IF LN<3 THEN 4580:'TOO SHORT FOR INDEXED
4570 IF MID$(O2$,LN-1,1)="" THEN 4600:'INDEXED?
4580 IF (R>47 AND R<58)OR(R>64 AND R<91)THEN MA=3 ELSE F2=-1:'ABSOLUTE? GIVES "ABS" FOR "REL"
4590 RETURN
4600 IF R=88 THEN MA=4 ELSE IF R=89 THEN MA=5 ELSE F2=-1:'INDEXED
4610 O2$=LEFT$(O2$,LN-2):RETURN:'EXTRACT OPERAND
4620 IF L<>40 THEN 4680:'OPENING BRACKET?
4630 R$=RIGHT$(O2$,3)
4640 IF R$="" THEN MA=6 ELSE IF R$="," THEN MA=7 ELSE IF R=41 THEN MA=8 ELSE F2=-1:'(IND,X)/(IND),Y/(IND)?
4650 IF F2 RETURN
4660 IF MA=8 THEN O2$=MID$(O2$,2,LN-2) ELSE O2$=MID$(O2$,2,LN-4):'EXTRACT OPERAND
4670 RETURN
4680 'IMMEDIATE?
4690 IF L<>35 F2=-1:RETURN:'#?
4700 MA=9:L=ASC(MID$(O2$,2,1)): 'SECOND CHAR
4710 IF L>47 AND L<58 THEN MI=1 ELSE IF L=36 THEN MI=2 ELSE IF L=37 THEN MI=3 ELSE IF L>64 AND L<91 THEN MI=4 ELSE F2=-1:RETURN:'IMMED. MODE?
4720 IF MI=1 OR MI=4 THEN O2$=RIGHT$(O2$,LN-1) ELSE O2$=RIGHT$(O2$,LN-2):'EXTRACT OPERAND
4730 IF MI=2 O2$=O2$+"H":IF LEFT$(O2$,1)>"9" O2$="0"+O2$
4740 IF MI=3 O2$=O2$+"B"
4750 RETURN
5000 'TRANSLATION SUBROUTINE
5010 F4=0:'END FLAG
5020 IF NOT F1 THEN 5040
5030 LN=1:GOSUB2000:OP$=LN$(1)+CT$:RETURN:'COMMENT LINE
5040 IF F2 OR (MA=8 AND IC<>33) THEN 9500:'OBVIOUS ERROR
5050 'DATA OK - SELECT TRANSLATION MODE
5060 IF IC=25 F4=-1:RETURN:'END
5070 IF IC<5 THEN GOSUB5200 ELSE IF IC>4 AND IC<16 THEN GOSUB5300 ELSE IF IC>15 AND IC<25 GOSUB5400
5080 IF IC>25 AND IC<41 THEN GOSUB5600 ELSE IF IC>40 AND IC<49 THEN GOSUB5800 ELSE IF IC>48 GOSUB6000
5090 RETURN:'TRANSLATION OVER
5200 'UNTRANSLATABLE LINES
5210 LN=2:GOSUB2000:OP$=LN$(1)+";***THE NEXT OPCODE IS UNTRANSLATABLE***"+C$+LN$(2)+IN$(1)+T1$+IN$(2)+T1$+IN$(3)+T1$+IN$(4)+C$:RETURN
5300 'CLI-SEI
5310 IF MA<>1 THEN 9500:'IMM. MODE?
5320 LN=1:GOSUB2000:OP$=LN$(1)+LB$+TV$(IC-4)+CT$+C$:RETURN
5400 'BCC-JSR
5410 IF MA<>3 THEN 9500:'ABS. MODE?
5420 LN=1:GOSUB2000:OP$=LN$(1)+LB$+TV$(IC-4)
5430 IF IC<24 THEN OP$=OP$+", " ELSE OP$=OP$+T1$: 'BRANCHES
5440 OP$=OP$+O2$+CT$+C$:RETURN
5600 'STND MULTI-MODE FORMAT ADC-STY
5610 IF MA=1 OR (MA=2 AND NOT(IC=28ORIC=34ORIC=36ORIC=37)) OR (MA=9 AND NOT(IC=26ORIC=27ORIC=29ORIC=31ORIC=35)) THEN 9500:'BAD SYNTAX
5620 LN=1:GOSUB2000
5630 IF MA=2 OR MA=9 OP$=LN$(1)+LB$+TV$(IC-5)+O2$+CT$+C$:GOTO 5700:'IMMED OR ACCUM
5640 IF MA=3 OR MA=8 OP$=LN$(1)+LB$+"LD HL,"+O2$+CT$+C$: 'ABS OR (IND)
5650 IF MA>3 AND MA<8 GOSUB8000:'INDEXED
5660 LN=1:GOSUB2000
5670 OP$=OP$+LN$(1)+T1$+TV$(IC-5)+"(HL)"
5680 IF O1$="STA" THEN D$="," ELSE IF O1$="STX" THEN D$="," ELSE IF O1$="STY" THEN D$="," ELSE D$="": 'SORT OUT "STORES"
5690 OP$=OP$+D$+C$
5700 IF O1$="CMP" LN=1:GOSUB2000:OP$=OP$+LN$(1)+T1$+"CCF"+C$: 'CONTROL CY FLAG
5710 RETURN
5800 'IRREGULAR SHORT
5810 IF MA<>1 THEN 9500:'NO OPERAND
5820 ID=IC-40:'OPCODE
5830 LN=TC(ID):GOSUB2000:OP$=LN$(1)+LB$+TA$(ID,1)+CT$+C$
5840 FOR I=2 TO TC(ID):OP$=OP$+LN$(I)+T1$+TA$(ID,I)+C$:NEXT I
```

Listing 1 continues


```

5850 RETURN
6000 'IRREGULARS
6010 ON (IC-48) GOSUB 6200,6400,6400,6600,6800,6800,7000,7200,72
00
6020 RETURN
6200 'CLV
6210 IF MA<>1 THEN 9500:'OPERAND?
6220 LN=8:GOSUB2000
6230 OP$=LN$(1)+LB$+"LD D,C"+CT$+C$+LN$(2)+T1$+"PUSH AF"+C$+
LN$(3)+T1$+"POP BC"+C$+LN$(4)+T1$+"RES 2,C"+C$+LN$(5)+T1$+"P
USH BC"+C$
6240 OP$=OP$+LN$(6)+T1$+"POP AF"+C$+LN$(7)+T1$+"LD C,D"+C$+L
N$(8)+T1$+"LD B,0"+C$
6250 RETURN
6400 'CPX,CPY
6410 IF NOT(MA=3 OR MA=9) THEN 9500
6420 P$="B":Q$="C":R$="D":IF IC=51 P$="D":Q$="E":R$="B":'CPX OR
CPY?
6430 LN=2:GOSUB2000:OP$=LN$(1)+LB$+"LD "+P$+",A"+CT$+C$+LN$(2)
+T1$+"LD A,"+Q$+C$
6440 IF MA=9 THEN 6470:'IMMEDIATE
6450 LN=2:GOSUB2000:OP$=OP$+LN$(1)+T1$+"LD HL,"+O2$+C$+LN$(2)+
T1$+"CP (HL)"+"C$
6460 GOTO 6480
6470 LN=1:GOSUB2000:OP$=OP$+LN$(1)+T1$+"CP "+O2$+C$
6480 LN=3:GOSUB2000:OP$=OP$+LN$(1)+T1$+"LD A,"+P$+C$+LN$(2)+T1
$+"LD "+P$+", "+R$+C$+LN$(3)+T1$+"CCF"+C$
6490 RETURN
6600 'LDA
6610 IF MA<3 THEN 9500:'BAD ADD. MODE?
6620 LN=1:GOSUB2000
6630 IF MA=3 THEN OP$=LN$(1)+LB$+"LD A,("+O2$+" )" +CT$+C$:GOTO
6670:'ABSOLUTE?
6640 IF MA=9 THEN OP$=LN$(1)+LB$+"LD A,"+O2$+CT$+C$:GOTO 6670:
'IMMED?
6650 GOSUB8000:'INDEXING
6660 LN=1:GOSUB2000:OP$=OP$+LN$(1)+T1$+"LD A,(HL)"+"C$
6670 LN=2:GOSUB2000:OP$=OP$+LN$(1)+T1$+"INC A"+C$+LN$(2)+T1$+"
DEC A"+C$:'SET FLAGS
6680 RETURN
6800 'LDX/Y
6810 P$="C":IF IC=54 P$="E"
6820 IF MA<3 THEN 9500:'BAD ADD MODE?
6830 LN=1:GOSUB2000
6840 IF MA=9 OP$=LN$(1)+LB$+"LD "+P$+", "+O2$+CT$+C$:GOTO 6870:
'IMMED.
6850 IF MA=3 THEN OP$=LN$(1)+LB$+"LD HL,"+O2$+CT$+C$ ELSE GOSU
B8000:'ABS.
6860 LN=1:GOSUB2000:OP$=OP$+LN$(1)+T1$+"LD "+P$+",(HL)"+"C$
6870 LN=2:GOSUB2000:OP$=OP$+LN$(1)+T1$+"INC "+P$+C$+LN$(2)+T1$
+"DEC "+P$+C$
6880 RETURN
7000 'SBC
7010 IF MA<3 THEN 9500:'BAD ADD MODE?
7020 IF MA<>9 THEN 7040
7030 LN=3:GOSUB2000:OP$=LN$(1)+LB$+"CCF"+CT$+C$+LN$(2)+T1$+"SBC
A,"+O2$+C$+LN$(3)+T1$+"CCF"+C$:RETURN
7040 LN=1:GOSUB2000
7050 IF MA=3 OP$=LN$(1)+LB$+"LD HL,"+O2$+CT$+C$:GOTO 7070
7060 GOSUB8000:'INDEXING
7070 LN=3:GOSUB2000:OP$=OP$+LN$(1)+T1$+"CCF"+C$+LN$(2)+T1$+"SBC
A,(HL)"+"C$+LN$(3)+T1$+"CCF"+C$:RETURN
7200 'TSX/TXS
7210 IF MA<>1 THEN 9500:'BAD ADD. MODE?
7220 LN=3:GOSUB2000:OP$=LN$(1)+LB$+"LD H,B"+CT$+C$+LN$(2)+T1$+
"LD L,B"+C$+LN$(3)+T1$+"ADD HL,SP"+C$:IF IC=56 THEN 7240
7230 LN=2:GOSUB2000:OP$=OP$+LN$(1)+T1$+"LD L,C"+C$+LN$(2)+T1$+
"LD SP,HL"+C$:IF IC=57 THEN 7250
7240 LN=1:GOSUB2000:OP$=OP$+LN$(1)+T1$+"LD C,L"+C$
7250 LN=2:GOSUB2000:OP$=OP$+LN$(1)+T1$+"INC C"+C$+LN$(2)+T1$+"
DEC C"+C$
7260 RETURN
8000 'INDEXED MODE
8010 OP$=LN$(1)+LB$+"LD HL,"+O2$+CT$+C$:'INITIALIZE HL
8020 LN=1:GOSUB2000:OP$=OP$+LN$(1)+T1$+"CALL "
8030 IF MA=4 OP$=OP$+"IXIX":FD=-1:'IND,X
8040 IF MA=5 OP$=OP$+"IXIY":FE=-1:'IND,Y
8050 IF MA=6 OP$=OP$+"IXIND":FF=-1:'(IND,X)
8060 IF MA=7 OP$=OP$+"INDIX":FG=-1:'(IND),Y
8070 OP$=OP$+C$:'FINISH OFF
8080 RETURN
9000 'WRAPUP ROUTINE
9010 IF FD THEN LN=2:GOSUB2000:OP$=LN$(1)+"IXIX"+T1$+"EX AF,AF

```

Listing 1 continues

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follow the program's instructions. It will call for a name for the output tape, and the line number at which the output must start. The program automatically increments each output line number by 10.

Error Detection

The translator does a fair amount of syntax checking on the 6502 program, but it only looks for errors that might confuse it. Examples are comments not starting with a semicolon; an operation field not having three characters; more than six characters in a label; and non-label and non-immediate operand fields. Some errors slip through, but they should be caught by the Z80 assembler after translation.

Manual Tuning

Once the 6502 program has been translated, a little manual fine-tuning can improve output efficiency. If the translated program has to handle interrupts several manual additions must be made.

Whenever a 6502 operation sets the flags, but the corresponding Z80 instruction does not, the translator adds:

```
INC n
DEC n
```

where n is A, C or E. This puts the flags into the correct state.

The next instructions often do not need the flags. Examine the translation and, if the flags are redundant, delete the INC/DEC pairs.

Listing continued

```
" +C$+LN$(2)+T1$+"ADD HL,BC"+C$:GOSUB9200:'IXIX?
9020 IF FE THEN LN=2:GOSUB2000:OP$=LN$(1)+"IXIY"+T1$+"EX AF,AF
"+C$+LN$(2)+T1$+"ADD HL,DE"+C$:GOSUB9200:'IXIY?
9030 IF FF THEN LN=6:GOSUB2000:OP$=LN$(1)+"IXIND"+T1$+"EX AF,A
F"+C$+LN$(2)+T1$+"ADD HL,BC"+C$+LN$(3)+T1$+"LD A,(HL)"MC$+L
N$(4)+T1$+"INC HL"+C$+LN$(5)+T1$+"LD H,(HL)" +C$+LN$(6)+T1$+"
LD L,A"+C$:GOSUB9200:'IXIND?
9040 IF FG THEN LN=6:GOSUB2000:OP$=LN$(1)+"INDIX"+T1$+"EX AF,A
F"+C$+LN$(2)+T1$+"LD A,(HL)" +C$+LN$(3)+T1$+"INC HL"+C$+LN$(
4)+T1$+"LD H,(HL)" +C$+LN$(5)+T1$+"LD L,A"+C$+LN$(6)+T1$+"ADD
HL,DE"+C$:GOSUB9200:'IXIND?
9050 LN=1:GOSUB2000:OP$=LN$(1)+T1$+"END"+C$+CHR$(26):GOSUB2500:'
FINAL LINE
9060 A=USR(504):'TAPE OFF
9070 RETURN
9200 'ALL "IX"S END SAME WAY
9210 LN=2:GOSUB2000:OP$=OP$+LN$(1)+T1$+"EX AF,AF"+C$+LN$(2)+T
1$+"RET"+C$:GOSUB2500:RETURN
9500 'SYNTAX ERROR
9510 LN=2:GOSUB2000:OP$=LN$(1)+";*** SYNTAX ERROR BELOW ***"+C$+
LN$(2)+IN$(1)+T1$+IN$(2)+T1$+IN$(3)+T1$+IN$(4)MC$:RETURN
10000 'DATA FOR OPCODE TRANSLATION
10010 DATA 26,27,28,16,17,18,1,19,20,21,2,22,23,41,3,5,49,29,50,
51,30,6,7,25,31,32,8,9,33,24,52,53,54,34,10,35,11,12,42,43,36,37
,44,13,55,14,4,15,38,39,40,45,46,56,47,57,48
10020 'DATA FOR TRANSLATION VECTOR
10030 'ONE-LINERS
10040 DATA EI,DEC C,DEC E,INC C,INC E,NOP,PUSH AF,PUSH
AF,RET,SCF,DI
10050 'JUMPS
10060 DATA JR NC,JR C,JR Z,JP M,JR NZ,JP P,JP
PE,JP PO,CALL
10070 'STANDARDS
10080 DATA "ADC A," ,AND ,SLA ,CP ,DEC ,XOR ,INC ,J
P ,SRL ,OR ,RL ,RR ,LD ,LD ,LD
10090 'DATA FOR TRANSLATION ARRAY
10100 DATA 2,SCF,CCF,4,POP HL,"LD A,H",INC A,DEC A,3,"LD
H,A",POP AF,"LD A,H",4,"LD H,A",POP AF,"LD A,H",RET
I
10110 DATA 3,"LD C,A",INC A,DEC A,3,"LD E,A",INC A,DEC
A,3,"LD A,C",INC A,DEC A,3,"LD A,E",INC A,DEC A
10120 'M/CODE DATA
10130 'START
10140 DATA 205,127,10,233
10150 'INPUT
10160 DATA 253,33,63,60,175,205,18,2,205,150,2,205,53,2,254,211,
40,6,205,248,1,195,154,10,6,6,205,53,2,16,251,33,0,120,17,8,7,6,
6,205,53,2,254,26,40,31,16,247,205,53,2,119,35,27,254,13,32,246,
62,42,253,190,0,32,2,62,32,253,119,0,203,122,40
10170 DATA 219,17,0,0,205,248,1,62,9,119,35,62,69,119,35,62,78,1
19,35,62,68,119,35,62,13,119,235,195,154,10
10180 'HEADER
10190 DATA 42,253,127,94,35,86,235,175,205,18,2,205,135,2,62,211
,205,100,2,6,6,126,205,100,2,35,16,249,201
10200 'OUTPUT
10210 DATA 42,253,127,70,35,94,35,86,235,14,5,126,254,26,32,4,20
5,100,2,201,203,255,205,100,2,35,5,13,32,237,126,205,100,2,35,5,
200,254,13,40,224,24,243
```

Listing continues

Because of the difference between the two micros' carry flags, the program has a CCF after each comparison operation. If the flag's state is irrelevant, delete the line. Be cautious—the carry flag may be used later. If in doubt, leave it in.

A third way of simplifying the translation is found in some addition and subtraction operations. The 6502 always takes the carry into account in these operations and has to achieve an add without carry by code like:

```
CLC
ADC TOTAL
```

which is translated as:

```
SCF
CCF
LD HL,TOTAL
ADC (HL)
```

and can be simplified to:

```
LD HL,TOTAL
ADD (HL)
```

Interrupt Handling

Other than by the presence of RTIs, the translator cannot tell that a 6502 program is interrupt driven. The translation must be modified before it will work. Add to the start of the program:

```
IMI ;THIS MODE EMULATES 6502
INTERRUPTS
;SUITABLE CODE TO DEFINE THE
INTERRUPT VECTOR
```

The 6502 saves the program counter and the flags in the stack during an interrupt, while the Z80 only preserves the program counter. Whenever an interrupt handler could affect the flags add PUSH AF to its start and POP AF before the RETI.

Assembler Directives

The assembler directives will be different from the originals. In addition, the stack area must be defined with a LD SP, wxyz; since the translation is set up to use a stack on a single page of memory, wxyz would be best as wx00.

For an example of the translator in action, see Program Listings 2 and 3. Listing 2 is a segment of 6502 code with several deliberate errors. Listing 3 is an unedited copy of its translation. All errors have been highlighted, and an error-free translation works perfectly.

Listing 3 also shows lines which could be edited. For instance, the INC/DEC in lines 1210 and 1220 is redundant; the instructions could safely be removed. On the other hand, the CCF in line 1410, after the compari-

Line No.	16K	32K	48K
30	1000	1500	1500
1070	32584	-16568	-184
1070	32762	-16390	-6
1080	127	191	255
1550, 1560	32588	-16564	-180
1600	P9 = 30720	P9! = 31232	P9! = 31232
1650	32765	-16387	-3
1650	32766	-16386	-2
1660	32691	-16461	-77
2520	32765	-16387	-3
2520	32766	-16386	-2
2530	32720	-16432	-48
3020, 3040	P9	Note 1	Note 1
3050, 3070	P9	P9!	P9!
3080, 3110	P9	P9!	P9!
3220	P9	Note 1	Note 1
10160	120	122	122
	(34th item)		
10160	7	69	133
	(37th item)		
10190	127	191	255
10210	127	191	255

Note 1:

In these lines, P9 should be replaced by:
P9! + (P9! > Z1)*Z2!

and an extra line should be inserted into the program

1085 Z1 = 32767:Z2! = 65536

Note 2:

Set the memory size to 31220 in the 32K and 48K versions.

Table 2. Conversion for 32K and 48K

```
00100 ;SUBROUTINE TO SAVE DATA HELD IN STACK
00110 ;SP TO THE DATA IS PASSED IN 'BASE'
00120 THIS IS A BAD COMMENT LINE
00130 SAVE LDX BASE ;RESET SP TO..
00140 TXS ;..BASE OF DATA
00150 TYA ;DOUBLE COUNT..
00160 ASL A ;..FOR STORAGE
00170 TAX ;SET INDEX
00180 NXTBYTT PLA ;BAD LABEL
00190 TAY ;SAVE BYTE
00200 AND #$0F ;TRUNCATE
00210 JSR ASCII ;CONVERT
00220 TYY ;BAD OPCODE
00230 LSR A
00240 ;PLUS 3 MORE 'LSR A'S
00250 JSR ASCII BAD COMMENT FIELD
00260 BNE NXTBYT ;FINISHED?
00270 RTS ;YES, RETURN
00280 ;
00290 ASCII ORA #$30 ;ASCII PREFIX
00300 CMP #$3A ;TEST TO SEE..
00310 BCC NUMBER ;..IF A-F
00320 ADC #6 ;ALPHA OFFSET
00330 NUMBER STA DATA-1,X ;SAVE CHARACTER
00340 DEX ;NEXT STORE
00350 RTS
00360 END
```

Program Listing 2

son, is vital because the next instruction tests the carry flag.

The translation shows the address-mode subroutine IXIX was needed to handle the STA DATA-1,X at line 330 of Listing 2. The other indexing subroutines were not added since they

were not required.

Limitations

A translation program of this kind has limitations. None are serious, but be aware of them:

- The operand must be a label or an

immediate quantity; you cannot use LDA \$12B7 or similar expressions.

●The 6502 can handle binary-coded decimal (BCD) quantities directly. It was not possible to translate this within the 16K size limitation.

●Because Z80 stack operations move two bytes at a time, compared with the 6502's single-byte operations, there can only be a maximum of 128 items on the stack at any time. Also, manipulating data in the stack may cause corruption.

●The overflow flag cannot always be trusted.

●Timing loops must be readjusted.

The translator can handle a fuller and more rational set of addressing modes than the 6502 actually provides. As far as the program is concerned, any address memory instruction can use any mode other than implied, which eliminates the 6502's arbitrary restrictions on what modes can be used when. Thus you can write pseudo-6502 code that makes the fullest possible use of the micro's unusually complete set of addressing options.

Extending the Program

The program would run perfectly in the bottom 16K of a 32K or 48K TRS-80, and it is easily modified to make use of the extra space. The modification enlarges the size of the input buffer to allow the program to translate larger 6502 programs.

Table 2 shows the changes you should make to match the program to the larger computers; the 32K expansion would give more than enough space for any likely source code.

Do not forget that, even with the larger memory, this will still be a cassette-based program.

Conclusion

This program is a useful tool for translating 6502 programs to run on Z80-based microcomputers. It is written for a TRS-80 Model I, but with a lot of effort, it could be adapted to other systems.

The program's output is less efficient than the original code, but the translation is adequate for most purposes. The program's main weakness is that, since it has to fit into a 16K computer, it is not as intelligent as it might be. ■

David Peckett, a chartered electrical engineer, can be reached at 1 Delapoeer Drive, Haverford West, Dyfed SA61 1HZ, Wales, UK.

```
01000      LD   B,0
01010      LD   D,0
01020      ;SUBROUTINE TO SAVE DATA HELD IN STACK
01030      ;SP TO THE DATA IS PASSED IN 'BASE'
01040      ;*** SYNTAX ERROR BELOW ***
01050      THIS IS A BAD COMMENT LINE
01060      SAVE  LD   HL,BASE ;RESET SP TO..
01070      LD   C,(HL)
01080      INC  C
01090      DEC  C
01100      LD   H,B ;..BASE OF DATA
01110      LD   L,B
01120      ADD  HL,SP
01130      LD   L,C
01140      LD   SP,HL
01150      INC  C
01160      DEC  C
01170      LD   A,E ;DOUBLE COUNT..
01180      INC  A
01190      DEC  A
01200      SLA  A ;..FOR STORAGE
01210      LD   C,A ;SET INDEX
01220      INC  A
01230      DEC  A
01240      ;*** SYNTAX ERROR BELOW ***
01250      NXTBYTT PLA ;BAD LABEL
01260      LD   E,A ;SAVE BYTE
01270      INC  A
01280      DEC  A
01290      AND  0FH ;TRUNCATE
01300      CALL ASCII ;CONVERT
01310      ;*** SYNTAX ERROR BELOW ***
01320      TYY ;BAD OPCODE
01330      SRL  A
01340      ;PLUS 3 MORE 'LSR A'S
01350      ;*** SYNTAX ERROR BELOW ***
01360      JSR  ASCII BAD COMMENT FIELD
01370      JR   NZ,NXTBYT ;FINISHED?
01380      RET  ;YES, RETURN
01390      ;
01400      ASCII OR   30H ;ASCII PREFIX
01410      CP   3AH ;TEST TO SEE..
01420      CCF
01430      JR   NC,NUMBER ;..IF A-F
01440      ADC  A,6 ;ALPHA OFFSET
01450      NUMBER LD  HL,DATA-1 ;SAVE CHARACTER
01460      CALL IXIX
01470      LD   (HL),A
01480      DEC  C ;NEXT STORE
01490      RET
01500      IXIX EX  AF,AF'
01510      ADD  HL,BC
01520      EX  AF,AF'
01530      RET
01540      END
```

Program Listing 3

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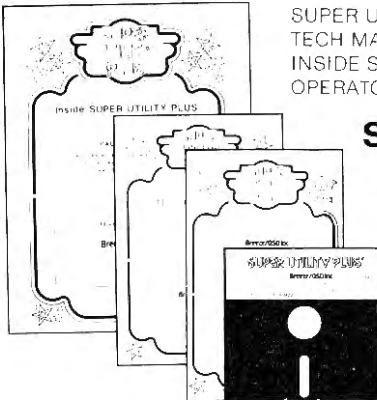
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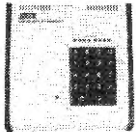
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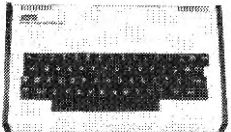
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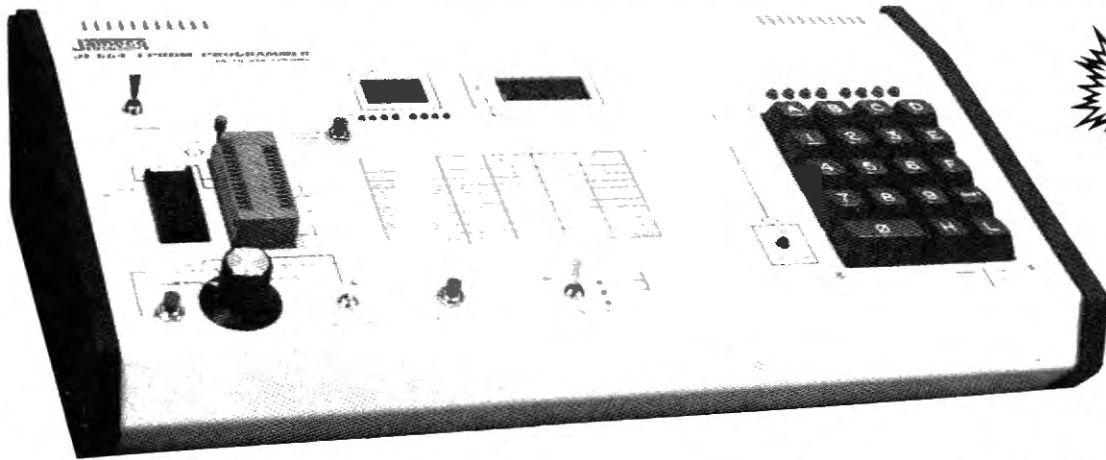
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JE664-A EPROM Programmer — Assembled & Tested (Includes JM16A Module) \$995.00

JE665 — RS232C INTERFACE OPTION — The JE665 RS232C Interface Option implements computer access to the JE664's RAM. A sample of software written in BASIC is provided for the TRS-80* Model I, Level II Computer. Baud rate: 9600. Word Length: 8 Bits — Odd Parity. Stop Bits: 2. This option may be readily adapted to other computers.

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JM16B	TMS2716 (3 Voltages)	Motorola, TI	\$14.95
JM32A	TMS2532	Motorola, TI	\$14.95
JM32B	2732	AMD, Fujitsu, NEC, Hitachi, Intel	\$14.95
JM64A	MCM68764, MCM68L764	Motorola	\$14.95
JM64B	2764	Intel	\$14.95
JM64C	TMS2564	TI	\$14.95

Super Spooler

by Ron Balewski

Don't let your printer tie up your computer during long tasks. Use this spooler, instead—it doesn't even require more hardware.

Do you have a *slow* printer that bogs down your TRS-80? How would you like to run another program, type in another program, or maybe even play a game of Star Trek while your printer grinds out your mailing labels? Not possible without some sort of extra hardware, right? Wrong. A print spooler will do everything I just described.

What Is a Print Spooler?

A spooler is a program that compensates for the slowness of a printer by accepting printed data as fast as the Basic interpreter can send it, and storing it in a buffer for later release to the printer at a speed slow enough for the printer to handle.

There are two types of spoolers, RAM based and disk based. Since I don't have a disk system, I use a RAM-based spooler. I reserve the top 32K (or however much I can do without) of memory for the spooler print buffer. This lets me store about 32,700 characters in the buffer. On my Centronics 737, which prints at 50 characters per second, this amounts to about 10 minutes printing time.

Use a disk-based spooler if you have a disk system. With this kind of spooler, printed data is not stored in

RAM (which is usually in short supply), but is spooled out to a disk. Whenever the printer requests more data, it's pulled back off the disk and sent to the printer. A typical 35-track disk should hold about 89,000 bytes of data.

On my 50-character-per-second 737, this would amount to almost a half hour printing time, obviously better than the 10 minutes offered by the RAM spooler.

How It Works

The print-spooler program takes advantage of the interrupt generated by the expansion interface so the computer appears to be doing two things at once: controlling the printer and running another program.

The first part of the program, up to line 650, is a new line printer-driver routine. This is patched into the line-printer DCB (data control block), bypassing Radio Shack's driver. Lines 230-270 make sure there's room in the buffer for another character. Lines 280-360 put the new character into the buffer and adjust the input pointer. Lines 470-650 contain a subroutine that is called when the print buffer is full. "Full" is printed on the screen by lines 480-510. Lines 530-570 then wait

until the buffer empties a bit. The "Full" is then erased and control returns to the main driver.

The second main part of the program, lines 770-1240, is the interrupt service routine. This section is called 40 times per second, regardless of what the TRS-80 is doing. During each call, the routine first checks if there's any data in the buffer. If not, the interrupt ends. If there is data in the buffer, the routine checks if the printer can accept some. If not, the interrupt ends.

Assuming there is data to be printed and the printer is ready to accept data, the interrupt service routine sends the next byte of data to the printer, delays for an instant, and loops back to perform the above two checks again.

Note that the delay loop in lines 990-1000 may have to be adjusted or possibly removed entirely, depending on your printer. My 737 has an 80-character print buffer built in and only prints after either 80 characters or certain control codes are received. Therefore, my interrupt service routine is designed to pass data to the printer in blocks instead of passing one character per interrupt (since the maximum speed at one character per interrupt is only 40 characters per second). When-

The Key Box

**Model I
32K RAM
Cassette Basic, Assembly**

ever a character is passed to the 737, though, it takes the printer a moment to decide whether or not it can accept another character before it must start printing. The 30 in line 990 reflects this time delay.

If your printer "thinks" faster, you can lower this number. You'll know if that number is too low because your printer will print slower than its maximum speed due to the fact that it's only getting 40 characters per second and not its maximum amount. If your printer has no input buffer, you can delete the delay loop entirely since you'll return from the interrupt after each character printed.

If your printer has no print buffer, the maximum speed it prints at under this spooling program is 40 characters per second, despite its maximum speed rating.

"The initialization section starts the ball rolling by enabling the interrupts and then executing a Clear."

The next three program sections, when called, kill all the data in the print buffer, enable interrupts to start the printer, and disable interrupts to stop printing, respectively. All three of these sections are patched into DOS reserved words and are explained more fully in the operating instructions.

The final section, lines 1610-1640, is the initialization section. It is run only once, immediately after you load the program. It starts the ball rolling by enabling the interrupts and then executing a Clear to fix the pointers messed up while loading.

The rest of the program just sets memory size for you and patches in the new printer driver, the interrupt service routine, and the spooler commands.

How to Use It

Now that you know the basics of how this spooler works, let me tell you about its special features and how to use them. The spooler responds to

three DOS key words—Open, Close, and Kill. Open enables the interrupts and starts the printer printing. Close

disables the interrupts and stops the printer. Of course, you'll still be able to do LPRINTs, even though the printer

```

                                Program Listing

                                00100 ; *****
                                00110 ; * RAM SPOOLER PROGRAM *
                                00120 ; *****
                                00130 ; BY RON BALEWSKI
                                00140 ; JULY 17, 1981
                                00150 ;
                                00160 ; LINE PRINTER DRIVER ROUTINE - STORES ALL LPRINTED
                                00170 ; DATA IN THE SPOOLING BUFFER.
3C00 00180 VIDEO EQU 3C00H
8000 00190 ORG 8000H ;TOP 32K
8000 C5 00200 LPRDVR PUSH BC
8001 D5 00210 PUSH DE
8002 E5 00220 PUSH HL
8003 ED5BB480 00230 LD DE,(INPTR) ;BE SURE ROOM IN BUFFER
8007 2AB680 00240 LD HL,(OUTPTR)
800A 13 00250 INC DE
800B DF 00260 RST 18H
800C CC2380 00270 CALL Z,BUFFUL ;IF NO ROOM, ? MSG & WAIT
800F 79 00280 LD A,C
8010 2AB480 00290 LD HL,(INPTR) ;PUT PRINTED CHAR IN BFR
8013 77 00300 LD (HL),A
8014 23 00310 INC HL ;INCREMENT INPUT POINTER
8015 7C 00320 LD A,H
8016 B5 00330 OR L
8017 2003 00340 JR NZ,LPRXIT
8019 21B880 00350 LD HL,BUFFER
801C 22B480 00360 LPRXIT LD (INPTR),HL
801F E1 00370 POP HL
8020 D1 00380 POP DE
8021 C1 00390 POP BC
8022 C9 00400 RET
                                00410 ;
                                00420 ;
                                00430 ; BUFFUL - THIS SUBROUTINE PRINTS FULL IN THE LOWER LEFT
                                00440 ; CORNER OF THE VIDEO SCREEN AND WAITS UNTIL THE
                                00450 ; BUFFER EMPTIES SOME. IT THEN ERASES FULL AND
                                00460 ; RETURNS.
8023 C5 00470 BUFFUL PUSH BC
8024 010400 00480 LD BC,4
8027 11F73F 00490 LD DE,VIDEO+1015
802A 214880 00500 LD HL,FULMSG
802D EDB0 00510 LDIR
802F FB 00520 EI
8030 ED5BB480 00530 STLFUL LD DE,(INPTR)
8034 2AB680 00540 LD HL,(OUTPTR)
8037 13 00550 INC DE
8038 DF 00560 RST 18H
8039 28F5 00570 JR Z,STLFUL
803B 010400 00580 LD BC,4
803E 11F73F 00590 LD DE,VIDEO+1015
8041 214C80 00600 LD HL,BLANKS
8044 EDB0 00610 LDIR
8046 C1 00620 POP BC
8047 C9 00630 RET
8048 46 00640 FULMSG DEFM 'FULL'
804C 20 00650 BLANKS DEFM ' '
                                00660 ;
                                00670 ;
                                00680 ; INTERRUPT SERVICE ROUTINE - THIS ROUTINE IS ACCESSED
                                00690 ; 40 TIMES A SECOND. IT CHECKS IF THERE IS DATA
                                00700 ; IN THE BUFFER AND IF THE PRINTER WILL ACCEPT SOME.
                                00710 ; IF SO, IT OUTPUTS DATA UNTIL THE PRINTER BUFFER
                                00720 ; IS FULL (PRINTER REFUSES TO ACCEPT MORE DATA),
                                00730 ; AND THEN RETURNS TO DO BASIC UNTIL IT CAN PRINT
                                00740 ; AGAIN.
                                00750 ;
                                00760 ;
8050 F3 00770 INTRTN DI
8051 F5 00780 PUSH AF
8052 C5 00790 PUSH BC
8053 D5 00800 PUSH DE
8054 E5 00810 PUSH HL
8055 ED5BB480 00820 NXTOUT LD DE,(INPTR) ;CHECK IF DATA IN BUFFER
8059 2AB680 00830 LD HL,(OUTPTR)
805C DF 00840 RST 18H
805D 2824 00850 JR Z,NOPRNT
805F CDD105 00860 CALL 05D1H ;CHECK IF PRINTER READY
8062 201F 00870 JR NZ,NOPRNT
8064 2AB680 00880 LD HL,(OUTPTR) ;GET NEXT LETTER
8067 7E 00890 LD A,(HL)
8068 F5 00900 PUSH AF
8069 23 00930 INC HL ;INC OUTPUT POINTER
806A 7C 00940 LD A,H
806B B5 00950 OR L
806C 2003 00960 JR NZ,NORES
806E 21B880 00970 LD HL,BUFFER
8071 22B680 00980 NORES LD (OUTPTR),HL
8074 F1 00981 POP AF
8075 B7 00982 OR A ;LETTER 0?
8076 281A 00983 JR Z,PRTOFF ;IF SO, THEN OFF PRINTER
8078 32E837 00984 LD (37E8H),A ;PRINT THE LETTER
807B 011E00 00990 LD BC,30 ;LET PRINTER ACCEPT DATA
807E CD6000 01000 CALL 0060H
8081 18D2 01010 JR NXTOUT
8083 2AEC37 01020 NOPRNT LD HL,(37E8H)
8086 2AE037 01030 LD HL,(37E0H)
8089 2AE037 01040 LD HL,(37E0H)

```

Listing continues

isn't going, since all printed data just goes into a buffer. Kill kills all data in the print buffer. This is a handy feature in case you accidentally do an LLIST. It won't take long to dump a lot of garbage to the print buffer. Kill gives you a way to throw out the garbage without resetting the system.

Another nice feature of the spooler is a print-hold feature. Since I frequently use single-sheet paper with my printer, I include in many of my programs an automatic stop after so many lines printed so I can put a new sheet of paper into the printer. Such a pause works fine when Basic is running the printer directly. Whenever Basic stops, the printer stops. However, things don't work quite so smoothly when a spooler is put between Basic and the printer.

In the blink of an eye, the computer was telling me to change the paper and press enter, but the printer was just getting started on that page! If I waited until the page was printed, changed the paper, and then pressed enter, I defeated the purpose of the spooler by once again making the computer wait for the printer. On the other hand, if I pressed enter and let the computer continue to pour data into the buffer, all

Listing continued

```

808C E1      01050      POP      HL
808D D1      01060      POP      DE
808E C1      01070      POP      BC
808F F1      01080      POP      AF
8090 FB      01090      EI
8091 C9      01100      RET
              01110 ;
              01120 ; WHEN A ZERO IS ENCOUNTERED IN THE PRINT BUFFER, CONTROL
              01130 ; BRANCHES HERE TO DISABLE THE INTERRUPTS AND
              01140 ; THEREFORE STOP THE PRINTER. THIS ALLOWS YOU TO
              01150 ; PUT PAUSES IN THE PRINTING FOR FORMS CHANGING.
              01160 ; TYPING OPEN WILL RE-START THE PRINTING.
8092 2AEC37  01170 PRTOFF LD      HL,(37E0H)
8095 2AE037  01180 LD      HL,(37E0H)
8098 2AE037  01190 LD      HL,(37E0H)
809B E1      01200      POP      HL
809C D1      01210      POP      DE
809D C1      01220      POP      BC
809E F1      01230      POP      AF
809F C9      01240      RET
              01250 ;
              01260 ;
              01270 ;
              01280 ; KILL - THE KILL COMMAND WILL KILL ALL DATA IN THE PRINT
              01290 ; QUEUE. THIS IS PROVIDED IN CASE A LOT OF USELESS
              01300 ; DATA IS ACCIDENTALLY DUMPED TO THE PRINTER.
80A0 21B800  01310 KILL LD      HL,BUFFER ;CLEAR THE PRINT BUFFER
80A3 22B400  01320 LD      (INPTR),HL
80A6 22B600  01330 LD      (OUTPTR),HL
80A9 C3191A  01340 JP      1A19H
              01350 ;
              01360 ;
              01370 ;
              01380 ; OPEN - THE OPEN COMMAND WILL TURN ON THE INTERRUPT AND
              01390 ; THEREFORE TURN ON PRINTING.
80AC FB      01400 OPEN EI
80AD C3191A  01410 JP      1A19H
              01420 ;
              01430 ;
              01440 ;
              01450 ; CLOSE - THE CLOSE COMMAND WILL DISABLE THE INTERRUPTS
              01460 ; AND THEREFORE STOP THE PRINTING. THIS IS
              01470 ; USEFUL BECAUSE YOU CAN'T READ OR WRITE A TAPE
              01480 ; WHILE THE INTERRUPT IS ENABLED. TO RE-START
              01490 ; PRINTING, TYPE OPEN.
80B0 F3      01500 CLOSE DI
80B1 C3191A  01510 JP      1A19H
80B4 B800    01520 INPTR DEFW  BUFFER
80B6 B800    01530 OUTPTR DEFW  BUFFER
80B8 00      01540 BUFFER DEFB   0
              01550 ;
              01560 ;
              01570 ;
              01580 ; INITIALIZATION SECTION - AFTER INITIALIZATION, THIS
              01590 ; CODE WILL BE OVERRITTEN AS PART OF THE PRINT
              01600 ; BUFFER.
80B9 FB      01610 INIT EI
80BA 21191A  01620 LD      HL,1A19H
80BD E5      01630 PUSH   HL ;SET A RETURN ADDRESS
80BE C37A1E  01640 JP      1E7AH ;DO A CLEAR
              01650 ;
              01660 ;
              01670 ;
              01680 ; SET PRINTER DCB ADDRESS
4026 01690 ORG      4026H
4026 0080    01700 DEFW   LPRDVR
              01710 ;
              01720 ;
              01730 ;
              01740 ; SET INTERRUPT ADDRESS
4012 01750 ORG      4012H
4012 C35080  01760 JP      INTRTN
              01770 ;
              01780 ;
              01790 ;
              01800 ; RESET TOP-OF-MEMORY POINTER
40B1 01810 ORG      40B1H
40B1 FF7F    01820 DEFW   LPRDVR-1
              01830 ;
              01840 ;
              01850 ;
              01860 ; RESET MEMORY SIZE PTR TO CLEAR 50
40A0 01870 ORG      40A0H
40A0 CD7F    01880 DEFW   LPRDVR-51
              01890 ;
              01900 ;
              01910 ;
              01920 ; SET KILL DOS VECTOR ADDRESS
4191 01930 ORG      4191H
4191 C3A080  01940 JP      KILL
              01950 ;
              01960 ;
              01970 ;
              01980 ; SET OPEN DOS VECTOR ADDRESS
4179 01990 ORG      4179H
4179 C3AC00  02000 JP      OPEN
              02010 ;
              02020 ;
              02030 ;
              02040 ; SET CLOSE DOS VECTOR ADDRESS
4185 02050 ORG      4185H
4185 C3B080  02060 JP      CLOSE
80B9 02070 END      INIT
00000 TOTAL ERRORS

```

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the output ran together without the planned pause.

The addition of the above-mentioned print-hold feature solved the problem. To turn off (Close) the printing at a given point, just LPRINT CHR\$(0). The printer prints up to the zero in the buffer and stops until you issue an Open command. You can include as many zeros in the print buffer as you want. The printer stops whenever it hits one.

If the buffer becomes full when the interrupt is off (closed), the interrupt is automatically enabled (opened) to keep the system from eternally waiting for the buffer to empty, even though the printer is closed.

Now for a bit of advice: Be sure to Close the printer before you read or write a cassette tape. If you try to do tape I/O with the interrupt enabled, the time spent in the interrupt service routine wreaks havoc with the tape timing. Don't worry about freely using Opens and Closes since no data is lost during their use.

You can change the size of the buffer by changing the ORG in line 190. All memory from the ORG value through FFFH is assumed to be available to the spooler. Using an ORG value of 8000H gives you 32K to be used by the spooler and 16K to be used by your program. An ORG value of C000H gives you 32K of memory for your program while leaving only 16K for the spooler. I keep an object file assembled with each of the two ORG values handy and reserve 32K for the spooler whenever possible. But if I can't afford 32K, I just load the copy that reserves 16K.

For Use With 32K

If you have a 32K system, you can get this spooler to run just by changing lines 330 and 950 to CP 0C0H. All this does is check to see if you went above BFFFH, the end of a 32K machine instead of FFFFH.

Once you use this spooler for a while, you'll never run your printer again without it.

Now for a challenge to all you 5¼-inch disk jockeys out there: How about writing a spooling program that uses a disk for temporary storage? That way, I won't have to write one when I get a disk system. ■

Ron Balewski (412 E. Ridge St., Nanticoke, PA 18634) is a freelance programmer. His interests include home video, community theater, and electronics.

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Election

by Robert Jacobs

Election teaches students about campaigning by introducing them to several facets of elections such as budgets and stands on issues.

Election simulates a Congressional District campaign and election. It incorporates the strategies of recent Congressional campaigns as well as those of other medium-sized campaigns. This simulation is valuable for teaching students about the political choices and strategies available to candidates for public office in the early 1980s.

You can alter the program to account for local political conditions, changing issues, or fluctuating interests in American politics. The calculations of the control functions have been kept separate from one another to allow you to alter the weights given the variables and to change the assumptions upon which the program is based. Although the assumptions are not extremely controversial, their applicability will vary for different sections of the country and from

one election to the next. You, as the instructor, should familiarize yourself with the assumptions.

The electorate is established as 52 percent Democrat and 48 percent Republican. This roughly reflects the total national Congressional vote in the 1980 election.

Regardless of other factors, the incumbent candidate receives .75 percent of the ultimate turnout for each week of the campaign. This reflects the American political scene, although situational factors may alter this percentage.

The amount of funds a candidate may raise has a predetermined ceiling. Students can discover this limit, as well as the proximate return for fund-raising efforts, by trial and error.

The voter turnout is set low, but it can be increased by taking controversial stances on issues. However, controversial positions can also be detrimental to the student's candidacy, so the student must find the balancing point between the two extremes.

The program minimizes the impact of candidates' positions on issues. In some American elections, the issues dominate, but in most elections the

candidates' positions become blurred and are almost indistinguishable from one another. The power of the positions can be changed, but I don't recommend this because the students' participation will become merely a hunt for "buried treasure," with the treasure being the "correct" stand on an issue.

Changing positions too frequently results in a penalty.

The effect of news headlines on the election is restricted. However, the weight and directional bias of the news stories may be changed by the instructor.

The student must allocate funds for several forms of mass communication to avoid erosion of support. The program ascribes heavier weight to television expenditures, since television is our dominant medium. The order of efficacy is: television, radio, newspaper advertising, and campaign souvenirs. The latter two do little to promote the candidacy, but they prevent erosion of support. This order of importance can be altered.

Using the Program

Election is written in Basic, and it uses most of the 16K. It is CLOADable on both Model I and III. Single characters, both alphabetic and numeric, are entered by single key strokes through the INKEY\$ function; when entering dollar amounts, press enter.

After listing the instructions, the

The Key Box

**Model I or III
16K, 32K RAM
Cassette or Disk Basic**

program asks the student to choose a political party and decide whether or not he wants to be the incumbent. Then, the student must allocate campaign funds among the various media. If the student errs or spends more than is allocated, the program loops back so he can redo the budget.

The student then selects political positions on five issues. The range of

choices span the range of "respectable" opinions as reported by American opinion polls. After these positions are entered, the first of several staff reports is offered. This lists the results of the week's polls, and it reports on the budget.

The campaign runs for 10 weeks. After each week, news headlines appear, and the student is asked whether

or not he wishes to revise any of the positions selected. A new budget must also be prepared. The staff report gives the student a running report of the campaign's progress.

At the end of the 10 weeks, the results of the election are announced, along with a summary of the monies expended and the number of position changes.

Instructors who think the student will gain access to the program listing to either change the variables or discover how to win can disable the break key by altering line 10 as follows:

10 POKE 16396, 175: POKE 16397, 201

To restore the key, POKE 16396, 201 from the command level or reset the computer. With disk systems on the Model I, different locations must be accessed. (See Table 1.)

Most Model III operating systems have a built-in break disable.

Classroom Use

For the most effective classroom use of Election, the students should pay attention to more than just winning the election; they can learn from the program only if it is approached systematically.

Several teaching strategies are available. The most useful of these is to divide the class into groups of participants, and, for each group, to hold one or more of the program variables constant. For example, one group of students might be required to be the incumbent while the other might be the challenger; one group might be Democrats and the other Republicans.

A log of each run should be kept and discussion of the strategies adopted held periodically. In this way, students can get some sense of the effect of each of the variables on the chances of winning the election. The instructor, who should be familiar with the assumptions built into the program as well as with contemporary politics, can explain some of the reasons for the outcome.

Election could also be tailored to incorporate the characteristics of a specific election or district. The students could research the amount of money spent by the candidates as well as the size of the district and its political composition. This research could be used to alter the program. This exercise is more demanding than the first, but it can be rewarding as it teaches students how to analyze American politics, how to do historical and political research,

DOS	Lockout Break	Restore Break
TRSDOS 2.3	POKE 23886,0	POKE 23886,1
NEWDOS 2.1	POKE 23461,0	POKE 23461,1
NEWDOS 80	POKE 19408,0	POKE 19408,1

Table 1

Program Listing

```

10 '
20 CLS:PRINTCHR$(23):PRINT,, "ELECTION"
30 PRINT:PRINT:PRINTTAB(8) "BY ROBERT JACOBS"
40 PRINT:PRINT"DRAFT - VERSION 2.1"
50 PRINT:PRINTTAB(8) "OCTOBER, 1981"
60 DIMHL$(30):DIMPH$(30):DIMHL(30):RANDOM:FORZ=1TO30:READHL$(Z),
HL(Z):NEXT
70 P$="$$###,###":Q$="##.##":F=30000:VP=31:CO=290000+RND(30000)
80 GOSUB2130
90 '
100 CLS:PRINT"YOUR CONSTITUENCY HAS";CO;" VOTERS IN IT. YOU WISH
TO WIN THE DISTRICT'S SEAT IN THE HOUSE OF REPRESENTATIVES."
110 PRINT"YOU START YOUR CAMPAIGN WITH";F;"DOLLARS. YOU MAY CHOO
SE TO"

```

Listing continues

Variable	Purpose	Appears in Line Number
CO	Size of Constituency	70 100 2450
DP	Democratic Percentage	390 400 420 430 440 450 500 510 580 590 670 2450
ET	Total Expenditure	2350 2360 2370 2390 2420
F	Current Campaign Fund Total	70 110 220 320 720 2190 2370 2380 2390 2410 2420
F2	Week's Receipts	300 310 320 710
FR	Total Fund Raising Expenditures	2220 2420 2630
MF	Media Factor	460 470 480 490 500 510
PS	Sum of Political Position Factors	290 340 350 360 370 440 450
RP	Republican Percentage	390 400 420 430 440 450 500 510 580 590 680 2450
SO	Total Souvenir Expenditure	2210 2420 2620
TE	Number of Position Changes	520 580 590 900
TV	Total Television Expenditures	2200 2420 2610
UP	Undecided Percentage	380 390 440 450 500 510 690
VP	Probable Turnout Percentage	70 340 350 360 370 380 700 2450 2480

Table 2. Election Variables

```

120 PRINT"USE ALL OR A PORTION OF IT ON THE LISTED POLITICAL ACT
IVITIES."
130 PRINT"YOU SHOULD BE AWARE THAT FUND-RAISING ITSELF HAS SUBST
ANTIAL"
140 PRINT"COSTS WHICH YOU WILL HAVE TO BEAR. YOU SHOULD SPEND YO
UR MONEY"
150 PRINT"SO AS TO MAXIMIZE YOUR CONTRIBUTIONS AS WELL AS YOUR S
TANDING"
160 PRINT"IN THE POLLS. YOU MAY FIND THAT THIS IS DIFFICULT TO D
O. AS THE"
170 PRINT"CAMPAIGN CONTINUES YOU WILL HAVE THE OPPORTUNITY TO CH
ANGE YOUR"
180 PRINT"STRATEGY SEVERAL TIMES. STRATEGY CHANGES MAY NOT BE IM
MEDIATELY"
190 PRINT"REFLECTED EITHER IN THE POLLS OR IN THE RATE OF CONTRI
BUTIONS."
200 PRINT:PRINT"GOOD LUCK!":GOSUB2130
210 GOSUB1000
220 CLS:PRINT"YOU NOW HAVE";F;"DOLLARS. PLEASE INDICATE HOW MUCH
YOU"
230 PRINT"WOULD LIKE TO SPEND FOR EACH OF THE FOLLOWING."
240 PRINT:PRINTTAB(7)"FUND-RAISING","TELEVISION ADVERTISING"
250 PRINTTAB(7)"NEWSPAPER ADVERTISING","RADIO ADVERTISING"
260 PRINTTAB(20)"CAMPAIGN SOUVENIRS":GOSUB2240
270 GOSUB1380
280 '
290 WE=WE+1:PS=P1+P2+P3+P4+P5
300 IFE1<2000THENF2=E1+E1*RND(1)ELSEIFE1<5000ANDE1>2000THENF2=E1
*(3+RND(2))ELSEF2=E1*(5+RND(2))
310 IFF2>49999THENF2=50000-RND(500)
320 F=F+F2:F8=F8+F2
330 ONWEGOTO340,340,340,350,350,350,350,360,360,360
340 IFPS<10ORPS>20THENVP=VP*1.03ELSEVP=VP*1.028:GOTO370
350 IFPS<10ORPS>20THENVP=VP*1.04ELSEVP=VP*1.038:GOTO370
360 IFPS<10ORPS>20THENVP=VP*1.045ELSEVP=VP*1.043
370 IFPS<6ORPS>23THENVP=VP*1.003
380 UP=(100-VP)/2.7+RND(2)
390 IFWE=1THENDP=(100-UP)*.52:RP=(100-UP)*.48
400 DP=DP+HL(N1)+HL(N2):RP=RP-HL(N1)-HL(N2)
410 NB=HL(N1)+HL(N2)
420 IF(C$="R"ANDP0$="I")OR(P0$="C"ANDC$="D")THENRP=RP+.75:DP=DP-
.75
430 IF(C$="D"ANDP0$="I")OR(P0$="C"ANDC$="R")THENDP=DP+.75:RP=RP-
.75
440 IFC$="D"THENDP=DP-ABS(15-PS)/10:RP=100-UP-DP
450 IFC$="R"THENRP=RP-ABS(15-PS)/10:DP=100-UP-RP
460 MF=0:IFE2>18000MF=MF+E2/18000ELSEMF=MF-1.5
470 IFE3>12000THENMF=MF+E3/12000ELSEMF=MF-1
480 IFE4>3000THENMF=MF+.5ELSEMF=MF-.7
490 IFE5>750THENMF=MF+.1ELSEMF=MF-.2
500 IFC$="D"THENDP=DP+MF:RP=100-DP-UP
510 IFC$="R"THENRP=RP+MF:RP=100-DP-UP
520 IFTE>3CLSEELSE610
530 PRINTCHR$(23)"IT LOOKS AS THOUGH YOU'VE"
540 PRINT"CHANGED YOUR MIND ONCE TOO"
550 PRINT"OPTEN. THE PRESS CHARGES YOU"
560 PRINT"WITH INCONSISTENCY - OR WORSE!"
570 PRINT"YOU LOSE ONE PERCENT!"
580 IFC$="R"THENRP=RP-1:DP=DP+1:TE=0
590 IFC$="D"THENRP=RP+1:DP=DP-1:TE=0
600 GOSUB2130
610 IFWE=10GOTO2430
620 '
630 CLS:PRINTCHR$(23)
640 PRINT@10,"STAFF REPORT, WEEK";WE
650 FORZ=11TO106:SET(Z,3):NEXT
660 PRINT@196,"POLL RESULTS"
670 PRINTTAB(7)"DEMOCRATIC: ";:PRINTUSINGQ$;DP
680 PRINTTAB(7)"REPUBLICAN: ";:PRINTUSINGQ$;RP
690 PRINTTAB(7)"UNDECIDED: ";:PRINTUSINGQ$;UP
700 PRINTTAB(7)"PROBABLE TURNOUT: ";:PRINTUSINGQ$;VP
710 PRINT@516,"WEEK'S RECEIPTS: ";:PRINTUSINGP$;F2
720 PRINT@580,"CAMPAIGN FUND: ";:PRINTUSINGP$;F
730 PRINT@644,"SPENT TO DATE: ";:PRINTUSINGP$;F1
740 PRINT@708,"TIME UNTIL ELECTION: ";10-WE;"WEEKS"
750 FORZ=11TO106:SET(Z,38):NEXT:GOSUB2130
760 '
770 CLS:PRINT"HERE IS A DIGEST OF THE WEEK'S MOST IMPORTANT NEWS
AS"
780 PRINT"IT RELATES TO THE CAMPAIGN:"
790 N1=RND(30):IFPH$(N1)<>"GOTO790
800 N2=RND(30):IFN2=N1GOTO800
810 IFPH$(N2)<>"THENGOTO800
820 PH$(N1)=HL$(N1):PH$(N2)=HL$(N2)

```

Listing continues

and how to rewrite a Basic computer program.

Since each run of Election lasts only 15 or 20 minutes, a systematic approach to it would be practical. Students will profit from such an approach since they can vary strategy decisions to be tested from one run to the next.

If anyone develops any other educational uses for this program, please let me know about them.

Altering Election 2.1

Table 2 contains a list of variables you will most likely want to alter.

To change the size of the constituency, alter CO in line 70. As CO is set, it is the approximate size of a Congressional District. If you set up the program for a particular district, you can use the population of that district. For non-Congressional elections, you would also have to change the text appearing in lines 100-190.

The initial campaign fund, F, is set to \$30,000 in line 70. E1 through E5, ET, F1 and F4 are temporary variables that carry items such as subtotals and the amount of money spent on each of the media. Assumptions regarding the effect of these expenditures appear in lines 460-490. For example, E3 is the amount spent on television each week. In line 470 you see that if a minimum of \$12,000 has not been spent on television advertising that week, the media factor, MF, is reduced by one. If television spending is greater than \$12,000, MF is incremented by one plus the amount spent divided by 12,000. Variable MF carries each of the media expenditure factors into the candidates vote total in lines 500 and 510.

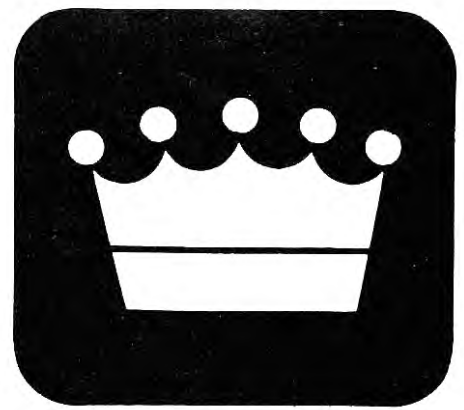
The initial Democratic "edge" is established by line 390.

The news headlines appear as data statements in lines 2780 to the end. The number after each headline is the percentage to be added to the Democratic side and subtracted from the Republican side. This calculation occurs in line 400. The text of the headlines and their political effect can be adjusted to work in either direction. The program goes through two-thirds of the headlines in each run, so the general direction, or balance, of the news, can be controlled by the programmer. More headlines can be added in machines that have more than 16K memory by adding data statements and adjusting the high number of the loop in line 60 to reflect the number of headlines to be read into HL\$(Z). For example, if there were 40

Listing continued

```
830 PRINT:PRINT:PRINT:PRINTPH$(N1)
840 PRINT:PRINT:PRINT:PRINTPH$(N2)
850 GOSUB2130
860 '
870 CLS:PRINT:PRINT:PRINTCHR$(23):PRINT"DO YOU WISH TO CHANGE AN
Y OF":PRINT"YOUR ANNOUNCED POSITIONS? (Y/N)";:GOSUB2140
880 IFZ$="Y"THENGOTO900
890 GOTO2160
900 TE=TE+1:TC=TC+1:CLS:PRINT"ON WHICH ISSUE DO YOU WISH TO CHAN
GE YOUR POSITION?"
910 PRINT:PRINT:PRINTTAB(5)"(1) SOCIAL WELFARE","CURRENT POSITIO
N IS # ";P1
920 PRINT:PRINTTAB(5)"(2) THE ECONOMY","CURRENT POSITION IS # ";
P2
930 PRINT:PRINTTAB(5)"(3) BUSING",,"CURRENT POSITION IS # ";P3
940 PRINT:PRINTTAB(5)"(4) WOMEN'S RIGHTS","CURRENT POSITION IS #
";P4
950 PRINT:PRINTTAB(5)"(5) FOREIGN POLICY","CURRENT POSITION IS #
";P5
960 PRINT:GOSUB2150:Z=VAL(Z$):IFZ<0ORZ>5GOTO900ELSEONZGOSUB1510,
1630,1750,1870,1990
970 CLS:PRINT@192,"WOULD YOU LIKE TO MAKE ADDITIONAL POSITION CH
ANGES? (Y/N)";:GOSUB2140
980 ILEFT$(Z$,1)="Y"THENGOTO900ELSEGOTO2160
990 '
1000 CLS:PRINT"YOU WILL NOW HAVE THE OPPORTUNITY TO MAKE SOME IN
ITIAL POLITICALCHOICES. YOU MAY BE AN INCUMBENT OR A CHALLENGER,
A DEMOCRAT OR REPUBLICAN. IF YOU WISH, THE COMPUTER WILL CHOOSE
FOR YOU."
1010 PRINT"AFTER MAKING YOUR INITIAL CAMPAIGN FUND DISBURSEMENTS
YOU"
1020 PRINT"WILL BE ASKED TO MAKE SOME POLICY CHOICES WHICH WILL
LOCATE"
1030 PRINT"YOU ON AN IDEOLOGICAL SCALE THUS HELPING DETERMINE WH
AT"
1040 PRINT"SHARE YOU WILL CAPTURE OF THE VOTE OF THE MAJOR GROUP
S IN "
1050 PRINT"YOUR CONSTITUENCY."
1060 PRINT:PRINT
1070 PRINTTAB(5)"WOULD YOU LIKE TO BE A (D)EMOCRAT OR A (R)EPUBL
ICAN -"
1080 PRINTTAB(8)"OR WOULD YOU LIKE THE (C)OMPUTER TO CHOOSE?":PR
INTTAB(8)"PRESS <D>,
<R>, OR <C>." :GOSUB2140
1090 C$=Z$:IFC$="C"THENIFRND(2)=1THENC$="D"ELSEC$="R"
1100 IFC$<>"R"ANDC$<>"D"THEN1000
1110 IFC$="R"GOTO1190
1120 CLS:PRINT:PRINT:PRINT:PRINTTAB(10)"YOU'VE MADE AN EXCELLENT
CHOICE."
1130 PRINTTAB(10)"NOW YOU CAN WRAP YOURSELF IN THE MANTLE
1140 PRINTTAB(10)"OF SUCH OTHER DEMOCRATS AS JEFFERSON,"
1150 PRINTTAB(10)"WILSON, ROOSEVELT, AND KENNEDY BY SELECTING"
1160 PRINTTAB(10)"POSITIONS YOU THINK APPROPRIATE TO THE"
1170 PRINTTAB(10)"DEMOCRATIC PARTY."
1180 GOSUB2130:GOTO1250
1190 CLS:PRINT:PRINT:PRINT:PRINTTAB(10)"A FINE CHOICE! NOW YOU M
AY"
1200 PRINTTAB(10)"ATTEMPT TO EMULATE SUCH REPUBLICANS AS"
1210 PRINTTAB(10)"LINCOLN, ROOSEVELT, AND EISENHOWER BY
1220 PRINTTAB(10)"SELECTING POLITICAL POSITIONS WHICH ARE
1230 PRINTTAB(10)"APPROPRIATE TO THE PARTY."
1240 GOSUB2130
1250 CLS:PRINT"WOULD YOU PREFER TO BE AN INCUMBENT OR CHALLENGER
?"
1260 PRINT"BEFORE DECIDING YOU SHOULD BE AWARE THAT IN AMERICAN
ELECTIONS"
1270 PRINT"INCUMBENTS ARE NORMALLY RE-ELECTED MORE THAN 60% OF T
HE TIME."
1280 PRINT"IN 'BAD' TIMES THIS PERCENTAGE MAY DROP SHARPLY. THE
'NATURE'"
1290 PRINT"OF THE TIMES FOR THIS SIMULATION ARE DETERMINED PARTL
Y BY"
1300 PRINT"THE PROGRAMMER(PESSIMISTIC ON THURSDAYS AND OPTIMISTI
C ON"
1310 PRINT"MONDAYS) AND IN PART BY THE NEWS HEADLINES WHICH ARE
SELECTED"
1320 PRINT"BY A RANDOM NUMBER GENERATOR."
1330 PRINT@715,"(I)NCUMBENT OR (C)HALLENGER?":GOSUB2140
1340 P0$=Z$:IFP0$<>"I"ANDP0$<>"C"THENGOTO1250
1350 IFP0$="I"CLS:PRINTCHR$(23):PRINT@260,"PLAYING IT SAFE MAY O
R MAY NOT":PRINT@346,"HELP":PRINT@530,"GOOD LUCK!":GOTO1370
1360 CLS:PRINTCHR$(23):PRINT@260,"AN UPHILL STRUGGLE. GOOD LUCK!
"
1370 GOSUB2130:RETURN
1380 '
1390 CLS:PRINT"YOU WILL NOW SELECT POSITIONS ON FIVE POLITICAL I
```

Listing continues



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headlines, the relevant portion of line 30 would say FOR Z = 1 TO 40:.

PS represents the total effect of the positions selected. The program sums the numbers of the student's policy choices. The low-end choices, 1 and 2, tend to be conservative, and the high-end choices, 4 and 5, tend to be liberal. The appropriate party is incremented or decremented in lines 440 and 450.

The size of the turnout, VP, is directly tied to the degree of controversy injected into the campaign by these choices. The constants that control this are found in lines 340-370. The issues can be changed, and different weights can be assigned to the policy choices. In lines 440-450, the effect of ideology could be increased as a whole by lowering the constant 10 by a small amount, or you can use a particular issue as a key issue by adding to these lines. For example, if issue 2 were given extra weight or effect, these lines could become:

```
440 IF C$ = "D" THEN
  DP = DP - (ABS(15 - PS) / 10) - ABS(3 - P2)
  RP = 100 - UP - DP
```

```
450 IF C$ = "R" THEN
  RP = RP - (ABS(15 - PS) / 10) - ABS(3 - P2)
  DP = 100 - UP - RP
```

If this technique is selected, you should adjust the content of the news headlines to reflect the increased importance of the selected issue.

The ideological range of each issue can best be adjusted at the point in the program where the choices are made—lines 1610, 1730, 1850, 1970, and 2100. The position value is set equal to the value of Z\$. At this point, you could alter the range by adding or subtracting an appropriate amount, for example:

```
1610 GOSUB 2150:P1 = VAL(Z$) - 2: IFP1 < 50R P1 > 1GOTO1510
```

This has the effect of moving the responses on issue 1 well toward the liberal side; adding 2 to P1 would move them toward the conservative side. The program is structured to accept a response of 3 to each position to indicate roughly the ideological center of the constituency. You should change the text of the positions, instead of the arithmetic of the program, since numerical changes, if too large, will have distorting effects that are multiplied over the 10 weeks of the campaign. ■

Robert Jacobs (Central Washington University, Ellensburg, WA 98926) is a professor of political science.

Listing continued

```
SSUES. THESE"
1400 PRINT"ARE SOCIAL WELFARE, THE ECONOMY, BUSING, WOMEN'S RIGH
TS AND FOREIGN POLICY. IN SELECTING YOUR PUBLIC POSITIONS YOU S
HOULD BE"
1410 PRINT"AWARE THAT YOU WILL BE EVALUATED BY THE VOTERS IN TER
MS OF YOUR"
1420 PRINT"CONSISTENCY AS WELL AS THE EXTENT TO WHICH YOUR POLIC
Y CHOICES"
1430 PRINT"ARE IN AGREEMENT WITH THEIRS. AS THE CAMPAIGN PROGRES
SES YOU"
1440 PRINT"MAY BE ASKED TO DISCUSS THESE ISSUES FURTHER, PERHAPS
IN THE"
1450 PRINT"LIGHT OF ANY NEWS WHICH MAY DEVELOP."
1460 PRINT:PRINT:PRINT"FOUR OR FIVE POLICY POSITIONS ARE SUGGEST
ED TO YOU BY"
1470 PRINT"YOUR STAFF ON EACH OF THE ISSUES. CHOOSE YOUR STAND B
Y"
1480 PRINT"ENTERING THE NUMBER OF THE POSITION YOU PREFER."
1490 GOSUB2130:GOSUB1510:GOSUB1630:GOSUB1750:GOSUB1870:GOTO1990
1500 RETURN
1510 '
1520 CLS:PRINT"HERE ARE THE PROPOSED POSITIONS ON SOCIAL WELFARE
:"
1530 :PRINT:PRINT"(1) I THINK THAT THE ONLY PRACTICAL WAY TO DE
AL WITH THE"
1540 PRINTTAB(5)"WELFARE SYSTEM IS TO IMPOSE SEVERE BUDGET CUTS.
"
1550 PRINT:PRINT"(2) WE SHOULD DO EVERYTHING WE CAN TO END WELF
ARE FRAUD."
1560 PRINT:PRINT"(3) WE MUST CONTINUE TO CARE FOR DEPENDENT CHI
LDREN, THE SICK"
1570 PRINTTAB(5)"AND THE ELDERLY IN A CONTEXT OF FISCAL RESPONSI
BILITY"
1580 PRINT:PRINT"(4) WE MUST INCREASE THE SERVICES WE OFFER THE
POOR."
1590 PRINT:PRINT"(5) THE POOR ARE THE VICTIMS OF AN UNFEELING S
YSTEM; THEY MUST"
1600 PRINTTAB(5)"BE AIDED TO THE MAXIMUM POSSIBLE EXTENT."
1610 GOSUB2150:P1=VAL(Z$):IFP1>50R P1<1GOTO1510
1620 RETURN
1630 '
1640 CLS:PRINT"HERE ARE THE PROPOSED POSITIONS ON THE ECONOMY:"
1650 PRINT:PRINT"(1) IMMEDIATE REDUCTION OF TAXES, BOTH CORPORA
TE AND PERSONAL;
1660 PRINTTAB(5)"ADDITIONAL TAX INCENTIVES TO BUSINESS."
1670 PRINT:PRINT"(2) BALANCED BUDGET EVEN IF SOME PROGRAMS HAVE
TO BE CUT."
1680 PRINT:PRINT"(3) SAME LEVEL OF EXPENDITURE AS LAST YEAR; NO
ADDED TAXES."
1690 PRINT:PRINT"(4) SOME NEW PROGRAMS TO HELP COPE WITH UNEMPL
OYMENT;"
1700 PRINTTAB(5)"NO NEW TAXES."
1710 PRINT:PRINT"(5) MAJOR PROGRAMS TO END UNEMPLOYMENT FINANCE
D BY NEW TAXES;"
1720 PRINTTAB(5)"LOWER CEILING ON INTEREST RATES."
1730 GOSUB2150:P2=VAL(Z$):IFP2>50R P2<1GOTO1630
1740 RETURN
1750 '
1760 CLS:PRINT"HERE ARE SOME PROPOSALS ON THE BUSING ISSUE:"
1770 PRINT:PRINT"(1) FAVOR AN ANTI-BUSING CONSTITUTIONAL AMENDM
ENT"
1780 PRINT:PRINT"(2) NO FEDERAL FUNDS TO BE USED FOR BUSING. A
RIDER
1790 PRINTTAB(5)"SHOULD BE ATTACHED TO THE APPROPRIATIONS BILL."

1800 PRINT:PRINT"(3) BUSING IS A LOCAL ISSUE; THE STATES CAN DE
AL WITH"
1810 PRINTTAB(5)"THE COURTS AND WORK IT OUT."
1820 PRINT:PRINT"(4) BUSING IS CONSTITUTIONALLY MANDATED AND IS
PART"
1830 PRINTTAB(5)"OF THE LAW OF THE LAND. THE FEDERAL GOVERNMENT
MUST"
1840 PRINTTAB(5)"CONTINUE TO SUPPORT IT."
1850 GOSUB2150:P3=VAL(Z$):IFP3>40R P3<1GOTO1750
1860 RETURN
1870 '
1880 CLS:PRINT"HERE ARE POSITIONS ON WOMEN'S RIGHTS:"
1890 PRINT:PRINT"(1) SUPPORT ANTI-ABORTION AMENDMENT, DEFEAT ER
A."
1900 PRINT:PRINT"(2) CONTINUE THE BAN ON FEDERAL FUNDING OF ABO
RTIONS;"
1910 PRINTTAB(5)"DEFEAT THE ERA"
1920 PRINT:PRINT"(3) ATTEMPT TO PRESERVE TRADITIONAL FAMILY STR
UCTURE."
1930 PRINT:PRINT"(4) ERA IS EFFECTIVELY LOST ANYWAY, BUT LEGAL
```

Listing continues

Listing continued

```
BARRIERS TO"
1940 PRINTTAB(5)"EQUAL RIGHTS FOR WOMEN SHOULD BE ABOLISHED."
1950 PRINT:PRINT"(5) SUPPORT ERA AND RESTORE FEDERAL MEDICAL AS
SISTANCE FOR"
1960 PRINTTAB(5)"ABORTIONS FOR THOSE WOMEN WHO CAN'T OTHERWISE A
FFORD THEM."
1970 GOSUB2150:P4=VAL(Z$):IFP4>5ORP4<1GOTO1870
1980 RETURN
1990 '
2000 CLS:PRINT"THESE ARE THE FOREIGN POLICY POSITIONS:"
2010 PRINT:PRINT"(1) ECONOMIC SANCTIONS AGAINST THE U.S.S.R; AB
ANDON SALT"
2020 PRINTTAB(5)"AND GIVE MORE SUPPORT TO ANTI-COMMUNIST REGIMES
"
2030 PRINT:PRINT"(2) CUT GRAIN AND HIGH-TECHNOLOGY EXPORTS TO T
HE SOVIET UNION;"
2040 PRINTTAB(5)"ADOPT A TOUGHER STANCE TOWARDS SALT."
2050 PRINT:PRINT"(3) TRADE WITH THE SOVIET UNION UNION TO CONTI
NUE AT PRESENT"
2060 PRINTTAB(5)"LEVELS; MAINTAIN EXISTING SALT AGREEMENTS AND S
UPPORT"
2070 PRINTTAB(5)"FURTHER DISARMAMENT AGREEMENTS."
2080 PRINT:PRINT"(4) ABANDON SUPPORT FOR AUTHORITARIAN REGIMES;
CUT MILITARY
2090 PRINTTAB(5)"SPENDING AND ADOPT STRONG HUMAN RIGHTS POLICY."

2100 GOSUB2150:P5=VAL(Z$):IFP5>4ORP5<1GOTO1990
2110 RETURN
2120 END
2130 PRINT@900,"PRESS <ENTER> TO CONTINUE";
2140 Z$="":Z$=INKEY$:IFZ$=" "THEN2140ELSERETURN
2150 PRINT"WHICH DO YOU CHOOSE?":GOSUB2140:RETURN
2160 '
2170 CLS:PRINT,"WEEK";WE+1;"OF THE CAMPAIGN"
2180 PRINT:PRINT" NOW YOU SHOULD DECIDE HOW MUCH OF YOUR WAR C
HEST TO"
2190 PRINT"SPEND ON EACH CAMPAIGN ACTIVITY FOR THIS WEEK. YOUR B
ALANCE IS";PRINTUSINGP$;F;:PRINT"."
2200 PRINT"THUS FAR YOU HAVE SPENT";:PRINTUSINGP$;TV;:PRINT" ON
TELEVISION,";:PRINTUSINGP$;RA
2210 PRINT"ON RADIO,";:PRINTUSINGP$;NE;:PRINT" ON NEWSPAPER ADVE
RTISING,";:PRINTUSINGP$;SO;:PRINT" FOR"
2220 PRINT"SOUVENIRS, AND";:PRINTUSINGP$;FR;:PRINT" ON FUND RAIS
ING." :GOSUB2240
2230 GOTO2080
2240 PRINT:PRINT:PRINTTAB(7)"ENTER EXPENDITURE FOR FUND-RAISING"
;:INPUTE1
2250 PRINTTAB(7)"ENTER EXPENDITURE FOR TELEVISION";:INPUTE2
2260 PRINTTAB(7)"ENTER EXPENDITURE FOR RADIO";:INPUTE3
2270 PRINTTAB(7)"ENTER EXPENDITURE FOR NEWSPAPERS";:INPUTE4
2280 PRINTTAB(7)"ENTER EXPENDITURE FOR SOUVENIRS";:INPUTE5
2290 CLS::PRINT"YOU HAVE SPENT YOUR CAMPAIGN MONEY AS FOLLOWS:"
2300 PRINT:PRINT:PRINTTAB(15)"FUND-RAISING";:PRINTUSINGP$;E1
2310 PRINTTAB(15)"TELEVISION:";:PRINTUSINGP$;E2
2320 PRINTTAB(15)"RADIO:";:PRINTUSINGP$;E3
2330 PRINTTAB(15)"NEWSPAPERS:";:PRINTUSINGP$;E4
2340 PRINTTAB(15)"SOUVENIRS:";:PRINTUSINGP$;E5
2350 FORZ=30TO79:SET(Z,25):NEXT:ET=E1+E2+E3+E4+E5
2360 PRINT:PRINTTAB(15)" TOTAL:";:PRINTUSINGP$;ET
2370 PRINT:PRINT:IFET>FTHENPRINT"SORRY, YOU HAVE ONLY";F;" DOLLA
RS IN THE TREASURY"ELSEGOTO2390
2380 INPUT"HIT <ENTER> TO REDO YOUR BUDGET";Z:CLS:PRINT"TOTAL AV
AILABLE IS";:PRINTUSINGP$;F:GOTO2240
2390 F4=F-ET:PRINT"THESE EXPENDITURES WILL LEAVE";F4;"DOLLARS"
2400 PRINT"IN YOUR CAMPAIGN TREASURY. IS THIS WHAT YOU WISH(Y/N)
";:GOSUB2140
2410 IFZ$<>"Y"THENCLS:PRINT"TOTAL FUNDS AVAILABLE";:PRINTUSINGP$
;F:GOTO2240
2420 F=F4:F1=F1+ET:FR=FR+E1:TV=TV+E2:RA=RA+E3:NE=NE+E4:SO=SO+E5:
RETURN
2430 '
2440 CLS:PRINT"HERE ARE THE RESULTS OF THE ELECTION:"
2450 XC=100*DP/(DP+RP):QC=100*RP/(RP+DP):VO=CO*VP/100
2460 PRINT:PRINT:PRINTTAB(5)"REPUBLICAN:",INT(VO*QC/100),:PRINTU
SINGQ$;QC
2470 PRINT:PRINTTAB(5)"DEMOCRATIC:",INT(VO*XC/100),:PRINTUSINGQ$
;XC
2480 PRINT:PRINTTAB(5)"TOTAL VOTE:",VO,:PRINTUSINGQ$;VP
2490 IFXC>QCANDC$="D"ORC$="d"GOTO2510
2500 IFQC>XCANDC$="R"THENGOTO2510ELSE2540
2510 PRINT:PRINT"YOU'VE WON! CONGRATULATIONS ON YOUR ELECTION. T
HE"
2520 PRINT"CHANCES ARE THAT YOUR PROBLEMS ARE ONLY BEGINNING. PR
ESS"
2530 PRINT"<ENTER> TO SEE A SUMMARY OF YOUR CAMPAIGN.":GOSUB2140
```

Listing continues

SUPER UTILITY PLUS S/E SPECIAL EDITION

This Special Limited Edition Package will be in high demand as only 500 copies will be made. They will be numbered 1-500 and will be personally signed by the author, Kim Watt. YOUR name will be embedded in the program as the serial number. The following is included with this SPECIAL LIMITED PACKAGE:

- 1) SUPER UTILITY PLUS S/E in CMD File Format. Both MOD I and III versions are included and your NAME will be the serial number. This will NOT be a protected disk, and you may make as many BACKUPS as you wish. The serial number is NOT changeable.
- 2) TWO attractive SOFT SE binders.
 - Binder #1 will include:
 - Three manuals in LARGF format (8 1/2 x 11")
 - (a) SUPER UTILITY - Manual
 - (b) INSIDER SUPER UTILITY by Paul Wiener foreward by Kim Watt
 - (c) SUPER UTILITY TECH Manual by Kim Watt & Pete Carr
 - Binder #2 will include THE SOURCE CODE for SUPER UTILITY PLUS.

Yes, the SOURCE CODE to this MAJOR program will be available to 500 programmers. This is FULLY commented by the author, Kim Watt, and is a machine language programmer's dream come true! After reading this, your machine language programming skill should increase tremendously. All of Kim's knowledge in ONE book! All at your disposal and for YOUR use.

- 4) The license to USE Kim Watt's sub-routine will be granted to those 500 registered owners! These 500 ONLY will be able to apply all of Kim's magic to THEIR programs. No royalty fee necessary. In other words, IMPROVE YOUR PROGRAMS! Take Kim's ideas and expand on them! Never has anything EVER been done like this before. These 500 ONLY have the right to use our sub-routines. This information is NOT being put in the public domain. We are allowing these 500 to use our routines by buying our special package. All copyrights and trademarks are retained by Breeze QSD, Inc.
- 5) SOURCE is NOT available from any dealer, but only directly through Breeze QSD, Inc. Customers will be handled on a one on one basis. Confirmed orders will be pre-registered and a matching card must be returned by purchaser for full support from Breeze QSD, Inc. We will know who each and every owner is, so full support can be given. We DO want you to sign and return our registration card for this support to commence however. No exceptions will be made.

- 6) This is a very important step that we are taking, and only a select group can appreciate the value in a package like this. This is NOT for the general mass market. It is a college education in machine language written by a recognized expert. It is SOURCE in CMD file form. It is a license to use Kim Watt's sub-routines. It is an opportunity to vastly improve your product. It is a collector's item, also. Limited. Indeed. Last, but not least, it is expensive. On the surface only, however, as this product will make you an expert programmer if that is what you want. You can literally write a DOS from studying the code! It will also make you a member of an elite group that has access to Kim's knowledge and can USE that knowledge to YOUR benefit.

Source Code is FULLY Commented
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\$500**

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*Credit to Kim Watt and Breeze QSD must be given in the program and in the documentation for sub-routines used. There is NO royalty fee to pay however.

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By: Gary Heimburger and Gary Robinson

(This adventure package is the first to be marketed that was created by The Adventure System! Look for more fantastic adventures coming soon! Each TAS adventure package includes TWO complete adventures for one low price!)

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The Scenario: A small South-sea island chain. Unfortunate navigation left you stranded on one island.

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Adventure 2: Lost City of Gold

The Scenario: You're on a mountain climbing expedition in South America (in Peru, near Lake Titicaca). After straying from the beaten path, you discover a cave that eventually leads to a forgotten part of the lost Incan city. Grab your pitons.

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...

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LDOS Users!

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SYSGEN

SYSGEN/CMD allows you to save one or more SYSGEN files as normal /CMD files. Keep several configurations on the same disk and reload as necessary by simply typing the filename. Especially useful when the preferred configuration consumes so much memory that large programs will not execute properly. SYSGEN/CMD may also be executed from a running BASIC program. When the resultant /CMD file is executed, the BASIC program will continue with the next statement, all program variables intact!

UNREPAIR

Model I TRSDOS cannot read LDOS disks due to the F8 DAM used for directory sectors. UNREPAIR will rewrite the directory track of a single density disk using the FA DAM that will be recognized by Model I TRSDOS. UNREPAIR should run with any Model I DOS and the Radio Shack E/I.

An extra BONUS! The TAS LDOS Utility pack includes Z80 source code (on disk) of most of the above utilities (the most informative). The LDOS Utility Pak is \$49.95. This package was written by Les Mikesell.

THE ALTERNATE SOURCE

69

STOPPER!

The BASIC Breakpointer
By Roxton Baker
Author of "TRAKCESS"

Stopper is a unique machine language utility that allows interactive program debugging when using Level II or Disk BASIC on the Model I and III. Stopper was designed by Roxton to help debug a new version of TRAKCESS that will be announced shortly, because there wasn't anything on the market that would provide the features needed.

Some of Stopper's commands: Set a breakpoint with a "hit" count, either when a line has been executed "n" times or a variable is equal a certain value; or not equal a certain value; breakpoints and variables may be viewed and modified at any time; selective execution of program statements and lines; display only the portion of the line where the error occurred; TRON functions are improved and may be routed to printer; set a "tolerance" on single and double precision numbers (to accommodate the inaccurate ROM routines and more. Naturally single stepping is fully supported.

With STOPPER you will know exactly where the error is and why it occurred. Program execution is under YOUR control!

A special offer from the author and TAS: Stopper is \$20 on tape or disk, BUT you are licensed to make up to four additional copies, making the cost for this valuable utility only \$4. Support co-op purchases by ordering today. BASIC debugging will never be easier, nor a better utility any cheaper. Extra manuals and Z80 source code are available.

EFFECTIVE COMMUNICATION

is easy with Modem80. There is absolutely no need to pay any more for a top-quality communication package. Modem80 can help your TRS-80 Model I and III talk to a wide variety of machines. The Modem80 translation table is easily modified to accommodate unusual protocol. Modem80 allows file uploading and downloading. XON and XOFF are supported to allow transmission of files larger than memory. A special protocol (compatible with the CP/M public domain program MODEM) allows error-free transmission without converting to ASCII. XMODEM, a special version of MODEM is included so that you may give your friends a copy to take advantage of faster error-free transmission. A host program is included at no extra charge to allow accessing your unattended TRS-80 from a remote location. All "local" parameters (baud rate, stop bits, parity, duplex and more) can be changed quickly and easily with a minimum of keystrokes. For specialized applications, one file may be transmitted while a different file is simultaneously being received. DOS commands may be executed while within Modem80. Special patches insure compatibility with all popular Model I and III operating systems. The previous screen is restored after DOS commands. Modem80 also allows disabling screen scroll to permit transmission speeds at up to 9600 baud (under direct connect situations). A special patch sheet is available for people wanting to use the Micronet Dow Jones service. Also available, on request, is a LYNX modem version that allows operation on a Model III even if RS-232 is installed. All this and many more features are what's making Modem80 one of our most popular programs! Oh, yes, the price helps too: \$39.95 complete including documentation in a three-ring binder. Modem80 is authored by Les Mikesell.

BRAND NEW!



By Bruce Hansen

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Listing continued

```
:GOTO2580
2540 PRINT:PRINT"YOU'VE LOST; PLEASE ACCEPT OUR REGRETS. PERHAPS
"
2550 PRINT"IT WILL CONSOLE YOU TO KNOW THAT YOUR OPPONENT'S TROU
BLES"
2560 PRINT"ARE JUST BEGINNING. PRESS <ENTER> TO SEE A SUMMARY"
2570 PRINT"OF THE CAMPAIGN.";GOSUB2140
2980 DATA"TWELVE ARRESTED IN WELFARE FRAUD RING",-2
2990 DATA"STUDY SHOWS SCHOOLCHILDREN IN BUSES MORE THAN TWO HOUR
S DAILY ON AVERAGE",-3
3000 DATA"STUDY SHOWS NEW BUS ROUTES CUT AVERAGE TRIP TO SCHOOL
BY FIFTEEN PERCENT",1
3010 DATA"YOUR OPPONENT TO MAKE THREE MAJOR TELEVISION ADDRESSES
THIS WEEK",0
3020 DATA"YOUR OPPONENT BEGINS PRINT MEDIA SATURATION CAMPAIGN",
0
3030 DATA"YOUR OPPONENT TAKES MIDDLE GROUND ON BUSING ISSUE",-1
3040 DATA"YOUR OPPONENT USING DOZENS OF RADIO SPOTS THIS WEEK",0
3050 DATA"INFLUENTIAL COLUMNIST SAYS YOU LOOK 'TIRED;' YOUR OPPO
NENT HIKES FORTY MILES",0
3060 DATA"WELL-KNOWN NEWSMAN REPORTS THAT YOUR OPPONENT IS FALLI
NG OFF IN THE POLLS",0
3070 DATA"OLD CHARGES OF TAX IRREGULARITIES SURFACE AGAINST YOU"
,0
2580 CLS:PRINTTAB(30);"SUMMARY":FORZ=60TO74:SET(Z,3):NEXT
2590 PRINT:PRINT" DURING THE COURSE OF THIS ELECTION CAMPAIGN"

2600 PRINT"YOU INCURRED EXPENDITURES AS FOLLOWS:"
2610 PRINT:PRINT"TELEVISION:";:PRINTUSINGP$;TV;:PRINT,"RADIO:
";:PRINTUSINGP$;RA
2620 PRINT"NEWSPAPERS:";:PRINTUSINGP$;NE;:PRINT,"SOUVENIRS:";:PR
INTUSINGP$;SO
2630 PRINT:PRINT"YOU RAISED";F8;"DOLLARS AT THE COST OF";FR;"DOL
LARS. THE"
2640 PRINT"BEST RATIO YOU COULD HAVE ACHIEVED IS ABOUT 5 TO 1."
2650 IFNB>0THEND$="DEMOCRATIC"ELSE$="REPUBLICAN"
2670 IFNB=0PRINT"DURING THIS RUN OF THE SIMULATION THE NEWS WAS
NEUTRAL.":GOTO2710
2680 PRINT"THE NEWS DURING THIS RUN OF THE SIMULATION FAVORED TH
E"
2690 PRINTD$;" SIDE BY";ABS(NB);"PER CENT."
2700 Z$="":IFTC>1THENZ$="S"
2710 IFTC=0GOTO2730ELSEPRINT"YOU CHANGED YOUR POSITION";TC;"TIME
";Z$;" , THUS LAYING YOURSELF"
2720 PRINT"OPEN TO THE CHARGE OF INCONSISTENCY.":GOTO2750
2730 PRINT"YOU DID NOT CHANGE YOUR POSITIONS AT ALL DURING THIS
RUN"
2740 PRINT"OF THE SIMULATION, THUS AVOIDING IMPUTATIONS OF INCON
SISTENCY."
2750 PRINT@900,"ANOTHER TRY? (Y/N)";:GOSUB2140
2760 IFZ$="Y"RUNELSEEND
2770 '
2780 DATA"SOVIETS INCREASE MILITARY FORCES IN AFGHANISTAN",-2
2790 DATA"SOVIETS INVADE POLAND, CRUSH FREE LABOR MOVEMENT",-4
2800 DATA"SOVIET UNION WITHDRAWS FROM AFGHANISTAN",2
2810 DATA"u.S. SUPPORTED REGIME IN EL SALVADOR IMPRISONS TWO AME
RICAN BISHOPS",2
2820 DATA"DISSIDENTS TORTURED BY U.S. SUPPORTED GOVERNMENT IN GU
ATEMALA",1
2830 DATA"OIL COMPANIES RAISE GASOLINE PRICES BY 4%",2
2840 DATA"DEPARTMENT OF ENERGY ANNOUNCES NEW FINDS OF NATURAL GA
S",1
2850 DATA"UNEMPLOYMENT RISES TO EIGHT PERCENT",2
2860 DATA"INFLATION RATE INCREASES TO 1.2% FOR LAST MONTH",2
2870 DATA"INFLATION RATE SAID TO DECREASE TO .4% LAST MONTH",-1
2880 DATA"JOBLESS RATE DROPS TO FIVE PERCENT",-2
2890 DATA"YOUR CAMPAIGN MANAGER ACCUSED OF HAVING A MERETRICIOUS
RELATIONSHIP WITH HIS SECRETARY",0
2900 DATA"YOU ARE ACCUSED OF SPENDING CAMPAIGN FUNDS FOR PERSONA
L PURPOSES",0
2910 DATA"YOUR OPPONENT'S SON ARRESTED FOR DRIVING WHILE INTOXIC
ATED",0
2920 DATA"YOUR OPPONENT FOUND TO BE RECEIVING ILLEGAL CAMPAIGN
DONATIONS",0
2930 DATA"SOME OF THE DONATIONS YOU HAVE RECEIVED ARE FOUND TO B
E ILLEGAL",0
2940 DATA"YOUR OPPONENT ANNOUNCES THAT HIS POLLS SHOW HIM LEADIN
G BY TEN PERCENT",0
2950 DATA"PRO-CHOICE AND PRO-LIFE DEMONSTRATORS CLASH AT COURTHO
USE",0
2960 DATA"TAX RELIEF PETITION SIGNED BY 34,000; DEMAND ACTION RI
GHT AWAY",-2
2970 DATA"WELFARE MOTHERS DEMAND HIGHER BENEFITS; CLAIM CHILDREN
STARVING",1
```



**THE MOST POWERFUL, FLEXIBLE
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To Boldly Go . . .

by Joey Robichaux

A unique application for your microcomputer, this menu-driven, Basic package will help amateur astronomers and other stargazers.

Program Listing

```

1 CLS:DEFDBLO-Z:DEFINTI-K,M,N:RA=.01745329:RE=23.43*RA:ID!=0
2 DINT1(8),T2(8),T3(8),T4(8),T5(8),T6(8),T7(8),T8(8),T9(8),PS(8)
,UB(25):UA=.065709:UC=1.002743:UD=.997257
3 GOSUB7050
8 CLS
10 PRINT@20,"STAR TRACK / MASTER MENU"
25 PRINT@266,"1. Determine planet coordinates"
27 PRINT@330,"2. Determine SUN information"
28 PRINT@394,"3. Determine MOON information"
30 PRINT@458,"4. Determine precession / rise and set"
32 PRINT@522,"5. Time system conversions"
34 PRINT@586,"6. Terminate program"
50 PRINT@138,"Please select an option"
55 QQ$=INKEY$:IFQQ$<"1"ORQQ$>"6"THEN55
57 I=VAL(QQ$)
60 IFI<1THEN50
65 IFI>6THEN50
70 ONIGOTO100,190,300,400,500,170
100 CLS:PRINT@20,"STAR TRACK / PLANET TRACKER"
105 PRINT@276,"1. MERCURY":PRINT@340,"2. VENUS":PRINT@404,"3. EA
RTH"
110 PRINT@468,"4. MARS":PRINT@532,"5. JUPITER":PRINT@596,"6. SAT
URN"
115 PRINT@660,"7. URANUS":PRINT@724,"8. NEPTUNE":PRINT@788,"9. P
LUTO"
117 PRINT@852,"A. Return to main menu"
120 PRINT@138,"Please select an option"
125 QQ$=INKEY$:IFQQ$="A"THENIP=10:GOTO130:ELSEIFQQ$<"1"ORQQ$>"9"
THEN125ELSEIP=VAL(QQ$)
130 IFIP<1ORIP>10THEN120
132 IFIP=10THENCLS:GOTO10
133 IP=IP-1
134 PRINT@138,"";
135 INPUT"Enter the desired date <MMDDYY>";D
136 GOSUB4000:IFNO=1THENGOTO134:ELSEIFIP=2THENGOTO180
137 S$=P$(IP)
140 ID=IM
145 GOSUB2200:GOSUB2300
150 IFIP<3THENGOSUB2400:ELSEGOSUB2500
160 GOSUB3000
165 GOSUB3500
166 PRINT@448,"      pressR&L> to return to last menu":PRINT"
      else press <SPACE BAR> for angular size":PRINTTAB(29)"dista
nce from earth":PRINTTAB(29)"phase of planet";
167 QQ$=INKEY$:IFQQ$="1"THEN100:ELSEIFQQ$=CHR$(32)THENGOSUB2640:
ELSEGOTO167
168 GOSUB7025:CLS:GOTO100
170 CLS

```

Listing continues

With Star Track, you can determine the position (right ascension and declination), the distance from Earth, angular size, and phase of any planet in the solar system. You can determine the positions of the sun and moon, their angular sizes and distances, and their rise and set times. You can calculate precession from the three most common epochs (1950, 1975, 2000), and determine rise and set times for any celestial object. You can also use Star Track to convert mean standard time to sidereal time, and vice versa.

Even though Star Track doesn't consider refraction or planetary perturbations when computing positions, the results are usually within a few percentage points of the actual figures. This is fine for amateur purposes, where the emphasis is on locating and observing objects.

Dictionary of Terms

Star Track introduces terms foreign to a beginner: right ascension (RA), declination (DEC), precession and epoch. The concepts involved are simple; understanding them allows you to locate any celestial object with star charts.

RA and DEC are terms concerned with locating objects in the sky (similar to latitude and longitude).

Latitude refers to how far up or down a point is from the equator, and ranges from 0-90 degrees. Zero degrees is a point on the equator, while 90 degrees north or south is either of the two poles. Latitude is expressed in de-

The Key Box

Model I & III
16K RAM
Basic Level II

degrees, minutes and seconds; 60 seconds equal one minute and 60 minutes equal one degree.

Longitude refers to how far around a point is on the Earth's surface. The key question is how far around from what, as there is no physical north-south circle to measure longitude from.

Greenwich, England is designated as 0 degrees longitude. Points west of this line are west longitude and points to the east are east longitude.

Longitude ranges east and west from 0-180 degrees; the 180-degree longitude line completes the circle begun by the 0-degree longitude line. Longitude is also expressed in degrees, minutes and seconds.

Declination is similar to latitude and uses the same reference point as latitude, the equator.

For example, if the Earth is a spinning ball in the center of a giant sphere and the circle formed by the Earth's equator were to expand until it touched this celestial sphere, it would trace a great celestial equator. Declination is measured in degrees north or south of this imaginary equator.

Right ascension is similar to longitude; both have an arbitrarily assigned reference point.

RA's reference point is the vernal equinox (or the first point of Aries). You don't have to locate the vernal equinox to use RA. A reference point has been established, and star charts and positions can be computed using this reference point.

Until now, RA and DEC have been almost identical to longitude and latitude. Now RA is expressed in hours, minutes and seconds instead of degrees, minutes and seconds.

The idea of measuring locations with a unit of time is slippery, but hours isn't a unit of time, it's a unit of measurement equal to 15 degrees. There are 24 hours in a circle, just as there are 360 degrees in a circle ($24 * 15 = 360$).

Right ascension is measured as you travel west from the vernal equinox. The vernal equinox is at RA 0h 0m 0s; if you travel 90 degrees to the west you're at RA 6h 0m 0s; 180 degrees to the west is RA 12h 0m 0s; 270 degrees is RA 18h 0m 0s. When you complete the circle, you're back at RA 0h 0m 0s (RA 24h = RA 0h).

Figure 1 shows RA and DEC on the star chart. Note that the celestial equator—the 0 DEC line—runs through the belt of Orion.

Now find RA 03h 43m, DEC 23° 43' N

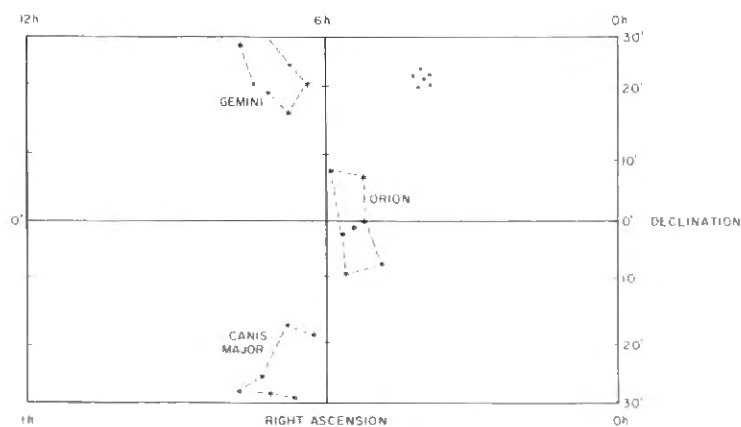


Figure 1

Listing continued

```

175 END
180 FORI=1TO300:NEXTI
185 CLS:PRINT:PRINT" On";D;" , the EARTH was located : "
187 PRINT:PRINT"DIRECTLY UNDER YOUR FEET"
188 GOSUB7025
189 CLS:GOTO100
190 CLS:PRINT@20,"STAR TRACK / SUN MENU"
195 PRINT@266,"1. Determine coordinates of SUN":PRINT@330,"2. De
determine distance and angular size":PRINT@394,"3. Determine sunri
se/sunset":PRINT@458,"4. Return to main menu"
200 PRINT@138,"Please press number of function";
210 QQ$=INKEY$:IFQQ$<"1"ORQQ$>"4"THEN210:ELSEIP=VAL(QQ$)
231 IFIP=4THENCLS:GOTO100
232 PRINT@138,"";:INPUT"Please enter the desired date (MMDDYY)";
D
233 GOSUB4000:IFNO=1THENGOTO232:ELSEID=IM
235 ONIPGOTO260,265,275
260 GOSUB2600:GOSUB3000:SS$="the SUN":GOSUB3500
261 GOSUB7025:CLS:GOTO190
265 GOSUB2600:GOSUB2620:GOSUB7010:CLS:PRINT@64,"On";D;" , the SUN
will have:";PRINT:PRINT"angular size of";IX;CHR$(130);IY;"'";IZ
"'':PRINT:PRINT"at a distance of";SR;"kilometers"
270 GOSUB7025:CLS:GOTO190
275 CLS:KH=0
276 GOSUB2630
278 TG=TR:GOSUB7020:TM=TG:GOSUB7010:I1=IX:I2=IY:I3=IZ:TG=TS:GOSU
B7020:TM=TG:GOSUB7010:I4=IX:I5=IY:I6=IZ
280 PRINT:PRINT"The SUN will rise at approximately";I1;".";I2;"a
m"
290 PRINT" and will set at approximately";I4;".";I5;"pm"
295 GOSUB7025:CLS:GOTO190
300 CLS:PRINT@20,"STAR TRACK / MOON MENU"
305 PRINT@266,"1. Determine coordinates of MOON":PRINT@330,"2. D
etermine distance, angular size, and phase":PRINT@394,"3. Determ
ine rise/set times":PRINT@458,"4. Return to main menu"
310 PRINT@138,"Please press number of function";
320 QQ$=INKEY$:IFQQ$<"1"ORQQ$>"4"THEN320:ELSEIP=VAL(QQ$)
321 IFIP=4THENCLS:GOTO100
322 PRINT@138,"";:INPUT"Please enter the desired date (MMDDYY)";
D
323 GOSUB4000:IFNO=1THENGOTO322:ELSEID=IM
324 IFIP=3THEN330:ELSEPRINT@176," "":PRINT@138,"";
:INPUT"Please enter the desired time (HHMM)";C
325 CH!=INT(C/100):CM=C-CH*100:CM=CM/60:CH=(CH+CM)/24:ID!=ID+CH
330 ONIPGOTO340,350,375
340 GOSUB2600:GOSUB2700:GOSUB3000:SS$="the MOON":GOSUB3500
345 GOSUB7025:CLS:GOTO300
350 GOSUB2600:GOSUB2700:D1=180-X6+VL:IFD1<0THEND1=D1+360:ELSEIFD
1>360THEND1=D1-360
355 F=(1+COS(D1*RA))/2:IFF>.99THENF=1.0
360 P=(1-.0549[2]/(1+.0549*COS((VM+VC)*RA))):TH=.5181/P:P=P*38440
1
361 P=INT(P):TM=TH:GOSUB7010
365 CLS:PRINT:PRINT:PRINT"The distance from earth is";P;"kilomet
ers"
367 PRINT"The angular diameter is";IX;CHR$(130);IY;"'";IZ"'':PR
INT"The phase is";F
370 GOSUB7025:CLS:GOTO300
375 CLS:PRINT:INPUT"Please enter your approximate latitude";TH:I
PTH<0ORTH>90THEN375

```

Listing continues

on the star chart. You should see a few dots north and east of Orion. If you locate Orion in the night sky, look east and north and you'll see a tiny smudge of light. If the night is dark, you might see what looks like a tiny Big Dipper. If you look through a pair of binoculars, you'll see one of the most beautiful sights in the sky, the Pleiades (play-uh-deez), or the Seven Sisters.

To explain precession and epoch, use the latitude and longitude examples again. Suppose there's an island located at 50° north latitude, 40° west

*“...you'll see
one of the most
beautiful sights
in the sky.”*

longitude. Unfortunately, it's a floating island, moving one degree west every year. In 1982, its coordinates might be 50° west, 40° north; in 1983, its coordinates would be 51° west, 40° north; in 1984, 52°W 40°N; and so on. The island has a steady precession; its location or coordinates are always changing.

If you look at a map of the island, you want to know the year the map is good for. So, on a 1982 map, Won't-Stay-Still Island is at 50°W 40°N. The epoch of the map is 1982, which is the year that the map's coordinates are correct.

Star coordinates aren't the same every year. The Earth's axis tilts; it wobbles in its rotation. The effect is small; the Earth completes one wobble every 25,800 years. Over the years, though, the precession (change) is enough to change star coordinates.

Star charts are written for particular epochs, currently either epoch 1950 or epoch 2000. Neither is exactly correct now, but the error is slight and doesn't affect amateur observing.

Star Track uses epoch 1975 for its coordinates as a compromise between 1950 star charts and 2000 star charts. Star Track can refigure coordinates to new epochs.

Using the Program

Load and run the program; three title pages appear. Each remains on the screen for several seconds. Star Track uses this slack time to load the variables that it needs.

After the title pages, Star Track displays the master menu.

Press 1 through 6 to select any op-

Listing continued

```

377 CH=0:GOSUB2600:GOSUB2700:GOSUB3000:DB=.05*COS((VL-VN)*RA):DA
=.55+.06*COS(VM*RA):XG=XI:XH=XU:XA=XA+(12*DA):XB=XB+(12*DB):GOSU
B3000
378 GOSUB3000
379 YB=XG:YA=XH:GOSUB2631:A1=TR:A2=TS:YB=XI:YA=XU:GOSUB2631:B1=T
R:B2=TS
380 TR=(12*A1)/(12+A1-B1):TS=(12*A2)/(12+A2-B2)
381 TG=TR:GOSUB7020:TM=TG:GOSUB7010:I1=IX:I2=IY:I3=IZ:TG=TS:GOSU
B7020:TM=TG:GOSUB7010:I4=IX:I5=IY:I6=IZ
383 PRINT:PRINT" The MOON will rise at approximately";I1;";";
I2;";";I3: PRINT" and will set at approximately";I4;
";";I5;";";I6:GOSUB7025:CLS:GOTO300
400 CLS:PRINT@20,"STAR TRACK / PRECESSION & RISE/SET"
405 PRINT@266,"1. Determine precession from 1950":PRINT@330,"2.
Determine precession from 1975":PRINT@394,"3. Determine precessi
on from 2000":PRINT@458,"4. Determine rise and set times":PRINT@
522,"5. Return to main menu"
410 PRINT@138,"Please press number of function";
420 QQS=INKEY$:IFQQS<"1"ORQQS>"5"THEN420:ELSEIP=VAL(QQS)
421 IFIP=5THENCLS:GOTO10
425 IFIP=4THENGOTO460
426 IFIP=1THENE1=1950:MS=3.07327:NS=1.33617:AS=20.0426:GOTO430
427 IFIP=2THENE1=1975:MS=3.07374:NS=1.33603:AS=20.0405:GOTO430
428 E1=2000:MS=3.07420:NS=1.33589:AS=20.0383:GOTO430
430 CLS:PRINT@138,"";:INPUT"Please enter desired epoch (ex. 1981
.8)";E:IFE<1950THEN430
432 CLS:PRINT@138,"";:INPUT"Please enter RIGHT ASCENSION (HHMMSS
)";A:II=INT(A/10000):IFII<0ORII>24THEN432
434 CLS:PRINT@138,"";:INPUT"Please enter DECLINATION (DDMMSS)";B
435 IX=INT(A/10000):IY=INT((A-IX*10000)/100):IZ=INT(A-IX*10000-I
Y*100):GOSUB7000:A1=TM
437 IX=INT(B/10000):IY=INT((B-IX*10000)/100):IZ=INT(B-IX*10000-I
Y*100):GOSUB7000:B1=TM
439 AD=A*15:SW=(MS+NS*SIN(AD*RA)*TAN(B1*RA))*(E-E1):SW=SW/3600:
TM=A1+SW:GOSUB7010:I1=IX:I2=IY:I3=IZ:S2=AS*COS(AD*RA)*(E-E1):S2=
S2/3600:TM=S2+B1:GOSUB7010:I4=IX:I5=IY:I6=IZ
441 PRINT@330,"The adjusted values for epoch";E;"are:"
443 PRINT@404,"RIGHT ASCENSION";I1;"h";I2;"m";I3;"s"
445 PRINT@468,"DECLINATION ";I4;CHRS(131);I5;"'";I6;"'"
447 GOSUB7025:CLS:GOTO400
460 PRINT@138,"";:INPUT"Please enter the desired date (MMDDYY)";
D:GOSUB4000:IFNO=1THENGOTO232:ELSEID=IM:CLS:PRINT@138,"";:INPUT
"Please enter your approximate latitude";TH:IFTH<0ORTH>90GOTO460
461 KH=0:CLS
462 PRINT@138,"";:INPUT"Please enter RIGHT ASCENSION (HHMMSS)";A
:II=INT(A/10000):IFII<0ORII>24THEN462
463 CLS
464 PRINT@138,"";:INPUT"Please enter DECLINATION (DDMMSS)";B
465 IX=INT(A/10000):IY=INT((A-IX*10000)/100):IZ=INT(A-IX*10000-I
Y*100):GOSUB7000:A1=TM
467 IX=INT(B/10000):IY=INT((B-IX*10000)/100):IZ=INT(B-IX*10000-I
Y*100):GOSUB7000:B1=TM
468 YB=B1:YA=A1:TW=(-TAN(TH*RA)*TAN(YB*RA)):IFABS(TW)>1THENGOTO4
69:ELSEGOSUB2631:GOTO470
469 PRINT@394," The object either does not rise above the horizon
,":PRINT@458," or it is circumpolar. It does not rise and se
t.":GOTO477
470 TG=TR:GOSUB7020:TM=TG:GOSUB7010:I1=IX+KH:I2=IY:I3=IZ:TG=TS:G
OSUB7020:TM=TG:GOSUB7010:I4=IX+KH:I5=IY:I6=IZ
473 PRINT@394," The object will rise at";I1;";";I2;";";I3
475 PRINT@458," and will set at";I4;";";I5;";";I6
477 GOSUB7025:CLS:GOTO400
500 CLS:PRINT@20,"STAR TRACK / TIME AND COORDINATES"
505 PRINT@266,"1. Convert mean time to sidereal time"
506 PRINT@330,"2. Convert sidereal time to mean time"
508 PRINT@394,"3. Return to main menu"
520 PRINT@138,"Please press number of function";
530 QQS=INKEY$:IFQQS<"1"ORQQS>"3"THEN530:ELSEIP=VAL(QQS)
532 IFIP=3THENCLS:GOTO10
550 PRINT@138,"";:INPUT"Enter the desired date <MMDDYY>";D:GOSU
B4000:IFNO=1THENGOTO550
551 YY=D-(INT(D/100)*100):IFY>0ANDYY<74THEN550
552 PRINT@168," ":PRINT@138,"";:INPUT"Enter t
he desired time <HHMMSS>";T
553 CH=INT(T/10000):CM=INT((T-(CH*10000))/100):CS=T-(CH*10000)-(
CM*100)
554 IFCH<0ORCH>24THEN552:ELSEIFCM<0ORCM>59ORCH<0THEN552:ELSEIFCM>59ORC
M<0THEN552
555 IX=CH:IY=CM:IZ=CS:GOSUB7000:IFY>00THENYY=25:ELSEYY=YY-75
556 ONIPGOTO560,557
557 UT=UA*KM-UB(YY):IFUT<0THENUT=UT+24
558 TM=TM-UT:IFTM<0THENTM=(TM+24)*UD:GOTO562:ELSETM=TM*UD:GOTO56
2

```

Listing continues

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Listing continued

```
560 UT=UA*KM-UB(YY):TM=TM*UC+UT:IFTM>24THENTM=TM-24:ELSEIFTM<0TH
ENTM=TM+24
562 GOSUB7010:IFIP=1THENGOTO564:ELSECLS:PRINT:PRINT"The mean tim
e is";IX;";";IY;";";IZ:GOSUB7025:CLS:GOTO500
564 CLS:PRINT:PRINT"The sidereal time is";IX;";";IY;";";IZ:GOSUB
7025:CLS:GOTO500
2200 OP=(360/365.25)*(ID/T1(IP)):OP=OP-(INT(OP/360)*360)
2205 X1=OP+(360/3.1415927)*T4(IP)*SIN((OP+T2(IP)-T3(IP))*RA)+T2(
IP)
2210 IPX1>360THENX1=X1-360:ELSEIFX1<0THENX1=X1+360
2215 VP=X1-T3(IP)
2220 XR=(T5(IP)*(1-T4(IP)[2])/(1+T4(IP)*COS((VP*RA)))
2225 X2=SIN((X1-T7(IP))*RA)*SIN(T6(IP)*RA)
2227 X2=ATN(X2/SQR(-X2*X2+1))
2230 X2=X2*57.29578
2235 X3=ATN(TAN((X1-T7(IP))*RA)*COS(T6(IP)*RA))*57.29578+T7(IP)
2236 GOSUB2350
2237 X4=XR*COS(X2*RA)
2240 RETURN
2300 PN=(360/365.25)*(ID/T1(2))
2305 PN=PN-(INT(PN/360)*360)
2310 PL=PN+(360/3.1415927)*T4(2)*SIN((PN+T2(2)-T3(2))*RA)+T2(2)
2315 IPPL>360THENPL=PL-360:ELSEIFPL<0THENPL=PL+360
2320 PV=PL-T3(2)
2325 PR=(1-T4(2)[2])/(1+T4(2)*COS(PV*RA))
2340 RETURN
2350 XZ=X1*.05
2360 FORJJ=-360TO360STEP180
2365 XQ=X3+JJ
2370 IFABS(XQ-X1)<XZTHENX3=XQ:RETURN
2375 NEXTJJ
2380 PRINT"ERROR":END
2400 XA=ATN((X4*SIN((PL-X3)*RA))/(PR-X4*COS((PL-X3)*RA)))
2410 XA=(XA*57.29578)+PL+180
2415 IFXA>360THENXA=XA-360:ELSEIFXA<0THENXA=XA+360
2420 XB=ATN((X4*TAN(X2*RA)*SIN((XA-X3)*RA))/(PR*SIN((X3-PL)*RA))
)
2425 XB=XB*57.29578
2430 RETURN
2500 XA=ATN((PR*SIN((X3-PL)*RA))/(X4-PR*COS((X3-PL)*RA)))
2505 XA=(XA*57.29578)+X3
2510 IFXA>360THENXA=XA-360:ELSEIFXA<0THENXA=XA+360
2515 XB=(ATN((X4*TAN(X2*RA)*SIN((XA-X3)*RA))/(PR*SIN((X3-PL)*RA)
)))
2520 XB=XB*57.29578
2530 RETURN
2600 SN=(360/365.25)*ID:SN=SN-(INT(SN/360)*360):SM=SN+279.041470
-282.510396:IFSM<0THENSMSM+360
2605 SE=(360/3.1415927)*.01672*SIN(SM*RA):XA=SN+SE+279.04147:IFX
A>360THENXA=XA-360
2610 XB=0:RETURN
2620 SV=SM+SE:SF=(1+(.01672*COS(SV*RA)))/(1-.01672[2]):SR=1495958
500/SF:S0=SF*.533128:TM=S0:SR=INT(SR):RETURN
2630 CLS:INPUT"Please enter your approximate latitude";TH:GOSUB2
600:GOSUB3000:IX=I1+KH:IY=I2:IZ=I3:GOSUB7000:YA=TM:IX=I4+KH:IY=I
5:IZ=I6:GOSUB7000:YB=TM
2631 TW=(-TAN(TH*RA)*TAN(YB*RA)):TW=-ATN(TW/SQR(-TW*TW+1))+1.570
8:TW=TW*57.29578/15
2632 TR=24+YA-TW:IFTR>24THENTR=TR-24
2633 TS=YA+TW:IFTS>24THENTTS=TS-24
2634 RETURN
2640 P2=PR[2+XR[2-(2*PR*XR*COS((X1-PL)*RA))]:AU=SQR(P2):AT=T8(IP)
/AU:WD=X1-X1:AF=(1+COS(WD*RA))/2:IFAF>.99THENAF=1.0
2642 PRINT@448,"The distance from earth is";AU; "AU ";PRINT@512
,"The angular diameter is";AT;"":PRINT@576,"The phase is";AF:R
ETURN
2700 VL=(360/27.3217)*ID!+124.8756:VL=VL-(INT(VL/360)*360):VM=VL
-(360/365.25)*(ID!/8.85)-145.9601:VM=VM-(INT(VM/360)*360):VN=248
.6441-(360/365.25)*(ID!/18.61):VN=VN-(INT(VN/360)*360)
2701 X6=XA
2705 VE=1.274*SIN((2*(VL-XA)-VM)*RA):VA=0.186*SIN(SM*RA):V3=0.37
*SIN(SM*RA):VM=VM+VE-VA-V3:VC=6.289*SIN(VM*RA):VL=VL+VE-VA-VC
2710 VV=.658*SIN(2*(VL-XA)*RA):VL=VL+VV:VN=VN-.16*SIN(SM*RA):XA=
ATN((TAN((VL-VN)*RA)*COS(5.1453*RA)))*57.29578:XA=XA+VN:X1=VL:X3
=XA:GOSUB2350:XA=X3
2715 XB=SIN((VL-VN)*RA)*SIN(5.1453*RA):XB=ATN(XB/SQR(-XB*XB+1))*
57.29578
2720 RETURN
3000 XB=XB*RA:XA=XA*RA
3005 XT=SIN(XB)*COS(RE)+COS(XB)*SIN(RE)*SIN(XA)
3010 XT=ATN(XT/SQR(-XT*XT+1))
3011 XT=XT*57.29578
3015 X9=(TAN(XA)*COS(RE))-((TAN(XB)*SIN(RE))/COS(XA))
3020 X9=ATN(X9)*57.29578:XA=XA/RA
```

Listing continues

tion. The menu for option 1 looks like this:

```
Star Track/Planet Tracker
Please select an option
1. Mercury
2. Venus
3. Earth
4. Mars
5. Jupiter
6. Saturn
7. Uranus
8. Neptune
9. Pluto
A. Return to main menu
```

Press 1 through 9, or A to return to menu. If you select a planet, you're asked to enter a date. Enter the date in MMDDYY format and press enter; you can use any date from 1950 to 2000.

Star Track then displays the RA and DEC of your planet. It asks you to press 1 to see the angular size, phase and distance from Earth in AU or to press the space bar to return to the last menu.

The menu for option 2 looks like this:

```
Star Track/Sun Menu
Please press number of function
1. Determine coordinates of sun
2. Determine distance and angular size
3. Determine sunrise/sunset
4. Return to main menu
```

If you select option 3 (sunrise and sunset) you are prompted for your approximate latitude. If you live north of the equator, enter a positive value; if you live south of the equator, enter a negative value.

The menu for option 3 looks like this:

```
Star Track/Moon Menu
Please press number of function
1. Determine coordinates of moon
2. Determine distance, angular size and phase
3. Determine rise/set times
4. Return to main menu
```

Since the moon has such a high apparent motion, you're prompted for the time as well as the date. Enter the time in an HHMM format using military time (i.e., 1800 = 6 p.m.).

For rise/set times, you're not asked to enter the time, but you must enter your approximate latitude.

The menu for option 4 is below:

```
Star Track/Precession and Rise/Set
Please press number of function
1. Determine precession from 1950
2. Determine precession from 1975
3. Determine precession from 2000
4. Determine rise and set times
5. Return to main menu
```


If you select 1, 2 or 3, Star Track prompts you for the epoch you wish to convert to. If you select function 1, you have a set of 1950 coordinates to convert to a new epoch.

This epoch is a four-digit year with an additional decimal digit denoting parts of a year for a total of five digits. For example, June 1979 is halfway through 1979. Six months is .5 of a year, so the proper epoch for June 1979 is 1979.5. October of 1986 is 10 months into 1986. 10 months is about $\frac{10}{12}$ of a year, so the epoch is 1986.8.

*“Star coordinates
aren’t the same
every year.”*

You can enter any epoch between 1975 and 2000. Once you enter the epoch you want to convert to, you’re asked for right ascension and declination. Enter RA in HHMMSS format and enter DEC in DDMSS format. Declinations north of the celestial equator are positive; those south of the equator are negative.

For example:

(RA = 12h 18m 03s) Please enter right ascension (HHMMSS)? 121803. (DEC = 16°S, 14’ 08”) Please enter declination (DDMMSS)? - 161408.

If you select function 4, you’re prompted for the date, your approximate latitude, and the RA and DEC of the desired object.

Option 5’s menu looks like this:

Star Track/Time

Please press number of function

1. Convert mean time to sidereal time
2. Convert sidereal time to mean time
3. Return to main menu

Functions 1 and 2 prompt you for the time and the date.

Hints

- All rise and set computations require your approximate latitude.
- Daylight-saving time is not used.
- When you respond to a request for a date, the program remembers that date. Pressing enter to the next prompt for a date results in the original date being used. This is handy when you want to determine several different functions for the same date, for example, positions of the planets, and rise/set of the sun and moon. ■

Listing continued

```

3021 IFXA<=90THENIQ=1:ELSEIFXA<=180THENIQ=2:ELSEIFXA<=270THENIQ=
3:ELSEIQ=4
3022 IFX9<0THENX9=X9+90:GOTO3022
3023 IFX9>360THENX9=X9-90:GOTO3023
3024 IFX9<=90THENJQ=1:ELSEIFX9<=180THENJQ=2:ELSEIFX9<=270THENJQ=
3:ELSEJQ=4
3025 X9=X9+((IQ-JQ)*90)
3029 X9=X9/15
3030 IFX9<0THENX9=X9+24
3031 XU=X9:XI=XT
3035 I1=INT(X9):X9=X9-I1
3040 I2=INT(X9*60):X9=(X9*60)-I2
3045 I3=INT(X9*60)
3050 I4=INT(XT):XT=XT-I4
3055 I5=INT(XT*60):XT=(XT*60)-I5
3060 I6=INT(XT*60)
3065 RETURN
3500 CLS
3510 PRINT@128," On";D;",";";SS;" will be at : "
3515 PRINT@256,"RIGHT ASCENSION = ";I1;"h";I2;"m";I3;"s"
3520 PRINT@320,"DECLINATION = ";I4;CHR$(130);I5;"'";I6;"'"
3540 RETURN
4000 IM=INT(D/10000)
4005 ID=INT((D-IM*10000)/100)
4010 IY=(D-(IM*10000)-(ID*100)):KY=IY
4011 IFIM<10RIM>12THENNO=1:RETURN:ELSEIFID<10RID>31THENNO=1:RETN
RN
4012 NO=0
4015 IL=INT(IY/4)*4
4020 IFIL=0THENLL=0:ELSEIFIL=IYTHENLL=1:ELSELL=0
4025 IFIM>2THEN4040
4030 IM=(IM-1)*(63-LL):IM=IM/2
4035 GOTO4050
4040 IM=INT((IM+1)*30.6)
4045 IM=IM-63-LL
4050 IM=IM+ID
4053 IFIY<75THENIY=IY+100
4054 KM=IM
4055 IY=IY-75:IFIY=0THENRETURN:ELSEIH=1
4057 KM=IM
4060 FORI=1TOIY
4065 IFI=IHTHENIM=IM+366:IH=IH+4:ELSEIM=IM+365
4070 IFIH=25ANDI=IHTHENIM=IM-1
4075 NEXTI
4085 RETURN
4100 DATA"MERCURY",.24085,320.66305,77.06645,.205629,.387099,7.0
0427,48.03493,6.74,1.918E-6
4105 DATA"VENUS",.61521,310.97453,131.21928,.006785,.723332,3.39
428,76.45475,16.92,1.721E-5
4110 DATA"EARTH",1.00004,99.53431,102.51044,.016720,1,0,0,0,0
4115 DATA"MARS",1.88089,249.62919,335.59881,.093382,1.523691,1.8
4983,49.36466,9.36,4.539E-6
4120 DATA"JUPITER",11.86224,355.21414,13.91992,.04846,5.202804,1
.3045,100.19608,196.74,1.994E-4
4125 DATA"SATURN",29.45771,104.17278,92.55833,.05563,9.538844,2.
48933,113.43842,165.6,1.74E-4
4130 DATA"URANUS",84.01247,205.78286,170.25472,.04725,19.181854,
.77316,73.87283,65.8,7.768E-5
4135 DATA"NEPTUNE",164.79558,249.91462,44.40592,.008586,30.05796
1.77236,131.50506,62.2,7.597E-5
4140 DATA"PLUTO",246.378,202.3345,224.2580,.246115,39.29976,17.1
4451,109.9965,8.20,4.073E-6
4150 DATA".397221,.413525,.363611,.379644,.395588,.411473,.361678
,.377595,.393506,.409421,.359625,.37554,.391454,.407368,.357573,
.373487,.389402,.405316,.355521,.371435,.387349,.403264,.353468,
.369383,.385297,.401211
7000 TM=((I2/60)+IY)/60+IX:RETURN
7010 IX=INT(TM):TM=TM-IX:IY=INT(TM*60):TM=(TM*60)-IY:IZ=INT(TM*6
0):RETURN
7020 W1=KM*UA-UB(KY-75):IFW1<0THENW1=W1+24
7022 TG=TG-W1:IFTG<0THENTG=(TG+24)*UD:ELSETG=TG*UD
7024 RETURN
7025 PRINT@900,"Press <SPACE BAR> to return to last menu"
7027 QQS=INKEY$:IFQQS<>CHR$(32)THEN7027:ELSERETURN
7050 PRINTCHR$(23)
7055 PRINT@278,"STAR TRACK"
7060 FORI=0TO2:READP$(I):READT1(I):READT2(I):READT3(I):READT4(I)
:READT5(I):READT6(I):READT7(I):READT8(I):READT9(I):NEXTI
7065 PRINT@398,"AN ASTRONOMY GUIDE"
7070 FORI=3TO8:READP$(I):READT1(I):READT2(I):READT3(I):READT4(I)
:READT5(I):READT6(I):READT7(I):READT8(I):READT9(I):NEXTI
7075 CLS:PRINT@281,"An aid for the":PRINT@407,"amateur astronome
r":PRINT@539,"written by":PRINT@667,"Joey Robichaux"
7080 FORI=0TO25:READUB(I):UB(I)=UB(I)+17:NEXTI
7085 RETURN

```

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Datascope

by Dennis Ridgway

Like an oscilloscope for software, Datascope reads data bit by bit, letting you recover data from glitched tapes or see data on tape.

Have you ever needed to retrieve a key piece of data from an unreadable tape, or wondered about the speed of your cassette recorder, wanted to know the format of some cassette file, or wished you could visually inspect the recorded image on a tape? This Level II 16K analyzer program addresses these problems.

This program is sort of a software oscilloscope for viewing pulses and gaps, those most fundamental particles of recorded data. Or it might be called a data microscope, allowing you to focus on recorded data at different levels of magnification, ranging from pulses and gaps, through bits and bytes, to Basic token words and two-byte pair values.

The Program

The program performs four distinct operations. The first, the load operation, reads data from a tape and stores it in an area of memory called the buffer. The next three operations work with the stored data. The analyzer operation observes the pulse and gap

patterns to determine the clock pulse alignment necessary for data bit interpretation. The search operation determines the bit alignment necessary for data byte interpretation. The translate operation changes data bytes into meaningful data forms.

The program is written in Basic and uses two Assembly-language subroutines. One subroutine is used in the load operation to read data from the cassette; the other is used by the search and translate operations for converting pulse and gap data into logical bits.

Load Operation

This operation loads data from any cassette tape into a 7000-byte buffer. It is not a read routine as no logical interpretation of the data is made, but is a transfer of pulse and gap sensings. The sensings, called peeps, are taken at precise time intervals. Each peep detects whether the read head of the recorder is positioned over a pulse or a gap and the result is stored in the buffer as a one bit or a zero bit, respectively.

The time interval between peeps is

operator selectable and can range from 58.5 microseconds to more than 1700 microseconds. Since both pulses and gaps usually last longer than 100 microseconds (at the 500-baud rate), multiple peeps are possible during the span of a single pulse or gap. For the interpreting operations to work properly, multiple peeps are desirable. Normally, intervals greater than 143 microseconds produce data that cannot be interpreted reliably by the other routines and intervals greater than 214 microseconds produce unintelligible data; whole pulses or gaps may be bridged between peeps.

Because the peeps are at precise time intervals, it is possible to make observations regarding your cassette player's running speed, acceleration time, and pulse width to gap width relationships for different volume settings. This information can be useful in diagnosing problems. The load operation does not perform an interpretive read like your familiar load commands; it can, therefore, be used to

The Key Box

Model I
16K RAM
Level II

load data from any tape and from any point on a tape. This makes it useful for identifying unlabeled tapes and files and for recovering partially over-written files.

Analyze Operation

This operation performs the initial steps of interpreting the raw data captured by the load operation. The operator is allowed to view the peeps in two different formats.

The first format, shown in Fig. 1, presents the peeps in a straight vertical line. Peeps are printed as # for pulses and — for gaps. A waveform and notations have been added to Fig. 1 to visualize pulse and gap patterns.

“You can view the peeps in two different formats.”

In the second format, shown in Fig. 2, the same peeps are being displayed. Here they have been separated into groups, with a group on each line representing one logical bit of information. Each print line starts with # peeps which it considers to be a clock pulse. These are followed by — peeps (a gap). Another series of # peeps indicates this is a one bit or a string of — peeps continue indicating this is a zero bit.

This vertical alignment of clock pulses is accomplished by the operator trying different bit widths during the analyze operation. The bit width is the average number of peeps from the start of one clock pulse to the start of the next. The routine starts at a clock pulse and skips across a number of peeps equivalent to .874 of the test bit width. At this time, the routine starts looking for the next pulse. When one is found it is considered to be the next clock pulse and a new line is started.

The T16 on the first line of Fig. 2 indicates the test bit width was 16. The whole number result of multiplying 16 by .874 is 13; the search for the next clock pulse was started after 13 peeps were printed.

Each line indicates the buffer address AD of the first peep on that line. Notice the print line with address AD2213:6 in Fig. 2. This shows that peep six of byte number 2213 was the location of the first peep on this line. (Buffer addresses run from 1-7000 and peep numbers run from 1-8.)

The T16 shows the test bit width and

```

AD 2213 :1 T O -
AD 2213 :2 T O -
AD 2213 :3 T O -
AD 2213 :4 T O -
AD 2213 :5 T O -
AD 2213 :6 T O #
AD 2213 :7 T O #
AD 2213 :8 T O #
AD 2214 :1 T O #
AD 2214 :2 T O -
AD 2214 :3 T O -
AD 2214 :4 T O -
AD 2214 :5 T O -
AD 2214 :6 T O #
AD 2214 :7 T O #
AD 2214 :8 T O #
AD 2215 :1 T O #
AD 2215 :2 T O -
AD 2215 :3 T O -
AD 2215 :4 T O -
AD 2215 :5 T O #
AD 2215 :6 T O #
AD 2215 :7 T O #
AD 2215 :8 T O #
AD 2216 :1 T O -
AD 2216 :2 T O -
AD 2216 :3 T O -
AD 2216 :4 T O -
AD 2216 :5 T O -
AD 2216 :6 T O -
AD 2216 :7 T O -
AD 2216 :8 T O -
AD 2217 :1 T O -
AD 2217 :2 T O -
AD 2217 :3 T O -
AD 2217 :4 T O -
AD 2217 :5 T O #
AD 2217 :6 T O #
AD 2217 :7 T O #
AD 2217 :8 T O #
AD 2218 :1 T O -
AD 2218 :2 T O -
AD 2218 :3 T O -
AD 2218 :4 T O -
AD 2218 :5 T O #
AD 2218 :6 T O #
AD 2218 :7 T O #
AD 2218 :8 T O #
AD 2219 :1 T O -
AD 2219 :2 T O -
AD 2219 :3 T O -
AD 2219 :4 T O #
AD 2219 :5 T O #
AD 2219 :6 T O #
AD 2219 :7 T O #
AD 2219 :8 T O -
AD 2220 :1 T O -
AD 2220 :2 T O -
AD 2220 :3 T O -
AD 2220 :4 T O -
AD 2220 :5 T O -

```

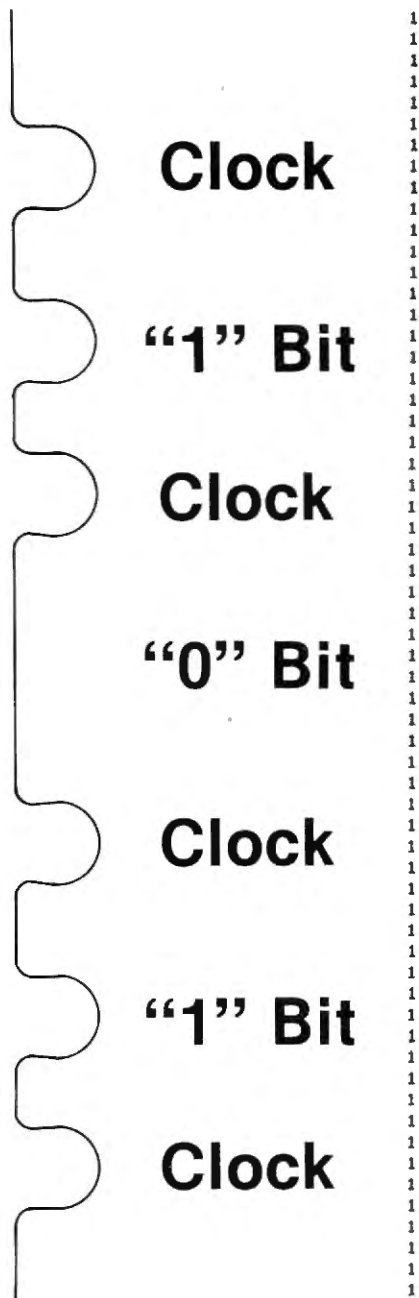


Figure 1

CATAMAN ™

Data Manager

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the 15 at the right shows the actual bit width of this bit line. The pulse/gap pattern of ##### shows this to be a one bit. You may notice this same pattern in Fig. 1, running vertically from line AD2213:6 to AD2215:4. This one bit happens to be the first one bit of the synchronization bit pattern of 10100101 at the begin-

ning of data on a tape file.

While the analyze operation was running, the right-arrow key (a delta in Fig. 2) and the left-arrow key (printed as a right bracket) increase or decrease the test bit width by one. Note line AD2270:8 of Fig. 2. The delta shows that a right arrow was invoked increasing the T value from 16 to 17. The right

AD 2203	18	T 16	####	-----	15
AD 2205	17	T 16	####	-----	16
AD 2207	7	T 16	####	-----	15
AD 2209	6	T 16	####	-----	16
AD 2211	6	T 16	####	-----	16
AD 2213	6	T 16	####	####	15
AD 2215	5	T 16	####	-----	16
AD 2217	5	T 16	####	####	15
AD 2219	4	T 16	####	-----	16
AD 2221	4	T 16	####	-----	15
AD 2223	3	T 16	####	####	16
AD 2225	3	T 16	####	-----	15
AD 2227	2	T 16	####	####	25
AD 2230	3	T 16	####	####	15
AD 2232	2	T 16	####	####	15
AD 2234	1	T 16	#####	-----	16
AD 2236	1	T 16	####	####	15
AD 2237	8	T 16	#####	-----	16
AD 2239	8	T 16	####	-----	15
AD 2241	7	T 16	####	####	16
AD 2243	7	T 16	####	#####	16
AD 2245	7	T 16	####	#####	15
AD 2247	6	T 16	####	####	15
AD 2249	5	T 16	#####	-----	16
AD 2251	5	T 16	####	####	15
AD 2253	4	T 16	####	-----	16
AD 2255	4	T 16	####	-----	15
AD 2257	3	T 16	####	####	16
AD 2259	3	T 16	####	#####	16
AD 2261	3	T 16	####	####	15
AD 2263	2	T 16	####	####	15
AD 2265	1	T 16	####	-----	16
AD 2267	1	T 16	####	####	15
AD 2268	8	T 16	####	-----	16
AD 2270	8	T 17	####	-----	15
AD 2272	7	T 17	####	####	16
AD 2274	7	T 17	####	#####	16
AD 2276	7	T 17	####	-----	15
AD 2278	6	T 16	####	####	16
AD 2280	6	T 16	####	-----	15
AD 2282	5	T 16	####	-----	16
AD 2284	5	T 16	####	-----	15
AD 2386	4	T 16	*	####	26
AD 2389	6	T 16	####	####	15
AD 2391	5	T 16	####	####	15
AD 2393	4	T 16	#####	-----	16
AD 2295	4	T 16	*	####	22
AD 2298	2	T 16	####	####	15
AD 2300	1	T 16	####	####	16
AD 2302	1	T 16	####	#####	15
AD 2303	8	T 16	####	-----	16
AD 2305	8	T 16	####	-----	16
AD 2307	8	T 16	####	-----	15
AD 2309	7	T 16	####	####	16
AD 2311	7	T 16	####	-----	15
AD 2313	6	T 16	####	-----	16

Figure 2

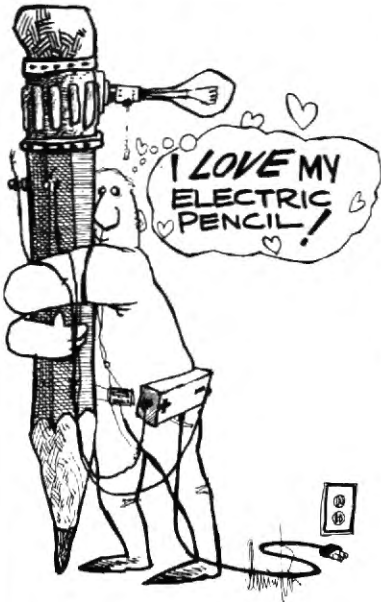
Figure 3

```

KEY 165
SEARCH ^STARTED AT BYTE- 2209 PEEP#- 6 WIDTH- 16
0010 1001 0111 0100 1111 0100 1111 0100 1101 0000 0100 0111
 29H      74H      F4H      F4H      DOH      47H
   41      116     244     244      208      71
)          t          STR6     STR6     /          G
          29737     -2956     -2828     -12044     18384
*****
KEY 165
    
```

Figure 3 continues

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D 32K I & III	20.95	16.00	SHOWDOWN			METEOR MISSION		
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Figure 3 continued

```

SEARCH ^STARTED AT BYTE- 2211 PEEP#- 6 WIDTH- 16
0101 0010 1110 1001 1110 1001 1110 1001 1010 0000 1000 1110
 52H      E9H      E9H      E9H      A0H      8EH
 82      233      233      233      160      142
 R      EOF      EOF      EOF      OUT      RUN
      -5806      -5655      -5655      -24343      -29024
*****
KEY 165
SEARCH JSTARTED AT BYTE- 2209 PEEP#- 6 WIDTH- 16
0010 1001 0111 0100 1111 0100 1111 0100 1101 0000 0100 0111
 29H      74H      F4H      F4H      DOH      47H
 41      116      244      244      208      71
 )      t      STR#      STR#      /      G
      29737      -2956      -2828      -12044      18384
*****
KEY 165
SEARCH JSTARTED AT BYTE- 2207 PEEP#- 7 WIDTH- 16
0001 0100 1011 1010 0111 1010 0111 1010 0110 1000 0010 0011
 14H      BAH      7AH      7AH      68H      23H
 20      186      122      122      104      35
      CSAVE      z      z      h      #
      -17900      31418      31354      26746      9064
*****
KEY 165
SEARCH ^STARTED AT BYTE- 2209 PEEP#- 6 WIDTH- 16
0010 1001 0111 0100 1111 0100 1111 0100 1101 0000 0100 0111
 29H      74H      F4H      F4H      DOH      47H
 41      116      244      244      208      71
 )      t      STR#      STR#      /      G
      29737      -2956      -2828      -12044      18384
*****
KEY 165
SEARCH ^STARTED AT BYTE- 2211 PEEP#- 6 WIDTH- 16
0101 0010 1110 1001 1110 1001 1110 1001 1010 0000 1000 1110
 52H      E9H      E9H      E9H      A0H      8EH
 82      233      233      233      160      142
 R      EOF      EOF      EOF      OUT      RUN
      -5806      -5655      -5655      -24343      -29024
*****
KEY 165
SEARCH ^STARTED AT BYTE- 2213 PEEP#- 6 WIDTH- 16
1010 0101 1101 0011 1101 0011 1101 0011 0100 0001 0001 1100
 A5H      D3H      D3H      D3H      41H      1CH
 165      211      211      211      65      28
 PUT      OR      OR      OR      A
      -11355      -11309      -11309      16851      7233
*****
MATCH

```

```

KEY 80      69      69      80      69      82
SEARCH ^STARTED AT BYTE- 575 PEEP#- 2 WIDTH- 16
1010 1010 0000 1000 1010 1000 1010 1010 0000 1000 1010 1010
 AAH      0BH      ABH      AAH      0BH      AAH
 170      8      168      170      8      170
 KILL      MERGE      KILL      KILL      KILL
      2218      -22520      -21848      2218      -22008
*****
KEY 80      69      69      80      69      82
SEARCH ^STARTED AT BYTE- 576 PEEP#- 7 WIDTH- 16
0101 0100 0001 0001 0101 0001 0101 0100 0001 0001 0101 0100
 54H      11H      51H      54H      11H      54H
 84      17      81      84      17      84
 T      Q      T      T      T
      4436      20753      21585      4436      21521
*****
KEY 80      69      69      80      69      82
SEARCH ^STARTED AT BYTE- 579 PEEP#- 2 WIDTH- 16
1010 1000 0010 0010 1010 0010 1010 1000 0010 0010 1010 1001
 ABH      22H      A2H      ABH      22H      A9H
 168      34      162      168      34      169
 MERGE      "      OPEN      MERGE      "      NAME
      8872      -24030      -22366      8872      -22238
*****
KEY 80      69      69      80      69      82
SEARCH ^STARTED AT BYTE- 581 PEEP#- 2 WIDTH- 16
0101 0000 0100 0101 0100 0101 0101 0000 0100 0101 0101 0010
 50H      45H      45H      50H      45H      52H
 80      69      69      80      69      82
 P      E      E      P      E      R
      17744      17733      20549      17744      21061
*****
MATCH

```

Figure 4

bracket on line AD2278:6 indicates the left arrow was invoked to decrement the T value back to 16.

The down and up-arrow keys increase and decrease the buffer byte address by 100. Line AD2386:4 shows the down-arrow key (printed as backward slash) was used to increase the byte address by 100. Line AD2295:4 indicates the up-arrow key (left bracket) was invoked. Any time the up or down arrow is used, the clock pulse may be thrown out of proper alignment for a few lines. (The arrows display properly on the CRT and may print properly on your printer.)

Any other keys cause the analysis to stop, at which time you can go back to the main menu to select another operation or continue the analysis.

Search Operation

The bit width determined in the analyze operation allows the raw data to be further interpreted by this search operation. This operation scans across the bits to determine byte alignment. A frame 48 bits wide is passed over the data. The 48 bits in the current frame position are treated as six bytes and are converted into hexadecimal, decimal, character, and Basic token word forms; pairs of bytes are converted into 16-bit binary values.

The frame is then shifted one logical bit to the right (or left) and the 48 bits found in the frame are converted. This is repeated until stopped by the operator or the data is exhausted. The left and right-arrow keys change the direction of the shift. Normally, when recognizable bytes are found the operator would stop the operation, note the byte alignment address, and proceed to the translate operation. When a left-shifting search is used, bits followed by exceptionally long gaps will not be interpreted correctly. Usually two bits will be wrong before alignment is restored.

A search key, one to six bytes long, can be entered for automatically stopping the search when a match is found. Figure 3 is an example of a one-byte search key, with decimal value 165, used to stop the search when the synchronization byte was found. Notice the address of 2213:6 near the bottom. This is the same data we were observing on Figs. 1 and 2. Figure 4 is an example of a six-byte search key of 80, 69, 69, 80, 69, and 82, which was used to find the name Peeper on the Assembler-language program tape. All search keys are entered in decimal form.

If this utility program is used to

identify an unlabeled file, the search operation might be as far as you need to go. However, if you are trying to recover some otherwise unreadable data, want to convert a short Assembly routine into decimal for string packing, or want to study the format of some file, note the byte and bit address where alignment occurred and proceed to the translate operation.

Translate Operation

The output of the translate operation (Figs. 5 and 6) is the same format as the output of the search operation. Again, a frame 48 bits wide is passed over the data. In the translate mode, after 48 bits are translated, the frame is shifted to the next 48 bits to the right. The translate operation runs until stopped by the operator or the data is exhausted.

Search and Translate Output Format

The output of both the search and translate operations consists of six lines of information for each 48 bits interpreted. Line 1 names the operation (search or translate); shows the direction of the frame shift, if in the search mode (again, right arrows appear as deltas and left arrows as right brackets); shows the byte and peep address of where this line group started; and finally, shows what bit width was being used.

Line 2 shows the 48 bits as zeros and ones. Line 3 contains the hexadecimal values; line 4 shows the decimal values; and line 5 contains the characters or Basic token words. Line 6 has the 16-bit binary values derived by treating the paired bytes in the sequence of least significant byte followed by most significant byte. When operating in the translate mode, the first byte of each line group is paired with the last byte of the preceding line group.

Figure 5 (as well as Fig. 4) was prepared using a cassette that contained a copy of the Assembly object program in Listing 2. The first line group divulges the program name of Peeper. The second line group divulges the hexadecimal 3C program section identifier, the decimal 128 (the number of bytes in the program section), the 16-bit binary value of "32512" (the ORG memory address for the program), and finally the hex 1158 (the first two bytes of the program code). The remaining lines on this figure show a continuation of the hexadecimal object code. The decimal values right below each hexadecimal value could

be used for string packing in a Basic program.

Figure 6 (also Figs. 1, 2, and 3) was prepared using a cassette containing a copy of the Basic Program Listing 1. The fifth line of the first line group on Fig. 6 shows "5 = VARPTR(E5"

from line 50 of the program. The remainder of line 50 can be read in line groups 2 and 3 of Fig. 6. In line group 3 following the (E6) we see the decimal value zero, which is the indicator for the end of a program line. Line group 4 starts with the 16-bit binary program

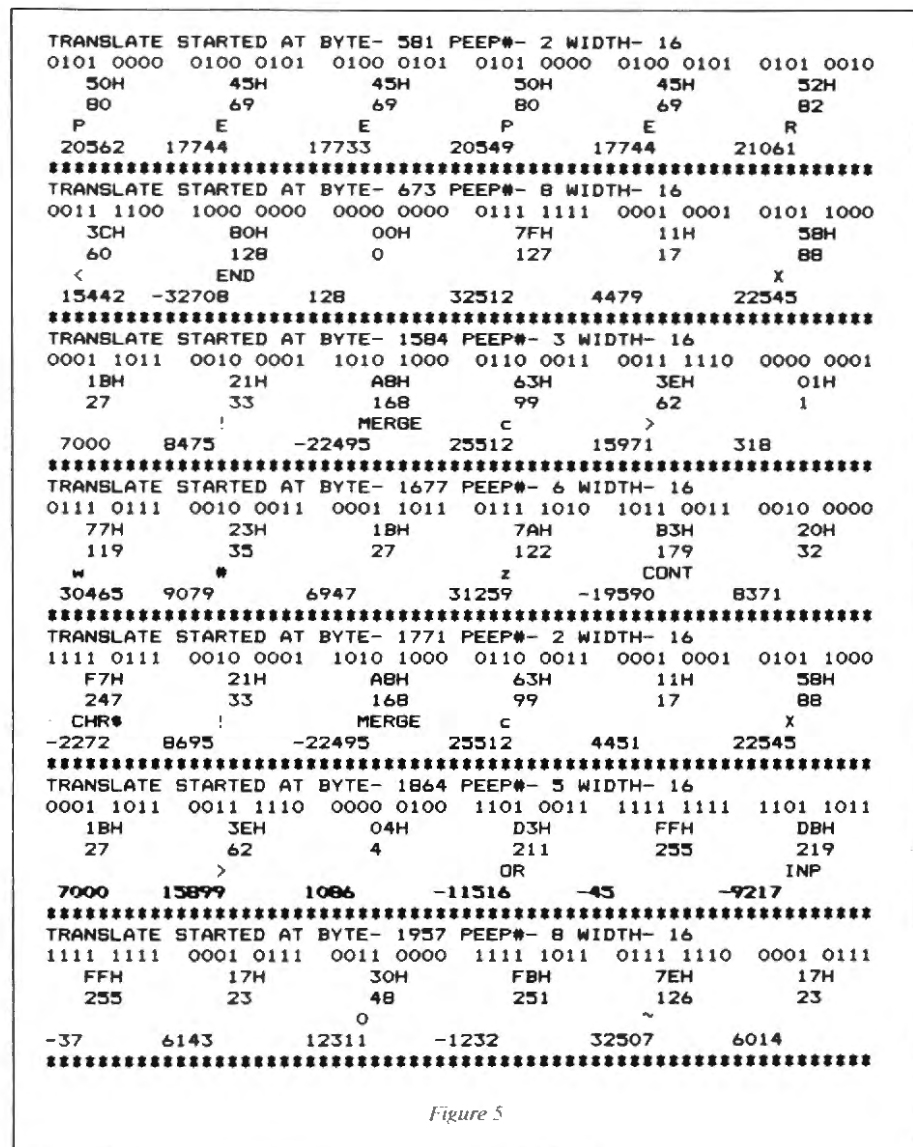


Figure 5

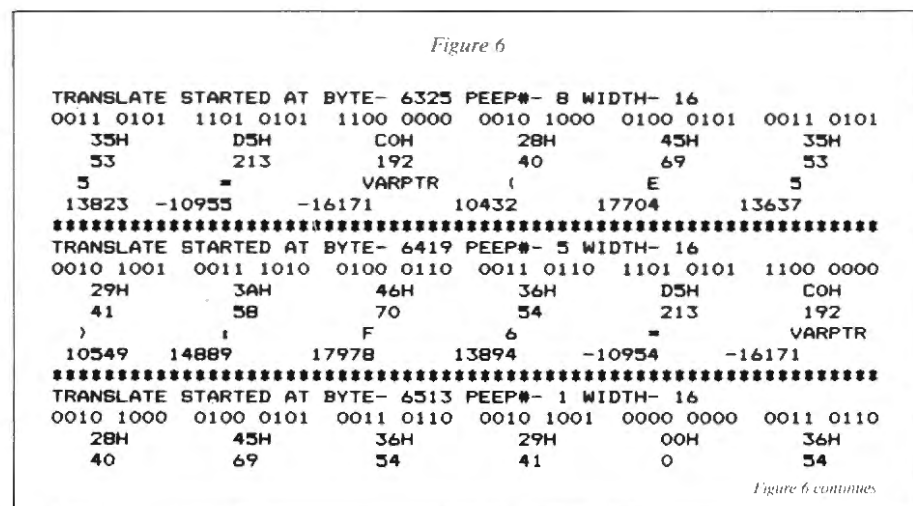


Figure 6

Figure 6 continues

```

(      E      6      )      6
10432 17704 13893 10550 41 13824
*****
TRANSLATE STARTED AT BYTE- 6606 PEEP#- 5 WIDTH- 16
0100 0100 0101 0000 0000 0000 0101 0100 0011 0010 1101 0101
 44H   50H   00H   54H   32H   D5H
 68    80    0    84    50    213
  D      F      T      2      =
17462 20548 80 21504 12884 -10958
*****
TRANSLATE STARTED AT BYTE- 6699 PEEP#- 8 WIDTH- 16
0011 0100 0011 0000 0011 1010 0101 0111 0100 1100 0010 0100
 34H   30H   3AH   57H   4CH   24H
 52    48    58    87    76    36
  4      0      1      W      L      6
13525 12340 14896 22330 19543 9292
*****
TRANSLATE STARTED AT BYTE- 6793 PEEP#- 3 WIDTH- 16
1101 0101 0010 0010 0011 0001 0011 0010 0011 0011 0011 0100
 D5H   22H   31H   32H   33H   34H
 213   34   49   50   51   52
 =     "     "     1     2     3     4
-10972 8917 12578 12849 13106 13363
*****
TRANSLATE STARTED AT BYTE- 6886 PEEP#- 7 WIDTH- 16
0011 0101 0011 0110 0011 0111 0011 1000 0011 1001 0011 0000
 35H   36H   37H   38H   39H   30H
 53    54    55    56    57    48
  5      6      7      8      9      0
13620 13877 14134 14391 14648 12345
*****
TRANSLATE STARTED AT BYTE- 6980 PEEP#- 2 WIDTH- 16
0011 0001 0011 1101 1111 1111 1111 1111 1011 1111 1111 1111
 31H   3DH   FFH   FFH   BFH   FFH
 49    61   255  255  191  255
  1      =      USING
12592 15665 -195 -1 -16385 -65
*****
END OF DATA

```

line address of 17462 followed by the 16-bit binary program line number of 80 and continues with the program code of T2 = . The program code then continues in line group 5.

The operating instructions are shown on Table 1. Be sure to position the cassette tape as close as possible in front of the portion of the tape to be loaded. Only a small portion of a tape can be loaded into the buffer with each load.

For example, these tables were prepared using a default time factor of 10, which yields a clock pulse to clock pulse width of about 16 peeps. These 16 peeps represent one logical bit of information, but require two bytes of the buffer for storage. Since there are eight logical bits to a logical byte, 16 storage bytes are used for one logical byte of information. In this manner, the 7,000-byte buffer only holds about 437 logical bytes of information. By increasing the time factor during the load, a moderately higher yield can be obtained, but a time factor beyond 14 distorts the data.

The program modules are described in Table 2.

Datascope is certainly not a simple

Program Listing 1

```

10 CLEAR360:DEFINTA-Z:M1$="STARTED AT BYTE-":M$="MICROSEC"
30 PMS=STRING$(10,"*");PM=VARPTR(PMS):PM=PEEK(PM+2)*256+PEEK(PM+
35 CF=0:PE=0:BI=0:B=0:DIMDC(6):DIMDD(6):DIMDP(6)
40 V1=VARPTR(CF):V2=VARPTR(PE):V3=VARPTR(BI):V4=VARPTR(B)
50 E1=0:E2=0:E3=0:E4=0:E5=0:E6=0:F1=VARPTR(E1):F2=VARPTR(E2):F3=
VARPTR(E3):F4=VARPTR(E4):F5=VARPTR(E5):F6=VARPTR(E6)
80 T2=40:WLS=STRING$(40,"*"):BPS=STRING$(48,"*")
83 VP=VARPTR(WLS):VP=PEEK(VP+2)*256+PEEK(VP+1)-1
84 BV=VARPTR(BPS):BP=PEEK(BV+2)*256+PEEK(BV+1)
90 B2=6999:BS=25511:YS=35:NO=95:ENS="END OF DATA":AR1=32:F=5712
95 OP$="OUTPUT 1-CRT ONLY 2-CRT & PTR"
100 FAS="FACTOR":HS="H" :QS="HIT M-MENU C-CONT"
110 DATA128,64,32,16,8,4,2,1:DIMV5(8):FORX=1TO8:READV5(X):NEXT
135 HX$=STRING$(12,"*"):HX=VARPTR(HX$):HX=PEEK(HX+2)*256+PEEK(HX
+1)
140 DATA0,3,6,11,14,17,20,26,30,34,39,42,46,49,53,56
145 DATA58,65,70,76,79,83,87,91,96,102,108,114,120,124,128,133
150 DATA139,142,144,148,153,156,159,164,168,173,177,181,185,189,
193,199
155 DATA205,208,212,217,221,225,230,236,240,245,250,255,258,262,
264,266
160 DATA271,277,280,283,286,293,298,303,308,311,317,321,324,328,
329,330
165 DATA331,332,333,336,338,339,340,341,344,347,350,353,356,359,
362,365
170 DATA368,371,374,377,380,383,387,390,393,396,399,402,405,409,
413,417
175 DATA421,425,429,432,435,439,442,445,449,454,460,464,468
180 DIMTK(125):FORX=0TO124:READTK(X):NEXT
900 INPUT"ENTER 1-LOAD 2-ANALYZE 3-SEARCH 4-TRANSLATE":M
910 ONMCGOTO1000,2000,3000,3001
920 GOTO900
1000 X=PEEK(32557):PRINT"TIME ";FAS;" =":X
1020 PRINTFAS;X;"* 6.5";M$;"* 52.0";M$;" =":X*6.5+52.0:M$
1030 INPUT"ENTER G-GOOD OR N-NO":I$:IF I$="G":1090
1050 INPUT"NEW FACTOR 1-255":X
1070 IFX<LORX>255THEN105ELSEPOKE32557,X:GOTO1000
1090 INPUT"READY CASSETTE":I$
1100 PRINT"NOW LOADING":POKE16526,0:POKE16527,127:X=USR(0)
1120 PRINT"LOADING COMPLETE":GOTO900
2000 PRINT"ANALYZE ROUTINE"
2010 PRINTOP$:INPUT"IFP<LORP>2GOTO2010
2020 PRINT"START ADDR 1 TO":B2:INPUTB:IFB<LORB>B2GOTO2020
2040 INPUT"TEST BIT WIDTH 0-NO TEST/ONE PEEP PER LINE
2TO 40 - TEST BIT WIDTH":T
2050 IFP<LORP>40THEN2040ELSECLS:LA=T2
2060 PRINT"CTL KEYS ";CHR$(92);"-AD+100 ";CHR$(91);"-AD-100
";CHR$(94);"-T+1 ";CHR$(93);"-T-1 S=STOP"
2070 PRINT"LOOKING FOR FIRST PULSE"
2080 Y=B+BS:Z=B+BS
2085 FORX=YTOZ:IFPEEK(X)<>0GOTO2095
2090 NEXT:GOTO2900
2095 B=X-BS
2100 T8=INT(.874*T)
2110 BI=1:IFB>B2GOTO2900
2200 IF(PEEK(B+BS)ANDV5(BI))=0THENC=NOELSEC=YS
2210 IFP=0THEN2300ELSEIFC=YSGOTO2300
2230 BI=BI+1:IFBI<9THEN2200ELSEB=B+1:GOTO2110
2300 FORX=1TOLA:POKEVP+X,32:NEXT
2320 LA=1:PRINT"AD";B;TAB(8);":";CHR$(BI+48);" ";CHR$(AR1);" T";T
;
2330 IFP=2THENLPRINT"AD";B;TAB(8);":";CHR$(BI+48);" ";CHR$(AR1);"
T";T;
2340 AR1=32
2400 POKEVP+LA,C:BI=BI+1:IFBI<9GOTO2400
2450 BI=1:B=B+1:IFB>B2GOTO2500
2480 IF(PEEK(B+BS)ANDV5(BI))=0THENC=NOELSEC=YS
2490 IFP=0GOTO2500
2492 IFLA>8THENIFC=YSGOTO2500
2494 IFLA=T2THEN2500ELSELA=LA+1:GOTO2400
2500 PRINTTAB(18)WLS;LA:IFP=2THENLPRINTTAB(18)WLS;LA
2530 IFB>B2GOTO2900
2600 IS=INKEY$:IFIS=""THEN2300ELSEX=ASC(I$)
2635 IPX=9THEN2660ELSEIPX=0THEN2640ELSE2700
2640 T=T-1:IFP<0THEN2660ELSEAR1=93:GOTO2080
2660 T=T+1:IFP>0THEN2640ELSEAR1=94:GOTO2080
2700 IFX=10THEN2740ELSEIFX=91THEN2720ELSE2745
2720 B=B-100:IFB<1THEN2740ELSEAR1=91:GOTO2300
2740 B=B+100:IFB>B2THEN2720ELSEAR1=92:GOTO2300
2745 PRINTQ$
2750 IS=INKEY$:IFIS=""GOTO2750
2760 IFIS="M"THEN900ELSE2300
2900 PRINT"END OF ANALYSIS":IFP=2THENLPRINT"END OF ANALYSIS"
2920 GOTO900
3000 PRINT"SEARCH ROUTINE":AR1=94:GOTO3005
3001 PRINT"TRANSLATE ROUTINE"
3005 PRINTOP$:INPUT"IFP<LORP>2GOTO3005
3020 INPUT# OF PEEPS BETWEEN CLOCK PULSES 4-40":LC
3030 IPLC<4ORLC>40GOTO3020
3040 INPUT"STARTING BYTE 1-6999":BA:IFBA<LORBA>6999THEN3040ELSE
BA=BA-1
3053 INPUT"STARTING PEEP 1-8":BB:IFBB<LORBB>8GOTO3053
3060 IFM=3THEN3070ELSECLS:GOTO3000
3070 INPUT"# BYTES IN SEARCH KEY 0-6 (0=NO KEY)":NB
3080 IFNB<ORNB>6GOTO3070
3090 IFNB=0GOTO3190
3110 PRINT"ENTER DEC VAL 0-255 FOR":NB;"BYTES"
3120 FORX=1TONB
3130 PRINT"BYTE":X:INPUTY
3140 IFX<ORY>255THEN130ELSESDP(X)=Y
3150 NEXT
3190 CLS:PRINT"CTL KEYS ";CHR$(93);"-LEFT SHIFT ";CHR$(94);
"-RIGHT SHIFT"
3200 IFNB=0GOTO3600
3210 PRINT"KEY":;FORX=1TONB:PRINTDP(X);" ";
;NEXT:PRINT
3220 IFP=2THENLPRINT"KEY":;FORX=1TONB:LPRINTDP(X);" ";
;NEXT
:LPRINT
3600 B=BA:BI=BB:GOSUB5000

```

```

3620 IFM=4ORNB=@GOTO4570
3640 FORX=1TONB:IFDP(X)>DC(X-1)GOTO4570
3670 NEXT:IFP=2LPRINT"MATCH"
3680 INPUT"MATCH FOUND HIT C-CONT SEARCH M-MENU";IS
3690 IFIS="M"GOTO900
4570 IFB>B2GOTO4810
4580 IS=INKEYS:IFIS=""THEN4610
4582 IFM=4THEN458ELSEX=ASC(IS)
4584 IFX=9THENAR1=94:GOTO4610
4586 IFX=8THENAR1=93:GOTO4610
4588 PRINTQS
4590 IS=INKEYS:IFIS=""THEN4590
4600 IFIS="M"THEN900
4610 IFM=4THENBA=B:BB=BI:GOTO3600
4620 Y=INT(LC*.874):IFAR1=93GOTO4700
4630 FORX=1TOY:BB=BB+1:IFBB=9THENBB=1:BA=BA+1
4660 NEXT
4670 IFBA>B2GOTO4810
4680 IF(PEEK(BA+1+BS)ANDV5(BB))=V5(BB)GOTO3200
4690 BB=BB+1:IFBB<9THEN4680ELSEBB=1:BA=BA+1:GOTO4670
4700 FORX=1TOY:BB=BB+1:IFBB=9THENBB=1:BA=BA+1
4710 NEXT
4720 IFBA<1GOTO4810
4730 IF(PEEK(BA+1+BS)ANDV5(BB))=V5(BB)GOTO4750
4740 BB=BB+1:IFBB>9THEN4730ELSEBB=8:BA=BA-1:GOTO4720
4750 BB=BB-1:IFBB>9THEN4770ELSEBB=8:BA=BA-1:IFBA<1GOTO4810
4770 IF(PEEK(BA+1+BS)ANDV5(BB))=V5(BB)THEN4750
4780 BB=BB+1:IFBB<9THEN3200ELSEBB=1:BA=BA+1:GOTO3200
4810 PRINTNS:IFP=2LPRINTNS
4820 GOTO900
5000 CF=INT(LC*.499):PE=INT(LC*.374)
5010 FORX=0TO47:POKEBP+X,48:NEXT
5020 IFM=3THENPRINT"SEARCH";CHR$(AR1);ELSEPRINT"TRANSLATE";
5030 PRINTM1S;B+1;"PEEP#";BI;"WIDTH";LC
5040 IFP=1THEN5050ELSEIFM=3THENPRINT"SEARCH";CHR$(AR1);ELSELPR
INT"TRANSLATE";
5045 LPRINTM1S;B+1;"PEEP#";BI;"WIDTH";LC
5050 POKEPM,PEEK(BV+1):POKEPM+1,PEEK(BV+2)
5060 POKEPM+2,PEEK(V1):POKEPM+3,PEEK(V1+1)
5070 POKEPM+4,PEEK(V2):POKEPM+5,PEEK(V2+1)
5080 POKEPM+6,PEEK(V3):POKEPM+7,PEEK(V3+1)
5090 POKEPM+8,PEEK(V4):POKEPM+9,PEEK(V4+1)
5100 POKE16526,64:POKE16527,127:X=USR(PM)
5110 POKEV3,PEEK(PM+6):POKEV3+1,PEEK(PM+7)
5120 POKEV4,PEEK(PM+8):POKEV4+1,PEEK(PM+9)
6000 PLS=MIDS(BPS,1,4)+" "+MIDS(BPS,5,4)+" "+MIDS(BPS,9,4)+" "+
MIDS(BPS,13,4)+" "+MIDS(BPS,17,4)+" "+MIDS(BPS,21,4)+" "+MIDS(
BPS,25,4)+" "+MIDS(BPS,29,4)+" "+MIDS(BPS,33,4)+" "+MIDS(BPS,37
,4)+" "+MIDS(BPS,41,4)+" "+MID$(BPS,45,4)
6010 PRINTPLS;
6020 IFP=2LPRINTPLS

```

```

6100 FORX=0TOLL:Z=0
6110 FORY=1TO4
6120 IFMIDS(BPS,X*4+Y,1)="1"THENZ=Z+V5(Y+4)
6130 NEXT:IFZ<10THENZ=Z+48ELSEZ=Z+55
6140 POKEHX+X,Z
6150 NEXT
6200 PLS="" "+MIDS(HXS,1,2)+H$+MIDS(HXS,3,2)+H$+MIDS(HXS,5,2)+H
$+MIDS(HXS,7,2)+H$+MIDS(HXS,9,2)+H$+MIDS(HXS,11,2)+H
6220 PRINTPLS;:IFP=2LPRINTPL$
6300 FORX=0TO5:A=ASC(MIDS(HXS,X*2+1,1)):IFA<58THENA=A-48ELSEA=A-
55
6310 Z=ASC(MIDS(HXS,X*2+1,1)):IFZ<58THENZ=Z-48ELSEZ=Z-55
6320 DC(X)=Z*16+A:NEXT
6400 PRINT"" ";DC(0);TAB(13)DC(1);TAB(24)DC(2);TAB(35)DC(3);TAB(
46)DC(4);TAB(57)DC(5)
6410 IFP=2THENLPRINT"" ";DC(0);TAB(13)DC(1);TAB(24)DC(2);TAB(35)
DC(3);TAB(46)DC(4);TAB(57)DC(5)
6600 FORX=0TO5:IFDC(X)<32ORDC(X)>250THENST$="" ":GOTO6729
6610 IFDC(X)<128THENST$=CHR$(DC(X))+" ":GOTO6729
6620 I1$="" ":I2$="" ":I3$="" ":I4$="" ":I5$="" ":I6$="" ":I7$=""
6630 Y=DC(X)-128:Z=TK(X):I1$=CHR$(PEEK(F+Z)-128)
6640 J=TK(Y+1)-Z-1:IFJ=@GOTO6720
6660 I2$=CHR$(PEEK(F+Z+1)):J=J-1:IFJ=@GOTO6720
6670 I3$=CHR$(PEEK(F+Z+2)):J=J-1:IFJ=@GOTO6720
6680 I4$=CHR$(PEEK(F+Z+3)):J=J-1:IFJ=@GOTO6720
6690 I5$=CHR$(PEEK(F+Z+4)):J=J-1:IFJ=@GOTO6720
6700 I6$=CHR$(PEEK(F+Z+5)):J=J-1:IFJ=@GOTO6720
6710 I7$=CHR$(PEEK(F+Z+6))
6720 ST$=I1$+I2$+I3$+I4$+I5$+I6$+I7$
6729 ONXGOTO6731,6732,6733,6734,6735
6730 S1$=ST$:GOTO6740
6731 S2$=ST$:GOTO6740
6732 S3$=ST$:GOTO6740
6733 S4$=ST$:GOTO6740
6734 S5$=ST$:GOTO6740
6735 S6$=ST$
6740 NEXT
6750 PLS$="" "+S1$+" "+S2$+" "+S3$+" "+S4$+" "+S5$+"
"+S6$
6760 PRINTPLS;:IFP=2LPRINTPL$
6780 CF=DC(0):IFM=3GOTO6800
6790 POKEP6+1,PEEK(V1):PRINT66;:IFP=2LPRINT66;
6800 POKEP1,PEEK(V1):CF=DC(1):POKEP1+1,PEEK(V1)
6810 POKEP2,PEEK(V1):CF=DC(2):POKEP2+1,PEEK(V1)
6820 POKEP3,PEEK(V1):CF=DC(3):POKEP3+1,PEEK(V1)
6830 POKEP4,PEEK(V1):CF=DC(4):POKEP4+1,PEEK(V1)
6860 POKEP5,PEEK(V1):CF=DC(5):POKEP5+1,PEEK(V1)
6870 POKEP6,PEEK(V1)
6880 PRINTTAB(8)E1;TAB(19)E2;TAB(30)E3;TAB(41)E4;TAB(52)E5
6890 IFP=2THENLPRINTTAB(8)E1;TAB(19)E2;TAB(30)E3;TAB(41)E4;TAB(5
2)E5
6910 PRINTSTRING$(64,"*");:IFP=2THENLPRINTSTRING$(64,"*")
7000 RETURN

```

Program Listing 2

```

7F00 00100 00110 BEGIN ORG LD 7F00H ;=32512
7F00 11581B 00110 LD DE,SIZE ;PREP TO PRES
ET STORAGE
7F03 21A863 00120 LD HL,BUFF
7F06 3E01 00130 INIT LD A,01H ;CONSTANT OF
0000 0001
7F08 77 00140 LD (HL),A ;STORE THE CO
NSTANT
7F09 23 00150 INC HL ;ADD 1 TO ADD
RESS
7F0A 1B 00160 DEC DE ;SUB 1 FROM
SPACE
7F0B 7A 00170 LD A,D
7F0C B3 00180 OR E
7F0D 20F7 00190 JR NZ,INIT ;JUMP IF MORE
SPACE
7F0F 21A863 00200 LD HL,BUFF ;1ST STORAGE
ADDRESS TO HL
7F12 11581B 00210 LD DE,SIZE ;SPACE AVAI
LABLE IN DE
7F15 3E04 00220 LD A,04H ;CASSETTE O
N
7F17 D3FF 00230 OUT (0FFH),A
7F19 DBFF 00240 WAIT IN A,(0FFH) ;WAIT FOR 1ST P
ULSE
7F1B 17 00250 RLA ;2.0 ROTATE
7F1C 30FB 00260 JR NC,WAIT ;3.5 LOAD BY
TE
7F1E 7E 00270 LOOP LD A,(HL) ;3.5 STORE B
YTE
7F21 DA267F 00300 JP C,BUMP ;5.0 JUMP IF
FULL BYTE
7F24 1802 00310 JR FLIP ;6.0
7F26 23 00320 BUMP INC HL ;ADVANCE STO
RAGE ADD 3.0
7F27 1B 00330 DEC DE ;REDUCE AVAI
LABLE SPACE 3.0
7F28 3E04 00340 FLIP LD A,04H ;3.5 CASSETT
E FLIP FLOP
7F2A D3FF 00350 OUT (0FFH),A ;5.5
7F2C 060A 00360 LD B,TIME ;3.5 LOAD DE
LAY FACTOR
7F2E 10FE 00370 DJNZ $ ;4.0 TIME
>1*6.5
7F30 7A 00380 LD A,D ;2.0
7F31 B3 00390 OR E ;4.0
7F32 2806 00400 JR Z,DONE ;3.5 JUMP IF NO SPAC
E AVAILABLE
7F34 DBFF 00410 IN A,(0FFH) ;5.5 TAKE A
PEEP
7F36 17 00420 RLA ;2.0 ROTATE

```

```

PEEP TO CARRY
7F37 C31E7F 00430 JP LOOP ;5.0 LOOP T
OTAL=58.5
7F3A 3E00 00440 DONE LD A,00H ; MICROSEC
WHEN TIME=1
7F3C D3FF 00450 OUT (0FFH),A
7F3E C9 00460 RET
000A 00470 TIME EQU 0AH ;DEFAULT OF
10
1B58 00480 SIZE EQU 1B58H ;7000 BYTES
OF SPACE
63A8 00490 BUFF EQU 63A8H ;START BUPFE
R AT 25512
7F3F 00 00500 CTR DEFB 0H ;48 BIT COUN
TER
7F40 CD7F0A 00510 CALL 2687 ;LOAD HL WIT
H ARGUMENT
7F43 E5 00520 PUSH HL
7F44 DDE1 00530 POP IX ;SET PARM AD
DR IN IX
7F46 DD6601 00540 LD H,(IX+1) ;MSB OF STRI
NG ADDR
7F49 DD6E00 00550 LD L,(IX+0) ;LSB
7F4C E5 00560 PUSH HL
7F4D FDE1 00570 POP IX ;ADDR OF BIT
LINE
7F4F DD4606 00580 LD B,(IX+6) ;LOAD B WITH
PEEP #
7F52 DD6609 00590 LD H,(IX+9) ;MSB OF BUFF
ER OFFSET
7F55 DD6E08 00600 LD L,(IX+8) ;LSB
7F58 11A863 00610 LD DE,BUFF ;LOAD BUFFER
START ADDRESS
7F5B 19 00620 ADD HL,DE ;DEVELOPE BY
TE ADDRESS
7F5C 3E00 00630 LD A,0H
7F5E 323F7F 00640 LD (CTR),A ;PRESET 48 BIT COUNT
ER
7F61 CDBE7F 00650 CALL X1 ;CHECK FOR C
LOCK PULSE
7F64 2005 00660 JR NZ,F1 ;JUMP IF FOU
ND
7F66 CDB47F 00670 FIND CALL PEEPS ;FIND THE CL
OCK PULSE
7F69 28FB 00680 JR Z,FIND ;LOOP TILL F
OUND
7F6B DD4E02 00690 F1 LD C,(IX+2) ;LOAD CLOCK
FADE VALUE
7F6E 79 00700 WAITF LD A,C ;LOAD A WITH
FADE VALUE
7F6F A7 00710 AND A ;SET Z/NZ FL
AG
7F70 CA7A7F 00720 JP Z,DIGIT ;JUMP IF FAD
E = ZERO

```

program, but a complete understanding is not necessary for its useful operation. As stated in the beginning of this article, it can be used to retrieve data from an otherwise unreadable tape; to check the tape passing speed of a recorder; to learn the format of an unfamiliar tape file; and to observe what

Listing 2 continued

7F73 CDB47F	00730	CALL	PEEPS		;INCREMENT T
O NEXT PEEP					
7F76 0D	00740	DEC	C		;DECREMENT F
ADE VALUE					
7F77 C36E7F	00750	JP	WAITF		;LOOP TILL F
ADE = ZERO					
7F7A 1630	00760	DIGIT	LD	D,30H	;LOAD D WITH
ASCII "0"					
7F7C DD4E04	00770	LD	C,(IX+4)		;LOAD PERIOD
IN C					
7F7F 79	00780	DIG2	LD	A,C	;LOAD A WITH
C					
7F80 A7	00790	AND	A		;TO SET Z/NZ
FLAG					
7F81 CA907F	00800	JP	Z,STASH		;JUMP WHEN P
AST PERIOD					
7F84 CDB47F	00810	CALL	PEEPS		;GET NEXT PE
EP					
7F87 CAB87F	00820	JP	Z,DECR		;Z=ZERO PEEP
(NO PULSE)					
7F8A 1631	00830	LD	D,31H		;LD ASCII "1"
ON PULSE					
7F8C 0D	00840	DECR	DEC	C	;DECREMENT P
ERIOD					
7F8D C37F7F	00850	JP	DIG2		;LOOP TILL P
AST PERIOD					
7F90 FD7200	00860	STASH	LD	(IY+0),D	;STASH 0 OR
1 FROM D					
7F93 FD23	00870	INC	IY		;BUMP BIT FI
ELD ADDRESS					
7F95 3A3F7F	00880	LD	A,(CTR)		;LOAD A WITH
BIT COUNTER					
7F98 3C	00890	INC	A		;BUMP BIT CO
UNTER					
7F99 323F7F	00900	LD	(CTR),A		;PUT AWAY BI
T COUNTER					
7F9C FE30	00910	CP	30H		;COMPARE TO
BIT LIMIT 48					
7F9E CAA47F	00920	JP	Z,RSTOR		;JUMP IF LIM
IT REACHED					
7FA1 C3667F	00930	JP	FIND		;LOOP TO FIN
D NEXT CLOCK					
7FA4 11A863	00940	RSTOR	LD	DE,BUFF	;LOAD DE WIT
H BUFFER START					
7FA7 B7	00950	OR	A		;TO CLEAR CA
RRY FLAG					
7FA8 ED52	00960	SBC	HL,DE		;CALC BYTE O
FFSET					
7FAA DD7006	00970	LD	(IX+6),B		;RET NEW PEE
P #					
7FAD DD7409	00980	LD	(IX+9),H		;RET NEW MSB
BUFFER ADD					
7FB0 DD7508	00990	LD	(IX+8),L		;RET NEW LSB
7FB3 C9	01000	RET			;RETURN
7FB4 04	01010	PEEPS	INC	B	;BUMP PEEP N
UMBER					
7FB5 3E09	01020	LD	A,09H		;LOAD A WITH
LIMIT					
7FB7 B8	01030	CP	B		;COMPARE TO
LIMIT					
7FB8 C2BE7F	01040	JP	NZ,X1		;JUMP IF NOT
LIMIT					
7FBB 0601	01050	LD	B,01H		;RESTART WIT
H PEEP 1					
7FBD 23	01060	INC	HL		;BUMP BYTE #
7FBE 78	01070	X1	LD	A,B	;PUT PEEP# I
N A					
7FBF FE01	01080	CP	01H		;PEEP# 1 ?
7FC1 C2C77F	01090	JP	NZ,TWO		;JUMP IF NOT
1					
7FC4 CB7E	01100	BIT	7,(HL)		;TEST PEEP#
1					
7FC6 C9	01110	RET			
7FC7 FE02	01120	TWO	CP	02H	;PEEP# 2 ?
7FC9 C2CF7F	01130	JP	NZ,THREE		;JUMP IF NOT
TWO					
7FCC CB76	01140	BIT	6,(HL)		;TEST PEEP#
2					
7FCE C9	01150	RET			
7FCF FE03	01160	THREE	CP	03H	;PEEP# 3 ?
7FD1 C2D77F	01170	JP	NZ,FOUR		;JUMP IF NOT
THREE					
7FD4 CB6E	01180	BIT	5,(HL)		;TEST PEEP#
3					
7FD6 C9	01190	RET			
7FD7 FE04	01200	FOUR	CP	04H	;PEEP# 4 ?
7FD9 C2DF7F	01210	JP	NZ,FIVE		;JUMP IF NOT
FOUR					
7FDC CB66	01220	BIT	4,(HL)		;TEST PEEP#
4					
7FDE C9	01230	RET			
7FDF FE05	01240	FIVE	CP	05H	;PEEP# 5 ?
7FE1 C2E77F	01250	JP	NZ,SIX		;JUMP IF NOT
5					
7FE4 CB5E	01260	BIT	3,(HL)		;TEST PEEP#
5					
7FE6 C9	01270	RET			
7FE7 FE06	01280	SIX	CP	06H	;PEEP# 6 ?
7FE9 C2EF7F	01290	JP	NZ,SEVEN		;JUMP IF NOT
SIX					
7FEC CB56	01300	BIT	2,(HL)		;TEST PEEP#
6					
7FEE C9	01310	RET			
7FEF FE07	01320	SEVEN	CP	07H	;PEEP# 7 ?
7FF1 C2F77F	01330	JP	NZ,EIGHT		;JUMP IF NOT
7					
7FF4 CB4E	01340	BIT	1,(HL)		;TEST PEEP#
7					
7FF6 C9	01350	RET			
7FF7 CB46	01360	EIGHT	BIT	0,(HL)	;TEST PEEP#
8					
7FF9 C9	01370	RET			
0000	01380	END			
00000					TOTAL ERRORS

1. Answer Memory-Size prompt with 25512.
2. Load the Basic program A.
3. Load the Assembly program Peeper.
4. Press break and type run.
5. Many different cassettes can be loaded and studied without the need to reload these programs.
6. From the main menu of "Enter 1-Load 2-Analyze 3-Search 4-Translate" any of the four operations can be selected at any time.
7. Select the load operation to read from a cassette into the buffer.
 - a. Select the time interval.
 - b. Carefully position the cassette about one counter position in front of the segment of tape to be studied.
 - c. Press Play/Press enter.
8. Select the analyze operation to visually inspect peeps and determine logical bit alignment.
 - a. Specify the output media.
 - b. Specify the starting byte address.
 - c. Specify the starting test bit width.
 - d. While the analyze is running
 - 1) Use the down-arrow and up-arrow keys to inspect different areas of the buffer.
 - 2) Use the right-arrow and left-arrow keys to try different test bit widths.
 - 3) Use any other keys to stop the operation.
 - e. Note the byte and peep addresses of interesting areas of data.
 - f. Note the actual average bit width.
9. Select the search operation to scan interpreted data to determine logical byte alignment.
 - a. Specify the output media.
 - b. Specify the bit width.
 - c. Specify the starting byte address.
 - d. Specify the starting peep address.
 - e. Specify the search key.
 - f. While the search is running
 - 1) Use the left or right-arrow keys to change the direction of the search.
 - 2) Use any other key to stop the routine.
 - g. Note the byte and peep addresses where byte alignment is achieved.
10. Select the translate operation to interpret the data.
 - a. Specify the output media.
 - b. Specify the bit width.
 - c. Specify the starting byte address.
 - d. Specify the starting peep address.
 - e. While the translate is running use any key to stop the routine.
11. When any of the routines reach the end of the buffer it automatically stops and returns to the main menu.

Table 1. Operator Guidelines

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effect different volume settings have on the pulse and gap width, allowing you to determine the optimum setting

for a particular tape.

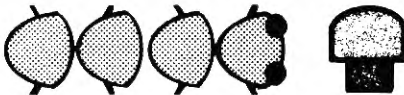
If you find other uses, I would appreciate hearing about them. ■

Dennis Ridgway lives at 2160 Frisco Avenue, Terre Haute, IN 47805.

Basic Program	5000-5120	Call Assembly Routine To Convert Peeps to Bits
Mainline Module	6000-6020	Print Bit Line
10-180 Initialize Variables	6100-6220	Convert Bits to Hex And Print
900-920 Main Operations Menu	6300-6320	Convert Hex to Decimal
Load Module	6400-6410	Print Decimal Line
1000-1070 Select Parameters	6600-6610	Convert Decimal to Character
1090-1120 Call Assembler Load Routine	6620-6720	Convert Decimal to Token Words
Analyze Module	6729-6760	Print Character and Token Line
2000-2050 Select Parameters	6780-6870	Convert Decimal to Integer Values
2060-2090 Look for First Byte With Pulses	6880-6890	Print Integer Values
2095-2230 Find First Pulse	6910-7000	Print Separator Line and Return
2300-2340 Prepare Printline	Assembly Program	
2400-2494 Fill Printline Until Next Clock Pulse Is Found	Load Subroutine	
2500-2760 Print Line And Test Control Keys	100-190 Initialize Buffer to Hex 01s	
2900-2920 End of Analysis	200-260 Wait for First Pulse	
Search And Translate Module	270-430 Load Buffer	
3000-3150 Select Parameters	440-450 Cassette Off and Return	
3190-3220 Print The Control And Key Lines	Peep To Bit Conversion Subroutine	
3600-3620 GOSUB 5000 "The Interpretation Subroutine"	500-640 Initialize Registers	
3640-3690 Test For Match	650-680 Find Clock Pulse	
4570-4600 Test Control Keys	690-750 Wait Past Clock Fade	
4610 Prepare for Next Translation	760-850 Check If 0 or 1 Bit	
4620-4690 Shift Right for Next Search	860-930 Store Digit and Test For Done	
4700-4780 Shift Left for Next Search	940-1000 Prepare for Return And Return	
4810-4820 End of Data	1010-1060 Bump to Next Peep	
Interpretation Module	1070-1380 Determine if Bit On or Off	

Table 2. Program Overview

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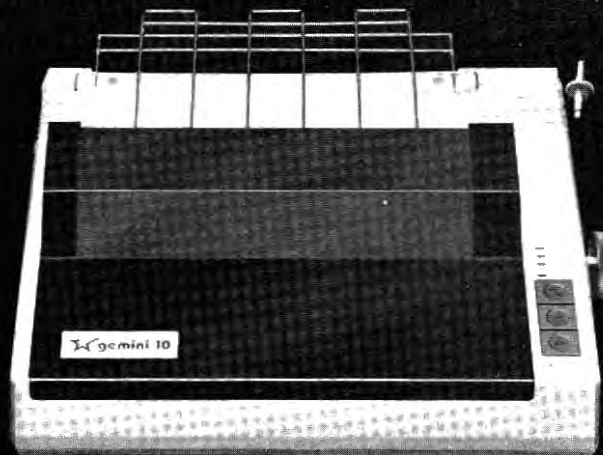
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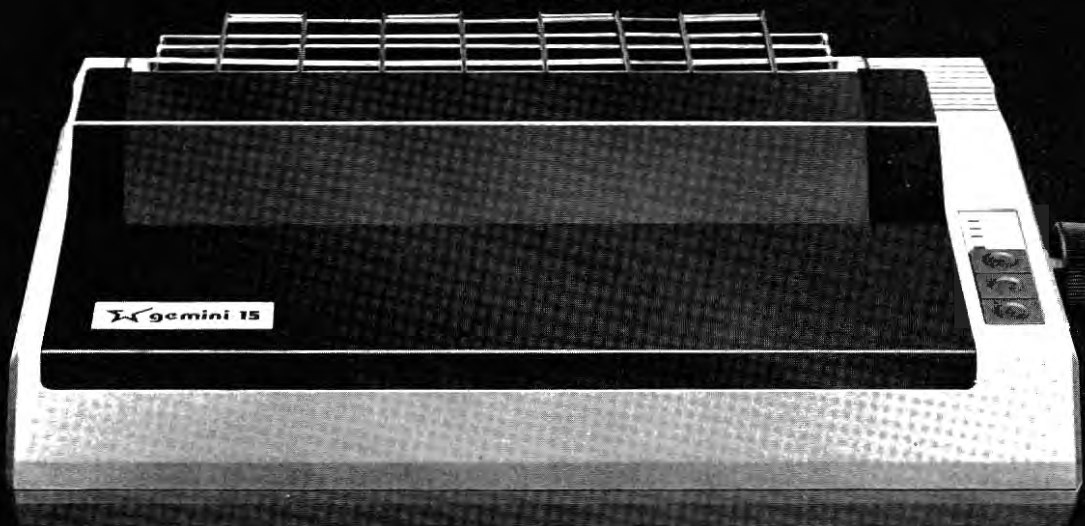
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Pick a Card . . .

by Norman Efroymsen

“Pick any number up to 255.” This line begins a magic trick where the subject picks a number within a given range, without revealing his choice to the magician. The magician displays several cards filled with rows of numbers and asks the subject to point out which cards contain his secret number. The magician looks at these cards for a moment, performs some hand waving and incantations, and reveals the number that the subject picked.

The solution is simple; the numbers on the cards are arranged from smallest to largest. The magician adds the numbers in the upper left corner of each card on which the subject says his number appears. That sum equals the number picked by the subject. In discussing how the trick works, see Fig. 1.

The cards are constructed in the following manner: All numbers that have bit 0 set (equal to 1) appear on card 0. All numbers that have bit 1 set appear on card 1 and so on. The bit position values are 1, 2, 4, 8, 16, . . . (from right to left) and these are the smallest numbers to appear on cards 0, 1, 2, 3, 4, . . . respectively.

If the subject chooses number 13, whose binary representation is

This program won't pull a rabbit out of a hat, but it will amaze and puzzle your friends.

00001101, the 13 is displayed on cards 0, 2, and 3. The first numbers on these cards are 1, 4, and 8, which add up to 13.

For the computer to play the magician's part, it must be able to construct the series of cards. Fortunately, the logical operator, AND, allows the computer to test the bit positions of each number. For example, should 5 be printed on card 2? Card 2 holds all numbers with bit 2 set. The value of bit 2 is 2^2 , or 4. We need to test bit 2 of the number 5 to see if it is set. This is determined by the Basic operation: 4 AND 5. If 5 has bit 2 set, the operation returns a true (-1). If not, it returns a false (0). If X represents the number in question and Y the value of the bit position then IF X AND Y THEN PRINT X will print X on the card.

We are now ready to prepare a pro-

gram that will play magician. Two loops are needed, one to count the cards and one to print the numbers on the cards. If N cards are used, the outer loop must range from 2^0 to 2^{N-1} . The inner loop ranges from 1 to 2^{N-1} .

Lines 50 and 130 form the loop that counts the number of cards to be printed. Lines 70 and 90 count the number of numbers to be tested, and if possible, to be printed on each card. Line 80 tests the bit position and prints the number if the bit position is set. Line 120 adds the value of the bit position (which is also the first number on the screen) to the total. The drawback to this system is that it's *slow* for several cards. You could take care of this by writing the program in machine code. Program Listing 2 contains the source and object codes for Magic Card.

Lines 180-200 give introductory information. Line 260 puts a one in the B and C registers. The B register is the equivalent to the variable Y in the Basic program, and holds the value of the bit position. The C register is equivalent to X and cycles through all the numbers in the range. Lines 270-290 clear the screen before printing each card. Lines 300-320 do the equivalent of the X AND Y operation in the Basic program. Line 330 routes a false answer to line 490. If true, the number is printed on the screen, so line 340 transfers the binary number from the C register to the L register to make use of the ROM subroutine that con-

Number	Binary								= bit positions
	7	6	5	4	3	2	1	0	
1	0	0	0	0	0	0	0	1	
2	0	0	0	0	0	0	1	0	
3	0	0	0	0	0	1	1		
4	0	0	0	0	1	0	0		
5	0	0	0	0	1	0	1		
10	0	0	0	1	0	1	0		
15	0	0	0	1	1	1	1		
20	0	0	1	0	1	0	0		

Figure 1

The Key Box
Model I
16K RAM
Basic Level II


```

10 CLS
20 INPUT "PICK THE NUMBER OF CARDS TO BE USED (UP TO 8)";N
30 PRINT "PICK A NUMBER BETWEEN 0 AND";2[N-1
40 INPUT "PRESS <ENTER> WHEN READY";A$
50 FOR Y=0 TO N-1
60 CLS: PRINT "CARD #";Y
70 FOR X=1 TO 2[N-1
80 IF X AND 2[Y THEN PRINT X;
90 NEXT X
100 PRINT
110 INPUT "IS YOUR NUMBER ON THE SCREEN";A$
120 IF LEFT$(A$,1) = "Y" THEN T=T+2[Y
130 NEXT Y
140 PRINT "YOUR NUMBER WAS";T

```

Program Listing 1

"Prepare a program that will play magician."

verts binary numbers in the HL pair into their ASCII decimal equivalents. Line 350 calls the subroutine which does this.

Upon return, lines 360-450 make sure the number printed to the screen won't overrun the end of a line. Since the range of numbers used in this program is 255, the greatest number of digits a number can have is three. In addition, every number has a trailing space. So allow for four characters. If a number is set to be printed in the last four print positions of a line, it is shifted to the start of the next line. Line 360 gets the cursor position and puts it into the DE register pair for manipulation. Line 370 puts the LSB of the cursor location (a number between 0 and 63) into the A register. Lines 380 and 390 test to see if the position is less than 60. If so, the program jumps to line 460; otherwise lines 400-450 start a new line.

Lines 590-630 ask the user if his number appeared on the screen. If the number was on the screen, lines 640-660 add the value of the position to the total. Line 670 checks to see if all the cards have been printed. If so, the program jumps to the closing routine at line 720; if not, line 690 advances B to the next bit position. Line 700 sets C equal to B because the lowest number placed on a card is the value of the bit position. Line 710 loops the program to print the next card.

Lines 850-900 contain the ROM subroutine to convert a binary number to its ASCII equivalent. Line 910 con-

tains the tally buffer. Lines 930-1050 contain the various messages to be printed.

You may alter the program to allow the user to pick the number of cards, and the number range. ■

Norman Efroymsen can be reached at 2976 Chadbourne Road, Shaker Heights, OH 44120.

```

00100 ;*****
00110 ;**          MAGIC CARD PROGRAM          **
00120 ;**          BY NORMAN EFROYMSON          **
00130 ;**          2976 CHADBOURNE RD          **
00140 ;**          SHAKER HTS., OHIO 44120    **
00150 ;**          JULY 9, 1981                **
00160 ;*****
7D00          00100 ORG          7D00H          ;ENTRY = 32000
7D00 CDC901   00100 START CALL 01C9H        ;CLEAR SCREEN
7D03 219A7D   00190 LD          HL,MSG      ;GET ADDRESS OF MSG
7D06 CDA728   00200 CALL 28A7H        ;PRINT IT
7D09 CD4900   00210 WAIT CALL 49H          ;WAIT UNTIL KEY PRESSED

7D0C FE01     00220 CP          01H          ;IS IT <BREAK>?
7D0E CA191A   00230 JP          Z,LA19H       ;IF YES, JP TO BASIC
7D11 FE0D     00240 CP          0DH          ;IS IT <ENTER>?
7D13 20F4     00250 JR          NZ,WAIT     ;IF NOT, TRY AGAIN
7D15 010101   00260 LD          BC,0101H        ;INITIALIZE LOOP COUNTER
RS
7D18 C5       00270 LOOP1 PUSH BC          ;SAVE LOOP COUNTERS
7D19 CDC901   00280 CALL 01C9H        ;CLEAR SCREEN
7D1C C1       00290 POP          BC          ;RESTORE LOOP COUNTERS
7D1D 78       00300 LOOP2 LD          A,B          ;PUT 2[N IN 'A' REGISTER
R
7D1E A1       00310 AND          C          ;MASK OUT OTHER BITS
7D1F B8       00320 CP          B          ;WAS BIT SET?
7D20 201E     00330 JR          NZ,CONT     ;IF SET, GET NEXT NUMBER
R
7D22 69       00340 LD          L,C          ;READY FOR CONVERT
7D23 CD8E7D   00350 CALL  DECIMAL    ;CONVERT HEX TO DECIMAL

7D26 ED5B2040 00360 LD          DE,(4020H) ;GET CURSOR POSITION
7D2A 7B       00370 LD          A,E          ;GET LSB
7D2B E63F     00380 AND          3FH        ;MASK OUT HIGH BITS
7D2D FE3C     00390 CP          3CH        ;ROOM FOR LAST NUMBER?
7D2F FA3B7D   00400 JP          M,NEXT     ;IF IF ROOM
7D32 E63F     00410 OR          3FH        ;LSB = END OF LINE
7D34 B3       00420 OR          E          ;RESTORE HIGH BITS
7D35 5F       00430 LD          E,A          ;DE NOW AT END OF LINE
7D36 13       00440 INC          DE          ;DE AT START OF NEXT LI
NE
7D37 ED532040 00450 LD          DE,(4020H),DE ;SAVE TO CURSOR
7D3B C5       00460 BC          PUSH          BC          ;SAVE LOOP COUNTERS
7D3C CDA728   00470 NEXT CALL 28A7H        ;PRINT THE NUMBER
7D3F C1       00480 POP          BC          ;RESTORE LOOP COUNTERS
7D40 0C       00490 CONT INC          C          ;INC LOOP FOR NEXT NUMB
ER
7D41 AF       00500 XOR          A          ;ZERO 'A' REGISTER
7D42 B9       00510 CP          C          ;IS 'C' REG = 0?
7D43 20D8     00520 JR          NZ,LOOP2    ;IF NOT, JP BACK TO LOO
P2
7D45 21C03F   00530 LD          HL,3FC0H        ;HL => TO LAST LINE
7D48 222040   00540 LD          DE,(4020H),HL ;CURSOR ON LAST LINE
7D4B 21837E   00550 LD          HL,MSG2      ;GET MESSAGE
7D4E C5       00560 PUSH          BC          ;SAVE LOOP COUNTERS
7D4F CDA728   00570 CALL 28A7H        ;PRINT IT
7D52 C1       00580 POP          BC          ;RESTORE LOOP COUNTERS
7D53 CD4900   00590 YESRNO CALL 49H          ;WAIT FOR KEY INPUT
7D56 FE4E     00600 CP          'N'         ;IS IT 'N'?
7D58 208B     00610 JR          Z,NXTCRD    ;IF NOT, JP TO NEXT CAR
D
7D5A FE59     00620 CP          'Y'         ;WAS KEY 'Y'?
7D5C 20F5     00630 JR          NZ,YESRNO    ;IF NOT, TRY AGAIN
7D5E 3A997D   00640 LD          A,(TOTAL)   ;GET SUBTOTAL
7D61 80       00650 ADD          A,B          ;ADD BIT POSITION'S VAL
UE
7D62 32997D   00660 LD          DE,(TOTAL),A ;SAVE TO TOTAL
7D65 CB78     00670 NXTCRD BIT 7,B          ;ALL CARDS BEEN PRINTER
?
7D67 2005     00680 JR          NZ,FINAL    ;GO IF YES
7D69 CB20     00690 SLA          B          ;SHIFT FOR NEXT CARD
7D6B 48       00700 LD          C,B          ;BEGIN COUNTER AT B
7D6C 18AA     00710 JR          LOOP1     ;BACK TO PRINT CARD
7D6E CDC901   00720 FINAL CALL 01C9H        ;CLEAR SCREEN
7D71 21267E   00730 LD          HL,MSG3      ;GET MESSAGE
7D74 CDA728   00740 CALL 28A7H        ;PRINT IT
7D77 3A997D   00750 LD          A,(TOTAL)   ;GET THE ANSWER
7D7A 6F       00760 LD          L,A          ;READY FOR CONVERT
7D7B CD8E7D   00770 CALL  DECIMAL    ;CONVERT IT TO DECIMAL
7D7E CDA728   00780 CALL 28A7H        ;PRINT THE ANSWER
7D81 AF       00790 XOR          A          ;ZERO 'A' REGISTER
7D82 32997D   00800 LD          DE,(TOTAL),A ;ZERO TOTAL BUFFER FOR
00810 ;NEXT GAME
7D85 21B27D   00820 LD          HL,MSG1      ;GET MESSAGE
7D88 CDA728   00830 CALL 28A7H        ;PRINT IT
7D8B C3897D   00840 JP          WAIT        ;RESTART GAME
7D8E 00A8     00850 DECMAL LD          BC          ;CONVERT ROUTINE
7D8F 2600     00860 LD          H,0          ;HL HAS HEX NUMBER
7D91 CD9A0A   00870 CALL 0A9AH        ;SAVE AS INTEGER
7D94 CDB00F   00880 CALL 0FB0H        ;CONVERT IT TO DECIMAL
7D97 C1       00890 POP          BC          ;RESTORE LOOP COUNTERS
7D98 C9       00900 RET
7D99 00       00910 TOTAL DEFB 0
7D9A 17       00920 MSG DEFB 23          ;32 CHAR/LINE MODE
7D9B 00       00930 DEFB ' M A G I C   G U E S S '
7D9C 0A0A     00940 DEFB 0A0AH        ;2 LINE FEEDS
7D9D 54       00950 DEFB 'THINK OF A NUMBER (0-255)'
7D9E 0A       00960 DEFB 10
7D9F 00       00970 DEFB 'PRESS <ENTER> WHEN READY.'
7DA0 5A       00980 DEFB 10          ;FOR BASIC
7DA1 4F       00990 DEFB 'OR PRESS <BREAK> FOR BASIC'
7DA2 00       01000 DEFB 0
7DA3 49       01010 MSG2 DEFB 'IS YOUR NUMBER IN THIS LIST (Y/N)?'
7DA5 00       01020 DEFB 0
7DA6 17       01030 MSG3 DEFB 23
7DA7 54       01040 DEFB 'THE NUMBER YOU PICKED WAS'
7DA8 00       01050 DEFB 0
7DA9 00       01060 DEFB 0
00000 TOTAL ERRORS

```

Program Listing 2. Source and Object Codes.

AND...OR...NOT

by Jeffrey Myers

Do you feel comfortable using Boolean logic? Or do the words **AND**, **OR**, and **NOT** scare you? This article explains just how they are used.

Just beyond beginner's Basic at the heart of your TRS-80's architecture and its machine language lurk creatures with which you should become familiar. They populate a branch of the mathematics family tree which belongs to the logic family. These basic beasts are named **AND**, **OR** and **NOT**.

Fortunately, **AND**, **OR** and **NOT** are about as fearsome as they look—harmless words that we English speakers have long since mastered. In logic (as in mathematics or computer science) they have precise definitions which distinguish them from the everyday **AND**, **OR** and **NOT**.

Perhaps you have seen them in your Basic manual or in someone else's programs. One such usage is very straightforward.

```
100 IF A = 5 AND B = -6 THEN 111
```

This Basic statement transfers program control to line 111 if A is 5 and B is -6. If either equation is false or if both are false, the program flows to the statement below line 100. Here,

```
10 INPUT X
20 IF X THEN 50
30 PRINT "DROPPED THROUGH"
40 GOTO 10
50 PRINT "BRANCHED"
60 GOTO 10
```

Program Listing 1

AND functions as you might guess. But what about the statement

```
200 IF A AND (B AND C) THEN 222
```

in which there are no relation symbols such as "=" or "<"? The answer will have to wait a bit, but it will reveal a fascinating world of programming techniques.

OR appears much as the **AND**s above and **AND** and **OR** can appear together in statements with predictable consequences such as:

```
300 IF (A = 1 AND B = 10) OR (A = 10 AND B = 1) THEN 333
```

This statement can send you to line number 333 in two ways: A and B equal 1 and 10 respectively, or vice versa. In mastering these logical operators one of the challenges is determining which if any parentheses to eliminate in line 300. This is beginning to sound like algebra, and for a good reason.

Anywhere they occur, **AND** and **OR** are binary operations. (This is not base two numeration.) It means that they must operate on two things at a time and the things are called operands. In

ordinary arithmetic, addition, subtraction, multiplication and division are binary operations. Procedures exist for adding columns of numbers at once, but fundamentally these techniques still add two numbers at a time. (Adding columns in various directions and combinations is reliable because addition has two special properties called commutativity and associativity. Subtraction has neither of these properties.)

By contrast, unary operations such as taking the square root of a number require only one operand. The term unary also refers to our third logical operator, **NOT**, which is performed only on single operands. The results can look mysterious at first.

Experiment with **NOT**ing numbers by entering commands like **PRINT NOT 2** or **PRINT NOT 10000** and so forth. Try enough numbers to allow a pattern to emerge and note what numbers are out of bounds for the operation **NOT**.

For legal values, a simple pattern emerges quickly, although the reason for calling this operation **NOT** is probably still obscure. **NOT 3** is -4. **NOT -4** brings you back to 3. Although this alone hardly proves the fact, this does work in general: If **NOT A** is B then **NOT B** is always A. Mathematically, **NOT** is said to be its own inverse.

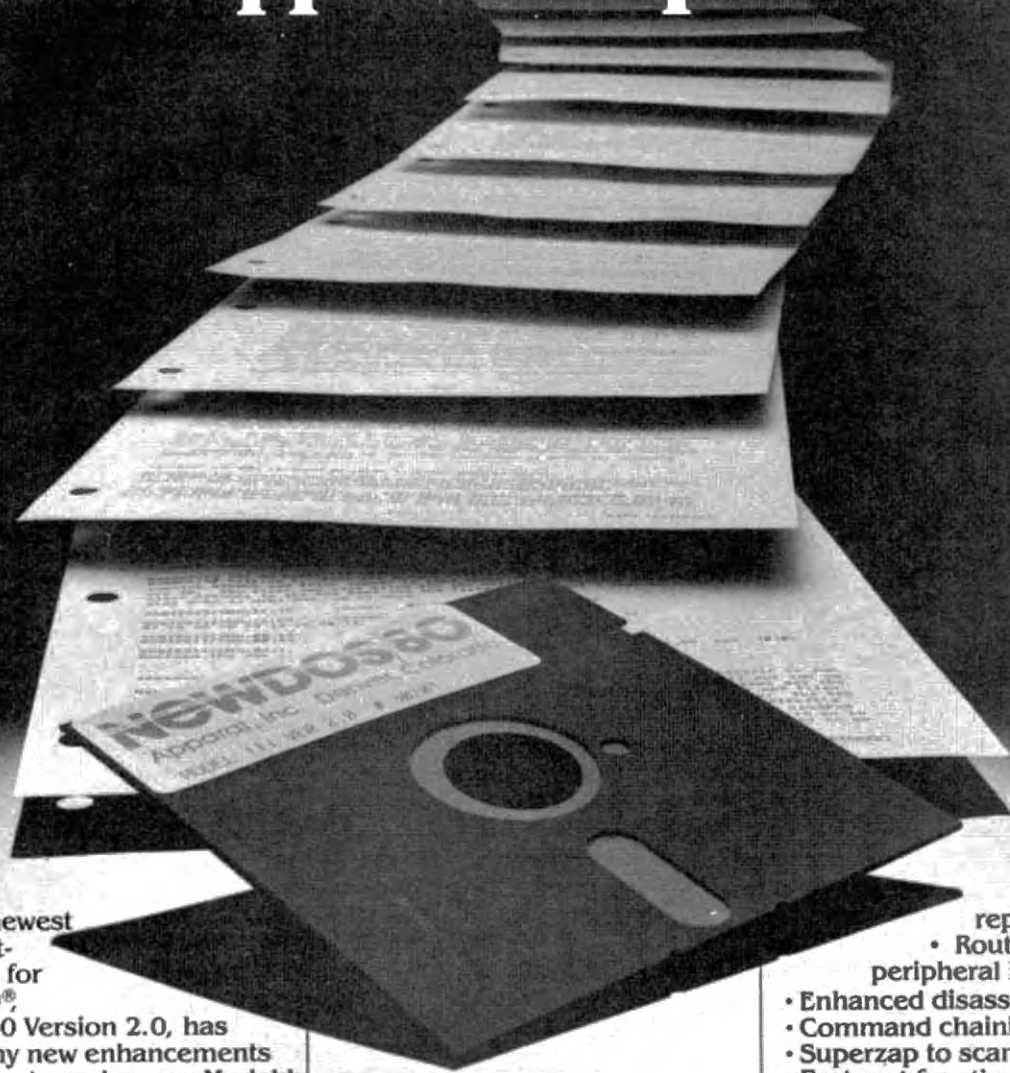
NOT treats decimal inputs as if the Basic **INT** function had been performed first. Instead of operating on the decimal value, **NOT** uses the largest integer less than or equal to it. This is a clue to the nature of **NOT**.

The lowest positive integer which produces an error message is 32678. The integer 32767 works and produces a -32768. The lowest acceptable integer is -32768 and when **NOT**ed, it produces 32767. These are the exact limits placed on integer variables in Basic. You declare integer variables by

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DEFINT or "%".

In Basic, integer variables can be stored internally in two bytes (16 binary digits) and most commonly, the highest digit shows the sign of the number with zero and one representing positive and negative respectively. The number 32767 is simply binary 0111111111111111, the highest number that fits this numeration scheme. In this context, binary means base two.

Two's Complement

Negatives are tricky since Basic stores them in a special form called *two's complement*. Briefly, the *one's complement* of a binary number has all bits (binary digits) opposite to those of the original number. This form is inefficient for operating with negatives, however. More popular is *two's complement* which is the *one's complement* plus one.

In binary form, the number one (0000000000000001) has a one's complement of 1111111111111110. Computers could use this internally to store negative one, but if the binary forms of 1 and -1 are added, 1111111111111111 results. This would equal -32767 under this plan. To use one's complement and the common addition algorithm, we would have to agree that $1 + (-1) = -32767!$

Using two's complement, negative one is one added to the one's complement, giving 1111111111111111. This, when added to one (0000000000000001) gives 0000000000000000 with a carry of 1. Ignore the carry and the rest of the answer is always correct! This type of operation is at the heart of integer arithmetic and is the reason computers can perform at high speed.

In light of the preceding information, NOT is one's complementer. It alters every bit of the binary form from 0 to 1 or 1 to 0.

AND and OR also perform bit-by-bit operations on the binary representations of numbers. This will open the door to conditional statements such as

```
400 IF P AND Q THEN 444
```

To understand this powerful program-

ming tool, the IF . . . Then statement needs some attention.

When interpreting Basic statements such as IF J=34 THEN 55, you make a judgment about the mathematical sentence "J=34". (Mathematical sentences include words like =, <, and so on.) In short, the computer assigns a truth value to it, using 0 for false and -1 for true. The flow of the program hinges on whether the hypothesis has a value of 0. If the truth value is zero, the program continues in numerical order. Otherwise the branch specified is performed. Verify this with a test program such as Program Listing 1. Only one input will cause the computer to print "DROPPED THROUGH". The key number for which the computer actually tests is zero.

The -1 commonly used for true is NOT 0 and has all ones in its two's complement signed binary form. As illustrated in Listing 1, other non-zero values function the same within a conditional statement.

In symbolic logic, NOT, AND, and OR are defined by the truth tables such as those shown in Table 1. Here, assume P and Q are statements whose truth can be determined and assume 0 = false and 1 = true. (Letting 1 stand for true is more common in logic and in some non-TRS-80 computers.)

By definition P AND Q is true only when *both* statements are true. P OR Q is true if P is true, if Q is true or if both are true. NOT reverses the truth value.

Consider the following Basic statement:

```
500 LET LO = -A*(A < B) - B*(A > = B)
```

This statement does not produce an error message when used in a program! In ordinary algebra, this might be meaningless, but to the Basic interpreter, it makes sense. On top of that, it performs a useful function: LO will be set equal to either A or B, whichever is numerically less.

If A is 1 and B is 2, the sentence in the first pair of parentheses is true and the other sentence is false. The computer will, in this type of statement, compute a truth value and substitute it

for each expression. In this example, it will assign LO a value equal to $-A*(-1) - B*(0)$ which equals A. If B is the smaller number, the first expression is false and the second is true. If A and B are equal, LO is assigned B's value (although this is arbitrary).

Altering line 500 to print the maximum of two numbers requires only slight changes. What about the maximum of three numbers? Try this as a programming challenge. A clue will emerge later.

Basic Mathematics

Basic's method of dealing with mathematical sentences explains why an incorrectly typed statement like

```
600 LET X=Y=Z
(where you meant LET X=Y-Z)
```

produces no error message, but assigns 0 or -1 to X depending upon whether Y and Z are unequal or equal. By the nature of a Let statement, the X must be the storage place for the computed variable. The computer then tries to compute Y=Z. Because this is a sentence rather than just an expression, it assigns a truth value to it. When the algebra of real numbers fails, TRS-80 Basic just shifts gears into the algebra of logic.

The Basic statements IF X<>0 THEN 99 and IF X THEN 99 perform the same task. The main difference is in execution speed. The speed advantage is important inside loops that are executed many times in a program.

Earlier, I gave a Basic statement that appears as line 20 in Program Listing 2. Read the program and predict the results before you read on.

This program ANDs according to the truth table definition as if the ones and zeros of the binary number were trues and falses. If you entered 1, 2 and 3 when running Listing 2, first the AND in parentheses is performed as shown in Fig. 1. This is then ANDed with one resulting in zero. It is interpreted as false and program control passes to line 30. To force the program to line 40, all three numbers must have ones in the same bit somewhere to make the answer non-zero. Three equal numbers do this. Inputs 2, 3, and 6 also make the conditional true because they are 10, 11 and 110 in binary and ANDING them results in 010. Like addition, you can AND by columns: If a column contains all ones write one, otherwise write zero.

Once again, remember that all non-zero truth values are treated as true.

P	Q	NOT P	NOT Q	P AND Q	P OR Q
1	1	0	0	1	1
1	0	0	1	0	1
0	1	1	0	0	1
0	0	1	1	0	0

Table 1. Truth table definitions

During the processing of an If . . . Then statement, the real question is "Is the truth value of the hypothesis zero or not?" If any bit of the truth value is one, it is treated as true.

The binary nature of ANDing helps explain such curiosities as PRINT 6 AND 5 producing the seemingly non-sensical answer of 4. PRINT 6 OR 5 produces a 7 on the screen, the result of ORing binary 110 with binary 101. Try to predict the result of PRINT 4 AND

5 OR 6, then test it. Your Basic manual will show that AND has priority over OR just as multiplication is performed before addition. This allows simpler expressions by eliminating some parentheses. Mastering the NOT-AND-OR hierarchy is an important step in symbolic logic.

AND, OR and NOT reveal some of what goes on at the machine level. Basic and other higher-level languages go to great lengths to accommodate base-10 numeration but meanwhile, the Z80 microprocessor hums along in base two. When a friend says "Hey, I

thought computers did everything in base two but it looks decimal to me!" type ?1AND2 and explain why 1 AND 2 equals zero.

Logical Operators

One of the powerful uses of logical operators is exemplified by the statement

```
700 IF PEEK(14400) AND 8 THEN 777
```

Each byte of memory consists of eight bits. If the highest bit is not a sign bit, decimal numbers from 0 to 255 can be stored in one byte. Commonly, the eight bits are numbered 0-7 from least to most significant.

The statement above helps spot whether the up-arrow key is pressed. This key sets bit 3 (to become 1) in the contents of memory location 14400. The effect of the AND is shown in Fig. 2. At the top are the eight bits of memory location 14400 with bit 3 set. Below is the number 8 in binary. The Xs may be set or reset (0) by other keys at the moment, but none of them will matter because each will be ANDed with the zero below it. In the example shown, the result of ANDing is 00001000 which (since it is not zero) will be inter-

decimal	binary
2	0010
3	0011
2 AND 3	0010
1	0001
1 AND (2 AND 3)	0000

Fig. 1. ANDing in binary

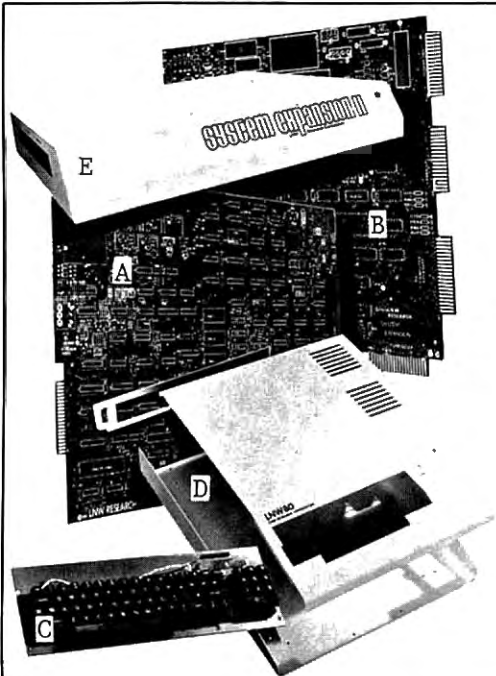
```
XXXX1XXX
AND 00001000
-----
00001000
```

Figure 2

```
10 INPUT A,B,C
20 IF A AND ( B OR C ) THEN 40
30 PRINT" DROPPED THROUGH":GOTO10
40 PRINT" BRANCHED":GOTO10
```

Program Listing 2

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preted as true. If the up-arrow key is not pressed, the upper 1 will be zero and the AND operation produces 00000000 or false.

The statement IF PEEK(14400) = 8 THEN 777 is not equivalent to line 700. Any of the eight keys that affect memory location 14400 will make the hypothesis false whether or not the up arrow is pressed. In situations like this, AND is a great time-saver in Basic programming.

The technique above is called masking. The effect of AND 8 was to hide (mask) all bits except bit 3. You can mask with AND to tell if an integer is even or odd (IF X AND 1 . . .) or to find the remainder after division by 16 (IF X AND 15 . . .). Masking is especially useful in lower-level languages that are more concerned with binary numbers than decimal. This will be investigated later.

If you consider AND, OR and NOT as the building blocks of the algebra of logic, you can derive other operations from them. Table 2 is a truth table definition of the exclusive-or operation for which the symbol XOR is used.

As its name implies, P XOR Q is true only when one or the other statement is true, but not both. By contrast, regular OR can be called *inclusive-or* since it includes the possibility that both statements are true.

Basic has no symbol for XOR, but you can define it in this way:

800 X = (A AND NOT B) OR (B AND NOT A)

This could be a short subroutine, or if

your Basic includes user-defined functions, you could make the above the definition of FNX(A,B). X in line 800 will be A XOR B. If you are not concerned about readability,

800 X = AANDNOTBORBANDNOTA

is equivalent since the operations order matches the existing parentheses.

Another way to accomplish *exclusive-or* is

800 X = (A OR B) AND NOT (A AND B)

You can prove that this always matches the output of the earlier line 800. In this formula of logic, dropping the parentheses radically alters its function. NOT A would then be the first operation performed, then the ANDs (left to right) and lastly the OR.

Exclusive-or has some interesting and useful properties. One technique for encoding a message involves this operation in a very straightforward way. Program Listing 3 shows this method at work.

In this program, you will code the message M\$ and you must supply a coding word C\$. Once the message is coded, this coding word alone will decode the message. The coding produces N\$. The program will print N\$ on the screen, but the coding may pro-

duce non-alphanumeric characters and the printout is unpredictable, so the ASCII codes of N\$'s characters are also shown.

The scheme is as follows: First, pointers CP and MP (for C\$ and M\$) are set to one. Second, the ASCII codes of the CPth letter of C\$ and the MPth letter of M\$ are XORed and N\$ gets an MPth character which has this result as its ASCII code. Third, CP and MP are incremented by one. If MP gets beyond the end of M\$, the task is completed. If not, then CP is checked to see if it is beyond C\$'s end. If it is, CP is set to one. Fourth, go to step two.

This leaves a string variable N\$ equal in length to M\$. How is the decoding done?

Decoding

Decoding is the same process with the same coding word. Once the program has shown N\$, it waits for a dummy input. Press enter and Listing 3 then decodes N\$ by setting M\$ = N\$

P	Q	P XOR Q
1	1	0
1	0	1
0	1	1
0	0	0

Table 2. Definition of XOR

```

5 CLEAR 100
10 INPUT "CODING WORD";C$
20 INPUT "MESSAGE TO BE CODED";M$
30 CP=0:MP=0:N$=""
40 MP=MP+1:IF MP > LEN(M$) THEN 100
50 CP=CP+1:IF CP > LEN(C$) THEN CP=1
60 A=ASC(MID$(M$,MP,1))
70 B=ASC(MID$(C$,CP,1))
80 X=(A AND NOT B) OR (B AND NOT A)
90 L=L+1:N$=N$+CHR$(X):GOTO40
100 PRINT N$
110 PRINT:FOR I=1 TO LEN(N$):PRINT ASC(MID$(N$,I));
120 NEXT:PRINT
130 INPUT Q$:M$=N$:GOTO30

```

Program Listing 3

```

10 INPUT P,Q,R
20 A=P:B=Q:GOSUB80
30 A=X:B=R:GOSUB80:PRINT X
40 A=Q:B=R:GOSUB80
50 A=X:B=P:GOSUB80:PRINT X
60 GOTO10
80 X=(A AND NOT B) OR (B AND NOT A)

```

Program Listing 4

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and jumping back to the beginning. The new N\$ turns out to be the original message! This trick works because of a curious property of the *exclusive-or* operation.

You can prove in symbolic logic that if $C = A \text{ XOR } B$ then $A = C \text{ XOR } B$. In other words, XORing with B takes you back and forth from A to C. The coding program applies this letter-by-letter. It produces a code that is not trivial to break, even if it is known that XOR is the method.

Related to this coding technique is a method for swapping the contents of two variables *without involving a third*. This is mostly a curiosity to the Basic programmer, but of more importance to Assembly-language programmers who have only a few easily accessible registers.

Here's the swapping procedure: Exclusive-or A with B and store in A; Exclusive-or this new A with B and store in B; Exclusive-or the current A and B and store in A. As if by magic, A and B

have exchanged their original contents. Work through some examples by hand (with binary numbers) and watch it happen.

Exclusive-or is like AND and OR in that the order of its operands does not matter; this property is called commutativity. Another property of interest in algebra is associativity. If an operation "o" is associative, then $(A \text{ o } B) \text{ o } C = A \text{ o } (B \text{ o } C)$. In other words, if an operation is associative, parentheses are not necessary in a series of these operations. Both AND and OR are associative, so $15 \text{ OR } 71 \text{ OR } 85 \text{ OR } 123$ gives consistent results no matter which numbers you OR first. What does $23 \text{ AND } 147 \text{ AND } 92 \text{ AND } 0 \text{ AND } 44$ equal, and how can the question be answered quickly?

Is XOR an associative operation? Will $1 \text{ XOR } 2 \text{ XOR } 3$ depend on which pair is done first? If it is associative, could you perform a "column *exclusive-or*?" You can use Program Listing 4 or one like it to investigate. The

more you try it, the more associative XOR seems to be. How long should you run the program to guarantee that it is associative?

Proving that $(A \text{ XOR } B) \text{ XOR } C = A \text{ XOR } (B \text{ XOR } C)$ is mathematically valid falls into the realm of algebraic logic. The foundation laid down so far qualifies symbolic logic to be called a Boolean Algebra or a Boolean Ring. Within this framework, you can prove certain simplification techniques and use XOR, AND, OR, and NOT to fuller advantage.

A Boolean Ring is an abstract mathematical entity within which many theorems have been proven. These laws are then applied in many ways: to symbolic logic (of interest here), to set theory (with intersection instead of AND, complements instead of NOT, and so on), to switching theory (where one and zero are closed and open switches, AND is two switches in series, and so on), and to many other applications. The fundamental rules for all these areas are precisely the same.

A AND 0 = 0	LAWS OF OPERATIONS WITH 0 AND 1
A OR 1 = 1	
A AND 1 = A	
A OR 0 = A	
A AND A = A	IDEMPOTENT LAWS
A OR A = A	
NOT (NOT A) = A	LAW OF DOUBLE NEGATION
A OR NOT A = 1	LAWS OF COMPLEMENTARITY
A AND NOT A = 0	
A OR B = B OR A	COMMUTATIVE LAWS
A AND B = B AND A	
(A OR B) OR C = A OR (B OR C)	ASSOCIATIVE LAWS
(A AND B) AND C = A AND (B AND C)	
A OR (B AND C) = (A OR B) AND (A OR C)	DISTRIBUTIVE LAWS
A AND (B OR C) = (A AND B) OR (A AND C)	
NOT (A OR B) = NOT A AND NOT B	DeMORGAN'S LAWS
NOT (A AND B) = NOT A OR NOT B	

In any valid logical equation, if all ones and zeros are exchanged and all ANDs and ORs are exchanged, the resulting sentence will also be valid.

Table 3. Fundamental Principles of Boolean Algebra

Basic Laws

Table 3 lists some of the basic laws of symbolic logic. You can prove these using truth tables since the variables can only stand for zero or one. With these same rules, circuit designers have laid out and simplified the Z80 chip. Here is a facet appearing in computer hardware and software alike—Boolean Algebra!

Especially notice the powerful Principle of Duality and how it relates to the pairing of entries in this table. Each logical statement has a dual in which all ANDs are changed to ORs, all ORs to ANDs, all ones to zeros and all zeros to ones. One of the classic techniques of simplifying electronic circuits is to form the dual of its Boolean expression, simplify it using the various laws, then form its dual, which will be equivalent to the original circuit.

You can prove theorems such as $\text{NOT}(A \text{ OR } B) = (\text{NOT } A) \text{ AND } (\text{NOT } B)$ by a truth table (see Table 4) which considers all combinations of truth values for A and B. Moving to the right, you fill in the columns on the basis of earlier columns and in accordance with the definitions of the operations. The fact that the final two columns are equivalent proves this theorem.

The theorem above relates to everyday logic in a simple way. The left side of the equation indicates that we are negating (making negative) an OR statement, like "It is not true that I will

A	B	A OR B	NOT A	NOT B	NOT (A OR B)	(NOT A) AND (NOT B)
1	1	1	0	0	0	0
1	0	1	0	1	0	0
0	1	1	1	0	0	0
0	0	0	1	1	1	1

Table 4

either go hiking or swimming." You can simplify this cumbersome statement by forming an AND composed of negations of the inner statements: "I will not go hiking and I will not go swimming." To differing degrees the various theorems can apply to logical reasoning patterns.

In truth-table proofs, eight rows are necessary if three variables are involved; 16 are required for four variables, and so on. This makes the truth-table method tedious for large numbers of variables. Algebraic techniques therefore have their place in simplifying logical expressions (or electronic circuits).

Earlier, I gave two different logical expressions that performed the exclusive-or operation on A and B. Table 5 shows a truth-table proof of this. Again, the last two columns are the crux of this proof. The codes 1-9 make the table hard to read, but printing full headings over the columns wastes space.

An alternative to the truth table is to apply various theorems of Boolean Algebra to transform one expression into the other. Table 6 shows one such sequence of steps and justifications which proves the equivalence of (A AND NOT B) OR (B AND NOT A) with (A OR B) AND NOT (A AND B). In the proof, the terms in parentheses indicate how that statement was derived from the statement preceding it.

Every step in the algebraic proof is logically equivalent to every other step,

so in writing a Basic program involving exclusive-or, you may choose the one that executes fastest or is easiest to type or easiest to comprehend, depending on your priorities. In electronics where each AND, OR and NOT is accomplished by transistors, diodes, and so on, the decision would probably fall between speed of execution and cost.

At the heart of TRS-80 Models I, II and III lies a Z80 microprocessor. In Z80 Assembly language, the techniques mentioned in this article become all the more useful because of the data's binary nature. Below are some simple illustrations.

- The commands AND, OR, XOR exist.

- The command CPL does the job of NOT or one's complementing and NEG does two's complementing.

- Most computations are performed in the accumulator, a one-byte register. The carry flag is one bit which is set to one if the last operation generated a carry (or a borrow). The commands AND A and OR A are famous tricks for resetting the carry flag to zero without changing A's contents (each command has A operating on itself). XOR A is a quick way to zero A.

- The blinking asterisk during cassette loads on Models I and III is accomplished by getting the contents of memory location 15423, XORing with 10, storing the result back in 15423, then repeating. (This is another use for

XOR: to toggle or flip-flop bits.

● AND, OR, and NOT and related functions are mainstays of the machine-language routines that make Basic work. In general, a thorough knowledge of logical algebra is a prerequisite for succeeding in Assembly-language programming.

Perhaps this article has inspired you to do some further investigations into the algebra of logic. If so, your computer can teach you a lot. Also, books about Boolean Algebra, switching circuits, logic, or set theory might help. The game WFF 'N PROOF is based on these concepts. (A wff is a well-formed formula composed of the type of ingredients mentioned above.)

Here are some suggested areas of exploration:

- In graphics, PEEKing at one of the video memory locations, then ANDing or ORing with various powers of two and POKEing it back will set and reset individual pixels.

- The NAND function is an AND followed by a NOT. It has been proven that any logical formula can be rewritten using only NANDS!

- Ditto for NOR.

- The listing of laws of symbolic logic only scratches the surface. Develop further formulas. Example: How can you safely remove the parentheses from A XOR (B AND C)?

- If you need to define a function which for an input of X gives SQR(X) if X is above four but which gives $5*X - 18$ for other Xs, try $Y = -(X > 4) * (SQR(X)) - (X <= 4) * (5*X - 18)$. This type of technique executes more quickly than a lot of If...Then. You can transplant this technique into many programming situations.

- Here's a partial answer to the challenge question of having the computer determine the highest of three numbers A, B, and C:

$$M = -A*(A > B \text{ AND } A > C) - B*(B > A \text{ AND } B > C) - C*(C > A \text{ AND } C > B).$$

This works unless all three inputs match. Fix the formula without using If.

- As a final challenge, use logical algebra to prove that (A XOR B) XOR B = A by using the formulas given for XOR and simplifying the left side until it equals A. ■

Jeffrey Myers (210 Park Ave., Hillsboro, OH 45133) has taught high school mathematics for 12 years.

A	B	1	2	3	4	5	6	7	8	9
1	1	0	0	1	1	0	0	0	0	0
1	0	0	1	1	0	1	0	1	1	1
0	1	1	0	1	0	0	1	1	1	1
0	0	1	1	0	0	0	0	1	0	0

1 = NOT A	4 = A AND B	7 = NOT (A AND B)
2 = NOT B	5 = A AND NOT B	8 = (A AND NOT B) OR (B AND NOT A)
3 = A OR B	6 = B AND NOT A	9 = (A OR B) AND NOT (A AND B)

Table 5. Truth table proof of two XOR formulas

1. (A & -B) OR (B & -A)	
2. ((A & -B) OR B) & ((A & -B) OR -A)	
3. ((A OR B) & (-B OR B)) & ((A OR -A) & (-A OR -B))	(distributive law of OR over AND)
4. ((A OR B) & 1) & (1 & (-A OR -B))	(distr. law of OR over AND, twice)
5. (A OR B) & (-A OR -B)	(law of complementarity)
6. (A OR B) & NOT(A AND B)	(law of ANDing with 1)
	(DeMorgan's Law)

Table 6

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Permanent Sound

by Richard C. McGarvey

Until Richard put a permanent audio amplifier into his CRT case, his desk was a tangle of wires. Now you can be more organized, too.

With two TRS-80s on one desk and all the associated clutter, I was getting tired of having the jumble of wires needed to hook up my amplifier for the sound effects that come with many of my games and other programs. It was only after opening my CRT that I realized there is more than enough room inside the computer's casing for a

permanent audio amplifier.

The modification should take only 30 minutes or so. Even the inexperienced hobbyist can easily make the installation. Read the instructions before starting and be sure you have all the parts and tools ready before you begin.

On Being Careful

The CRT casing is made of soft plastic. Drilling into plastic can be troublesome, so make a pilot hole using a very fine drill bit. Increase bit sizes in small increments until you get the correct hole size. It would be better to use a hand drill or a drill bit held in a pair of vise-grip pliers rather than a power drill.

Be sure you have correctly located all holes to be drilled *before drilling*. Check and double check before you drill. You cannot undrill a hole.

You will be working inside a tv set. High-voltage residue can cause serious electric shock. Picture tubes are fragile and can cause serious injury if they implode. Be careful!

Assembly

Assemble the potentiometer and potentiometer switch as indicated on the package backs. These components will be your remote on/off and volume controls. Color coding is important at

this stage. You will need at least four colors of light-gauge wire.

On the rear of the completed potentiometer are two connection points (Fig. 1). These are the on/off switch connections. Cut two lengths of red wire long enough to reach from the pot to the amplifier board; 10 inches should be long enough. Connect one wire to each of the rear connect points and solder.

Next, cut three wires of different colors the same length as the red switch wires. Attach one of these wires to each contact on the pot and solder. Twist or braid these wires into a cable for neatness. Leave an inch or so unbraided on each wire; strip the insulation from their ends and set it aside.

Now open the amplifier case. The PC board is small and can be removed by removing one screw, the volume knob, and the jack nuts on the outside of the case. Save the parts for later use. Remove the speaker also. It is fastened with a screw and gum-type glue. Remove the screw and carefully pry away the speaker.

For the next step, the power hook up, you have two options. To use a 9-volt battery, extend the power wires through a hole in the back of the CRT and mount a battery clip to hold the battery. This will make battery changing simple.

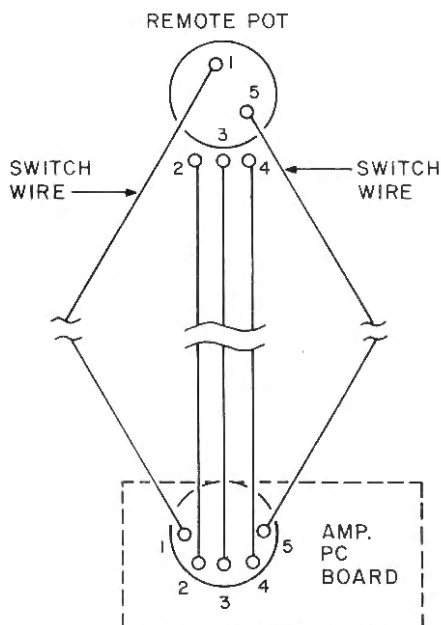


Fig. 1. Wire Set-up Between Pot and PC Board

The Key Box

Model I

I use a power supply. The amplifier is designed to handle 9 volts dc. I can handle up to 15 volts without burning or as little as 5 volts dc. In either case, you will have to extend the wires.

Extending the Wires

You will have to extend the wires at two locations: between the PC board and power connect point and between the PC board and speaker. It is better to replace the wires rather than to splice on extra.

To do this, cut wires long enough to reach from the intended PC board location to the speaker and power connect. Next, unsolder one end of a wire to be extended and solder the longer wire in its place. Then unsolder the other end of the short wire and solder the other end of the replacement wire in its place. Do this until all four wires have been extended. Again, twist the wires for neatness. If you remove all the wires at once, you will most likely forget where they belong.

Installation

The easiest location for the pot on/off switch is on the same side of the CRT casing as the amplifier. This requires drilling one hole.

To install the pot with the knob on the front of the CRT (Photo 1), open the CRT back carefully. Don't worry if the inside of your TRS-80 looks different than mine (Photo 2); there are different versions.

First, drill the pilot hole for the pot shaft from the outside. Drill exactly between the S and the - in TRS-80. This will neatly center the control knob. Continue to enlarge the hole until the pot shaft fits through.

Now cut a rectangular piece of plastic from the amplifier casing that will span the hole on the inside of the CRT. This piece will be used to mount the pot (Fig. 2). Drill a hole in the piece large enough to fit the pot shaft and thread. Put the washer and nut on the pot and mount it securely to the plastic piece.

Insert the pot shaft through the CRT casing hole so the plastic mounting piece is flush with the inside of the casing. Using a small drill bit, drill a hole through one side of the mounting piece and into the casing. Be sure the drilled hole is slightly smaller than the screws you removed from the PC board and speaker. You will use these screws to mount the pot to the casing.

Screw the mounting piece and pot in place. Make sure the pot shaft is centered, and then drill the hole

through the other side of the mounting bracket. Do not install the screw yet. Extend the pot far enough away from the front of the CRT so the knob does not scrape when turned. Mark this spot on the pot shaft. Remove the pot and cut the shaft at the mark. Be sure to

clamp the pot by the shaft for cutting and not by the pot itself.

Decide where you want to connect the amplifier PC board, and drill a small pilot hole for one of the jacks. On the outside of the CRT, place the PC board on the side of the CRT



Photo 1. Completed installation. Notice the centered control knob directly below the Radio Shack logo; the black speaker grating for covering speaker holes; and the marked audio and power jacks on the casing's right side.

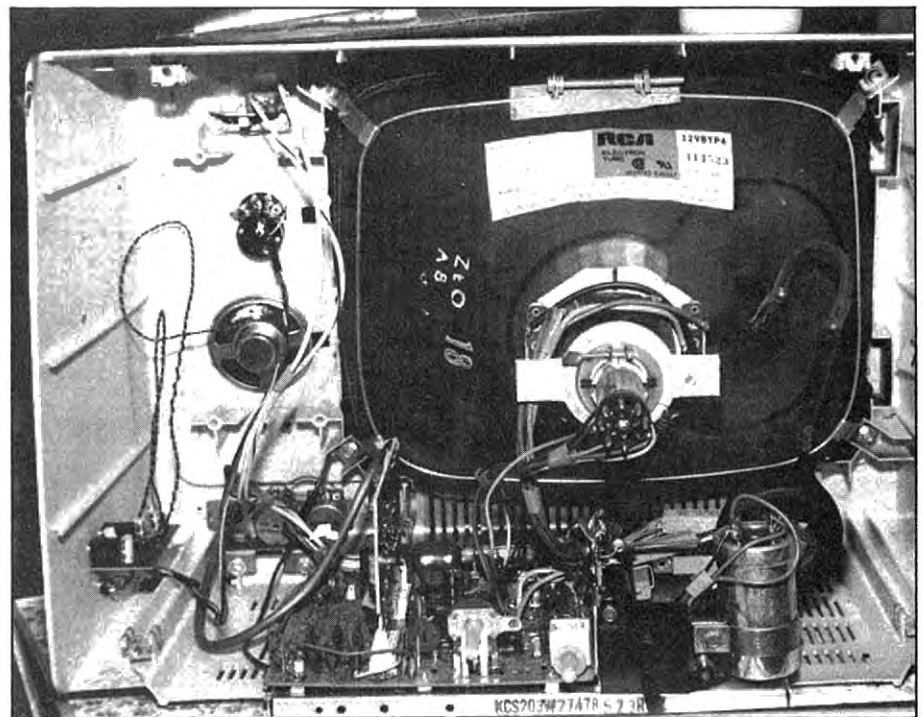


Photo 2. Opened casing. PC board is located at lower-left with the power jack just below that. The speaker is to the left of the video tube with the partially mounted pot above.

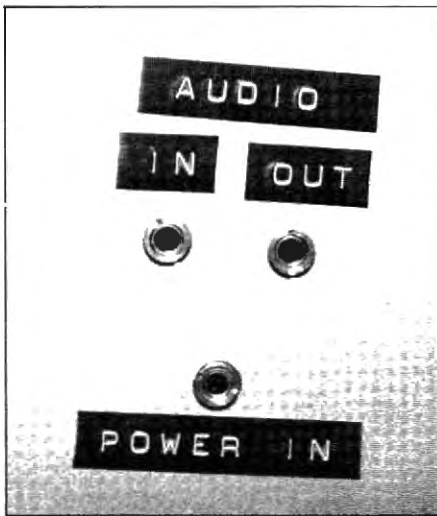


Photo 3. Close-up of Labeled Jacks

casing so the jacks are pointing down with one jack centered over the pilot hole. Mark the location of the center of the second jack and drill that pilot hole. Enlarge the holes until the jacks fit through. Do not install the PC board yet.

If you are going to use an external power supply, decide on a location for the jack that will prevent confusion between jacks. I placed mine centered below the PC jacks (Photos 2 and 3). Drill this hole as the others. Be certain it is not too close to the PC board.

Now select the location for the speaker and drill four holes from the inside for sound to pass through. Inside the CRT, just below the installed pot, is a good location for the speaker (Photo 2). The holes can be covered in front with a black or silver grating (Photo 1). Do not mount the speaker at

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1—Phone jack. Size is dependent on power input plug. Check with your local RS store for the proper jack. If you use a 9-volt battery instead of the power supply you can get a battery clip instead of the jack. Note the installation instructions for the particulars.

Table 1. The parts listed are Radio Shack, but may be substituted with any brand.

- 1—1/4 inch nut driver to remove rear of video
- Assorted drill bits ranging from very fine to 1/2 inch
- Hand drill or locking pliers
- 1—Small common screwdriver
- 1—Very small cross point screwdriver
- Light gauge wire (four colors): Shielded wire is not necessary
- Pencil-style soldering iron (low watt)
- Solder

Table 2. Tool List

this time.

Once you are certain everything fits, remove the parts and prepare to connect the pot. Set the PC board so its soldered connections are facing you (Fig. 1). Solder one of the red switch wires to the first point. Solder the other red switch wire to the fifth point. Make sure the installed pot is in the off position. If you want, carefully bend back the switch contact to prevent accidentally turning the power on. Solder the remaining three wires from the remote pot to their corresponding points on the installed pot.

Now for the test. Connect power and audio input, and run a sound program. Turn the remote pot on and in-

crease the volume. If the volume starts out loud and decreases or stays at one level, switch the second and fourth wires. The center wire should always be the center wire. If all checks out, install the system in the CRT casing and put on your finishing touches, such as jack labels.

That's all there is to it. Now you have sound in your unit where it belongs.

Oh, Something Else

People have asked how to get clear photos from the video display (Photo 1). The procedure uses a flash and untimed shutter speed.

Set the camera on a tripod angled

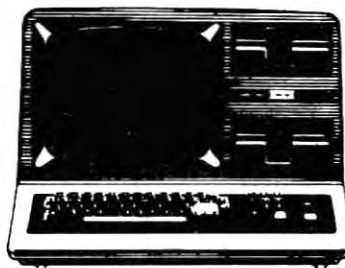
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against flash rebounding on the CRT. Shoot as you would a normal flash shot, but hold the shutter open for 10, 20, and 30 seconds. The flash exposes the casing while the extended exposure burns in the screen contents without significantly darkening the rest of the photo.

Use a cable release when taking long exposures to prevent accidental move-

ment.

I also use a green screen and a Radio Shack anti-glare screen. The screens prevent room light reflection. ■

Richard McGarvey is a police officer with a degree in psychology. He lives at 221 Hirschfield Drive, Williamsville, NY 14221.

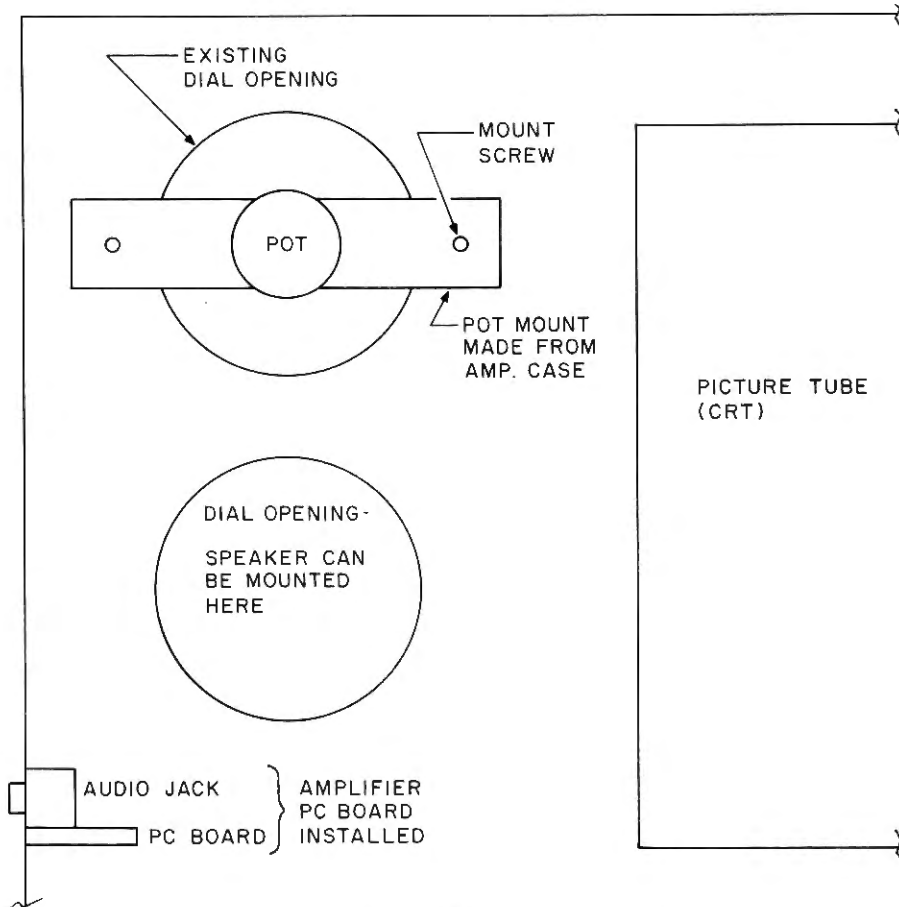


Fig. 2. CRT Casing with Back Removed

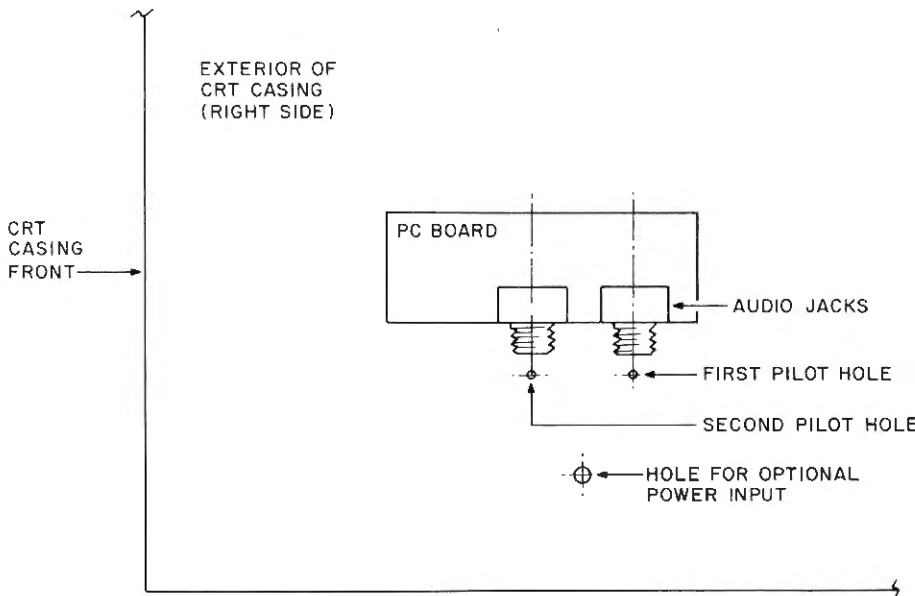


Fig. 3. CRT Casing Right Side Exterior

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Android Picture Gallery

by M. K. Cook

Here's a new game for you! It seems that there are no humanoids left on the planet Rehabul. Who will take over dusting the art gallery?

Long ago the planet of Rehabul was inhabited by a humanoid species that, as it grew in sophistication, developed androids to help with the more mundane tasks. But once they had enough androids for the mundane tasks, a lot of android engineers were out of work.

This so alarmed the government that it gave large grants to the industry to keep it going and help it develop even better androids to perform more interesting tasks.

Then, as more and more of the civilization's tasks were taken over by the androids the humanoid species went into a decline. Robbed of all the interesting tasks, they lost their zest for life and did nothing. So a million years of evolution came to naught, and the humanoids became extinct.

Unfortunately, nobody notified the androids, who continued mechanically about their daily duties: composing sonnets, acting in plays, and painting. Where there are painters there must be galleries and exhibitions, the National Android Gallery being one of the most famous.

As a legacy of the long-since extinct humanoid species, things are not always

as simple as they could be. An example is the anti-android duster used to clean the frames for the next exhibition. The duster removes the old android picture from the frame but has the annoying

side-effect of reversing the nearby frames. The curator of the android gallery, therefore, has a puzzling task when he comes to clear the gallery to make way for the next exhibition.

Also, all the android portraits must be in frames, not suspended in space as the duster sometimes leaves them, before a new exhibition can be opened. The problematic duster means an extended training period is needed for android curators. To save on dusters, a computer simulation was written and has been mysteriously transferred to

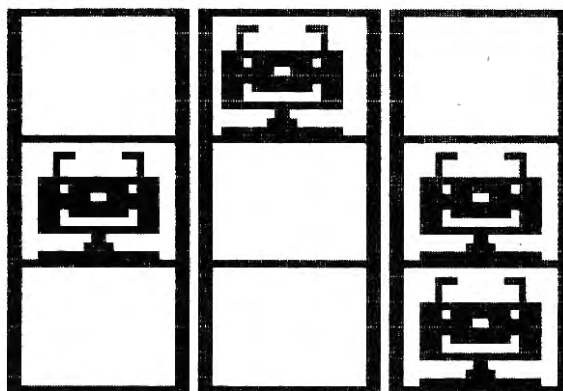


Figure 1

```
CLEAR THE GALLERY
7 8 9
4 5 6
1 2 3

CAN BE COMPLETED IN 6
TURN NUMBER 5
ENTER NUMBER - 5
```

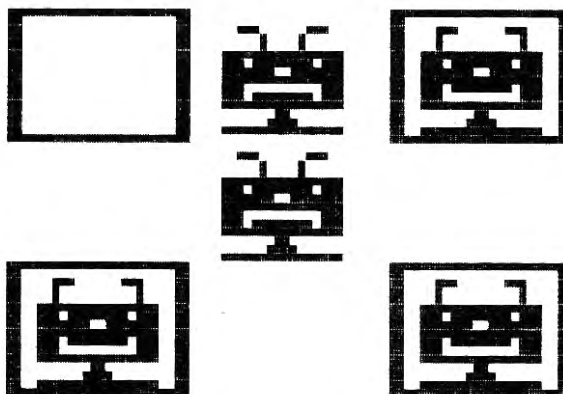


Figure 2

```
ANDROID GALLERY
7 8 9
4 5 6
1 2 3

CAN BE COMPLETED IN 10
TURN NUMBER 2
ENTER NUMBER - 6
```

The Key Box

Model I or III
16K, 32K RAM
Cassette or Disk Basic

earth via a crossed telephone line. So, you have the opportunity to train as an android curator as you play Android Gallery.

Android Gallery was written for a TRS-80 Model I computer using cassette or Disk Basic. It is two games in one—the clearing of the gallery and the setting up of an exhibition. In either mode you can let the computer set up your starting positions, in which case you are told the minimum number of duster applications needed to complete the task. Or you can set up the positions yourself.

To use the duster on a frame, press the key corresponding to that frame. It is the same layout as the numeric keyboard, but you can only use the duster on a frame, or a space, that is occupied with an android portrait.

Once you've sorted this out, you are left with the puzzle of organizing the gallery. The appearance and disappearance of the androids is accompanied by audio tones whose frequency corresponds to the frame number and duration, depending on whether the android portrait is appearing or disappearing. This allows the more adventurous reader to play the game blindfolded. (You could create a position where you could not possibly win, in which case you will be told.)

You might like to work out exactly how the program works and add more starting positions, not forgetting to include the minimum number of turns in which the puzzle can be completed. You might also like to tackle a program to solve the puzzle.

To test the program, enter the following initial conditions: For the simple game, set the Androids at 2, 5, 7, 8, 9 and play 5, 7, 9 to win.

For the full game, set the Androids at 4, 5, 6 and set frames at 1, 2, 3, 4, 6, 7, 8, 9; then play 6, 4, 5 to win.

Only try this if you're having trouble getting the program entered, since it might tell you something about the operation of the anti-android duster.

To adjust the program for Disk Basic, change the value in line 50. The accompanying diagrams are screen dumps of the game made by an MX-80 printer. One illustrates the simple game Clear the Gallery, and the other, the more complex, full game of Android Gallery. ■

M. K. Cook's address is 8 Fairhill, Helmsshore Rossendale, Lancaster, BB4 45Y, England.

Program Listing

```

5 'ANDROID PICTURE GALLERY BY M.K.COOK G8HBR
10 CLS
20 CLEAR 1000
30 DEFINT A-Z
40 DIM PA(9,4),FG$(1,31),SG$(15)
50 BA=0 '0 FOR DISK BASIC 1 FOR LEVEL ii
60 RANDOM
70 FOR A=1 TO 9
80 READ FT(A)
90 NEXT
100 PRINTCHR$(23):PRINT:PRINTSTRING$(32,42);
110 FOR A=1 TO 9
120 READ RT(A)
130 NEXT
140 PRINT"*** ANDROID PICTURE GALLERY ***";
150 PRINTSTRING$(32,42)
160 PRINT:PRINT:PRINT"DO YOU WANT THE RULES ? ";
170 FOR A=1 TO 31
180 READ FG$(0,A),FG$(1,A)
190 NEXT
200 FOR A=1 TO 15
210 READ SG$(A)
220 NEXT
230 AS=INKEY$:IF AS="" THEN 230
240 PRINTAS
250 IF AS<>"Y" THEN 390
260 PRINTCHR$(28)
270 PRINT@256,
280 PRINT"YOU ARE THE CURATOR OF THE ANDROID GALLERY"
290 PRINT"IN THE SIMPLE GAME YOU HAVE TO - "
300 PRINT"CLEAR THE GALLERY READY FOR THE EXHIBITION"
310 PRINT"YOU DO THIS BY USING YOUR ANTI-ANDROID DUSTER"
320 PRINT"THIS WILL CLEAR AN OCCUPIED FRAME BUT UNFORTUNATELY"
330 PRINT"FRAMES NEAR BY WILL BE REVERSED"
340 PRINT"CORNER - CENTER - MIDDLE OF ROW ----- EACH PRODUCE A
"
350 PRINT"DIFFERENT (BUT CONSISTENT) PATTERN OF CHANGE AND SOUND
"
360 PRINT"IN THE FULL GAME YOU HAVE TO GET ALL THE GIVEN FRAMES
OCCUPIED"
370 PRINT"BY HAPPY ANDROIDS (THEY'RE NOT HAPPY OUT OF A FRAME). "
380 PRINT"TYPING A 'Q' WILL QUIT THE CURRENT GAME AND START A NE
W ONE"
390 PRINT"TYPE S FOR THE SIMPLE GAME ":PRINT"ANY KEY FOR THE FUL
L VERSION ";
400 GS=INKEY$:IF GS="" THEN 400
410 PRINTGS
420 IF AS="Y" THEN 460
430 PRINT"DO YOU WANT TO ENTER YOUR OWN ":PRINT"STARTING POSITIO
NS ? ";
440 DAS=INKEY$:IF DAS="" THEN 440
450 PRINTDAS;
460 'SET UP FACE STRING
470 PRINT" OK"
480 FOR N=0 TO 7
490 F$(N)=" "
500 FOR N1=1 TO 8
510 READ T
520 F$(N)=F$(N)+CHR$(T)
530 NEXT N1,N
540 FOR N=1 TO 9
550 FOR N1=1 TO 4
560 READ PA(N,N1)
570 NEXT N1,N
580 BL$=STRING$(35,"A")
590 A=PEEK(VARPTR(BL$)+2):B=PEEK(VARPTR(BL$)+1)
600 AD1=A*256+B
610 IF AD1>32768 THEN C9=AD1-65536 ELSE C9=AD1
620 IF BA=0 THEN DEFUSR1=C9:CMD"T" ELSE POKE 16527,A:POKE 16526,
B
630 FOR A=C9 TO C9+29
640 READ T:POKE(A),T
650 NEXT
660 CLS
670 IF DAS<>"Y" THEN 860
680 FOR N=1 TO 9:BC(N)=0:NEXT
690 PRINTCHR$(23);"TYPE IN ANDROID POSITIONS"
700 PRINT"TYPE X WHEN FINISHED"
710 PRINT:PRINT:PRINT"ANDROIDS AT -";
720 GOSUB 2130
730 IF AS="X" THEN 750
740 BC(N)=1:GOTO 720
750 FOR N=1 TO 9

```

Listing continues

Listing continued

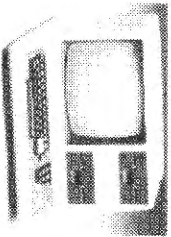
```

760 BF(N)=1
770 NEXT N
780 CLS
790 IF G$="S" THEN 1090
800 FOR N=1 TO 9:BF(N)=0:NEXT N
810 PRINTCHR$(23);"ENTER FRAME POSITIONS":PRINT"TYPE X WHEN FINI
SHED":PRINT
820 PRINT"FRAMES ARE AT - ";
830 GOSUB 2130
840 IF A$="X" THEN CLS:GOTO 1090
850 BF(N)=1:GOTO 830
860 NA=1:NF=0
870 FOR N=1 TO 9
880 BC(N)=0:BF(N)=0
890 NEXT
900 IF G$="S" THEN A$=SG$(RND(15)): TT$=RIGHT$(A$,2): GOSUB 2080
: GOSUB 2200 : GOTO 1010
910 C=RND(31)
920 A$=FG$(1,C)
930 TT$=RIGHT$(A$,2)
940 GOSUB 2080
950 FOR N=1 TO 9
960 BF(N)=BC(N)
970 NEXT
980 FOR A=1 TO 9:BC(A)=0:NEXT
990 A$=FG$(0,C)+" "
1000 GOSUB 2080
1010 FOR N=1 TO RND(4)
1020 FOR A=1 TO 9
1030 TF(RT(A))=BF(A):TC(RT(A))=BC(A)
1040 NEXT
1050 FOR A=1 TO 9
1060 BC(A)=TC(A):BF(A)=TF(A)
1070 NEXT
1080 NEXT
1090 TN=0
1100 FOR F=1 TO 9
1110 IF BF(F)=1 THEN GOSUB 1740
1120 NEXT F
1130 FOR F=1 TO 9
1140 IF BC(F)=1 THEN GOSUB 1840
1150 NEXT F
1160 P=38
1170 IF G$="S" THEN PRINT@P,"CLEAR THE GALLERY"; ELSE PRINT@P,"A
NDROID GALLERY";
1180 P=P+128
1190 PRINT@P," 7 8 9 ";P=P+64
1200 PRINT@P," 4 5 6 ";P=P+64
1210 PRINT@P," 1 2 3 ";P=P+128
1220 IF DA$>"Y" THEN PRINT@P,"CAN BE COMPLETED IN ";TT$;
1230 P=P+128
1240 PRINT@P,"TURN NUMBER ";TN;P=P+128
1250 PRINT@P,"ENTER NUMBER - ";P=P+64
1260 A$=INKEY$:IF A$="" THEN 1260
1270 TN=TN+1
1280 IF A$="Q" THEN 660
1290 F=VAL(A$)
1300 PRINT@694,A$;

```

Listing continues

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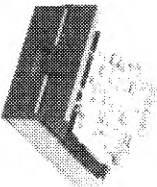
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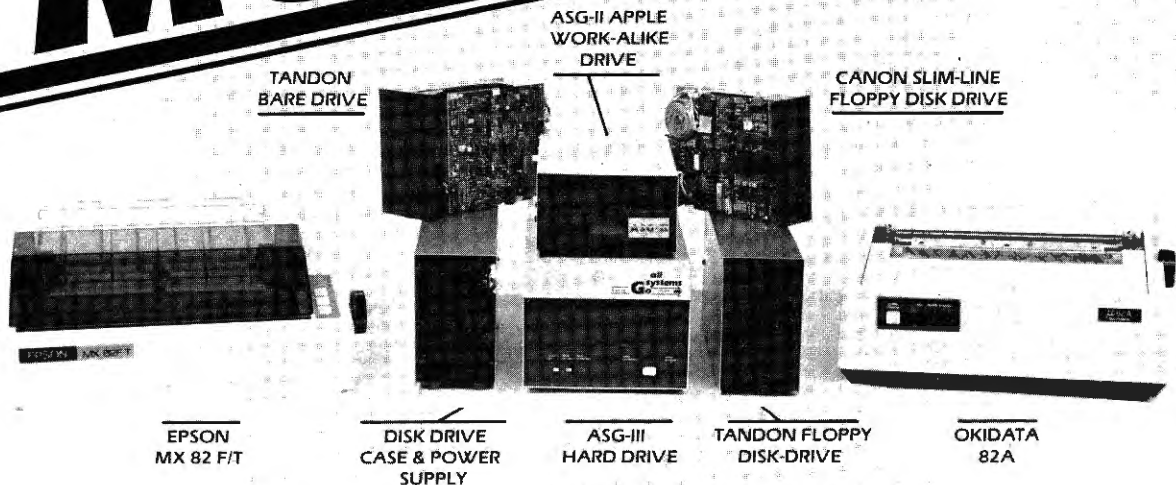
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Listing continued

```

1310 PRINT@562,TN;
1320 IF F>6 THEN F=F-6 : GOTO 1340
1330 IF F<4 THEN F=F+6
1340 IF BC(F)=0 THEN 1260
1350 C=F
1360 BC(F)=0:GOSUB 1980
1370 FOR N2=1 TO 4
1380 F=PA(C,N2)
1390 IF F=0 THEN 1410
1400 IF BC(F)=0 THEN BC(F)=1:GOSUB 1840 ELSE BC(F)=0:GOSUB 1980
1410 NEXT N2
1420 ET=1:AC=1
1430 FOR N=1 TO 9
1440 IF BC(N)<>BF(N) THEN ET=0
1450 IF BC(N)=1 THEN AC=0
1460 NEXT N
1470 IF AC=1 AND G$<>"S" THEN 1590
1480 IF AC=1 AND G$="S" THEN 1500
1490 IF ET=0 THEN 1260
1500 PRINT@806,"THAT'S IT !! ";
1510 PRINT@934,"HIT KEY FOR NEW GAME";
1520 FOR A=9 TO 1 STEP -1
1530 POKE(C9+14),FT(A)
1540 IF BA=0 THEN X=USR1(150) ELSE X=USR(150)
1550 FOR A1=1 TO 30:NEXT
1560 NEXT
1570 A$=INKEY$:IF A$="" THEN 1570
1580 GOTO 660
1590 PRINT@806,"YOU CAN'T WIN NOW";
1600 GOTO 1510
1610 TC=F:TR=1
1620 IF TC<4 THEN 1650
1630 TC=TC-3:TR=TR+1
1640 GOTO 1620
1650 TC=TC-1:TR=TR-1
1660 RETURN
1670 X=(12*TC)+1
1680 IF TC=2 THEN X=X+1
1690 Y=64*(TR*5)+1
1700 L=X+Y
1710 X=(TC*24)+12:Y=TR*15
1720 FP=POINT(X,Y)[2
1730 RETURN
1740 GOSUB 1610
1750 X1=TC*25:X2=TC*25+22
1760 FOR Y=TR*15 TO TR*15+15
1770 SET(X1,Y):SET(X1+1,Y):SET(X2,Y):SET(X2+1,Y)
1780 NEXT Y
1790 Y1=TR*15:Y2=TR*15+15
1800 FOR X=TC*25 TO TC*25+22
1810 SET(X,Y1):SET(X,Y2)
1820 NEXT X
1830 RETURN
1840 GOSUB 1610
1850 GOSUB 1670
1860 IF FP=1 THEN PRINT@L,F$(0);ELSE PRINT@L,F$(1);
1870 L=L+64
1880 IF BF(F)=1 THEN PRINT@L,F$(2);ELSE PRINT@L,F$(7);
1890 L=L+64

```

```

1900 PRINT@L,F$(3);
1910 L=L+64
1920 IF BF(F)=1 THEN PRINT@L,F$(4);ELSE PRINT@L,F$(6);
1930 L=L+64
1940 PRINT@L,F$(5);
1950 POKE(C9+14),FT(F)
1960 IF BA=0 THEN X=USR1(100) ELSE X=USR(100)
1970 RETURN
1980 GOSUB 1610
1990 GOSUB 1670
2000 IF FP=1 THEN PRINT@L,STRING$(8,131); ELSE PRINT@L,STRING$(8,128);
2010 FOR N=1 TO 4
2020 L=L+64
2030 PRINT@L,STRING$(8,128);
2040 NEXT N
2050 POKE(C9+14),FT(F)
2060 IF BA=0 THEN X=USR1(200) ELSE X=USR(200)
2070 RETURN
2080 L=LEN(A$)-2
2090 FOR A=1 TO L
2100 BC(VAL(MID$(A$,A,1)))=1
2110 NEXT
2120 RETURN
2130 A$=INKEY$:IF A$="" THEN 2130
2140 IF A$="X" THEN RETURN
2150 N=VAL(A$)
2160 IF N>6 THEN N=N-6 : GOTO 2180
2170 IF N<4 THEN N=N+6
2180 PRINTA$;";";
2190 RETURN
2200 FOR A=1 TO 9
2210 BF(A)=1
2220 NEXT
2230 RETURN
2240 DATA 60,70,80,90,100,110,120,130,140,3,6,9,2,5,8,1,4,7
2250 DATA 1,2345678913,1346,789 5,25,12345610,25,134678911
2260 DATA 3,159 3,134679,124579 6,124,3678910,5,1234678911,456,1
2310,1379,5 9,9,1 8,12346789,5 5,2,5 8,12358,12346789 7
2270 DATA 5,2 4,5,1379 9,2,1345678911,5,46 7,258,2468 7,19,1 6,8
,1238 7,1,36789 8,124,3678910,19,37 8,5,19 7,5,456 8,258,134679
9
2280 DATA 19,137910,258,12346789 3,357,159 8,1,37 4
2290 DATA 13579 9,1 6,13789 5,2468 4,135 5,1234678 4,138 5
2300 DATA 2 9,137 4,5 5,123456789 5,159 3,37 6,1289 8,12358 3
2310 DATA 131,179,147,131,131,163,179,131
2320 DATA 128,176,144,128,128,160,176,128
2330 DATA 176,181,176,176,176,176,186,176
2340 DATA 191,189,191,183,187,191,190,191
2350 DATA 191,181,179,179,179,179,186,191
2360 DATA 176,176,176,190,189,176,176,176
2370 DATA 191,181,188,188,188,188,186,191
2380 DATA 176,176,186,176,176,181,176,176
2390 DATA 2,4,5,0,1,3,0,0,2,5,6,0
2400 DATA 0,1,7,0,2,8,4,6,3,9,0,0
2410 DATA 4,5,8,0,7,9,0,0,5,6,8,0
2420 DATA 205,127,10,14,1,219,255,203,119,32,2,203,217,6
2430 DATA 100,0,16,253,121,238,3
2440 DATA 211,255,79,43,124,181,32,240,201

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Using DEFFN

by Ralph Rideout

The DEFFN statement lets you create your own functions. Using the DEFFN statement simplifies your programming and saves memory.

The DEFFN function is a powerful Disk Basic statement. The TRSDOS Disk Basic manual defines the DEFFN statement as "(It) lets you create your own implicit functions." Don't look for your tattered calculus text yet! An implicit function is a variable defined by an equation or set of equations. For example, consider the following equation:

$$f(X) = A + B$$

The variable X is defined as the sum of A and B. Since A and B can take on

any values in determining the value of X, the equation is an implicit function of X (f[X]). If the above equation read $X = 1 + 2$, it is obvious that the value of X must be three. In this case, X is defined by the explicit function $1 + 2$.

The expression following the DEFFN is implicit because it is in a general algebraic form. For example, the above equation in the DEFFN expression would appear as follows:

$$\text{DEFFNX(A,B)} = A + B$$

```
TB$="TITLE NAME":TB%=FNTB%(TB$):PRINTTAB(TB%);TB$
TN$="TITLE NAME":TN%=FNTB%(TN$):PRINTTAB(TN%);TN$
TN$="TITLE NAME":PRINTTAB(FNTB%(TN$));TN$
TN$="TITLE NAME":PRINT@0+FNTB%(TN$),TN$
```

Figure 1

Here the X variable is defined as the sum of A and B. In mathematical terms, X is the dependent variable while A and B are the independent variables. Since A and B occur within the parentheses, they are called arguments. Once the DEFFN expression is coded within a program, it can be evoked (called) by the statement FNX(A,B).

The expression is evaluated based on the current values of the arguments (A and B) within the program at the moment the function is initiated. For example, if A and B were 1.24 and 2.34, respectively, the FNX(A,B) would return the value 3.58, the sum of the arguments. The variable names (A and B) used as arguments are not assigned exclusively to the function; you don't have to use the same variables in calling the DEFFN statement. To add the variables X2 and HH together using the DEFFN expression, simply insert them as the arguments. For example, the statement FNX(X2,HH) returns the sum of X2 and HH. The arguments serve only as a means of passing values to the expression for evaluation.

Using the DEFFN statement in numerical expressions can simplify your programming by eliminating repetitious equations, thereby saving precious memory. There are other ap-

```
100 MN$="JANFEBMARAPRPMAYJUNJULAUAGSEPOCTNOVDEC"
110 DEFNDT$(M%,D%,Y%)=MID$(MN$,M%+((M%-1)*2),3)+CHR$(47)+STRING
$(3-LEN(STR$(D%)),48)+RIGHT$(STR$(D%),LEN(STR$(D%))-1)+CHR$(47)+
RIGHT$(STR$(Y%),2)
120 INPUT"ENTER MONTH NUMBER ";M%
130 IF M%<1 OR M%>12 THEN 120
140 INPUT"ENTER DAY NUMBER ";D%
150 IF D%<1 OR D%>31 THEN 140
160 INPUT"ENTER YEAR NUMBER ";Y%
170 IF Y%<10 OR Y%>=100 THEN 160
180 DATE$=FNDT$(M%,D%,Y%)
```

Program Listing

The Key Box

Disk Basic
Model I or III
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plications of the DEFFN function. The statement can be used for string manipulation as well.

DEFFN Strings

My first application of the DEFFN statement for string operations was a rather simple one: centering titles on the video display. The following statement computes the print tab position at which a title is centered.

```
DEFFNTB%(X$) = 32 - LEN(X$)/2
```

In the above statement variable TB% is the integer tab position to be computed from the string variable X\$ (the title). The LEN statement returns the length of the string. The length is then divided by two and subtracted from 32. For example, if a title has 40 characters, the above function returns a tab position of 12 where the title (when printed) is centered on the video screen. Any valid Basic string variable name can be passed to the function via the X\$ argument.

There are several methods to center a title. I use the four samples shown in Fig. 1. All four samples produce the same result. The choice is a matter of individual style or specific application. The above example is only one of the many uses I've found for the DEFFN function in string manipulations. The extent of its uses depends on your specific program requirements, but the following example may give you better insight into its power.

Formatting a Date

Many programs require date entries as part of filing information. The DEFFN function lets you create a date format with little programming effort. This is very important if you are working with random direct access files where a proper format is required by a specific number of bytes for a disk buffer. A date format may be defined for eight bytes of storage: MM/DD/YY. This numerical date format is very popular. Oftentimes, however, you need to have a date in a format that includes the name of the month (AUG/05/82) instead of its numerical counterpart. Although this is a more readable format, entering the month name and slashes many times can become tedious. The Program Listing shows how the DEFFN function can solve the problem.

Variable MN\$ (line 100) is assigned the first three letters of each month. The DEFFN statement in line 110 uses

this string for converting the numerical month entry into its alphabetic name. The final date format we seek is MMM/DD/YY. The string operations defining the final date (DT\$) are computed based on the desired format from left to right, starting with the month. The formatting is accomplished with the use of several important Basic string statements: MID\$, CHR\$, STRING\$, LEN, STR\$, and RIGHT\$. In the DEFFN statement, I have chosen the arguments M% (integer month number), D% (integer day number), and Y% (integer year number last two digits).

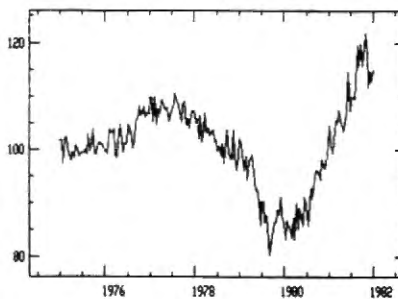
Take note of the data-entry lines (120-170). I have inserted validation checks on the month number, day number, and year number that are entered. This is a precaution to avoid an error message. It is also a good programming technique.

To see how the DEFFN function works, let's take an example through the process. Let's choose the date 8/5/82 or AUG/05/82. Since the desired final date format is MMM/DD/YY, the first DEFFN statement operation converts the numerical

month input to the appropriate month name. This is accomplished through the MID\$ statement. Here, the month number (M%) must be used to calculate the proper character position in the MN\$. The computation is done in the expression $M\% + ((M\% - 1) * 2)$. For example, if the month number is eight (AUG) the result of the calculation would be $8 + ((8 - 1) * 2)$ or 22. The 22nd position of MN\$ is where the month letters AUG begin. The third argument of the MID\$ statement (numeral 3) returns the three characters beginning with the 22nd position, namely AUG, the desired month name.

Once the month name has been evaluated, the next step is to get the slash mark separating the month name from the day number. The program concatenates (links together) the month letters with CHR\$(47), the character code for a slash. The result is AUG/.

Since the desired format (MMM/DD/YY) requires a day number with two characters, a single digit, such as 5, must become 05. A two-digit day remains unchanged. The Basic statements STRING\$, LEN, STR\$, and RIGHT\$ perform the day evaluation.



From the review in INFOWORLD (7/12/82, p. 41)

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In the STRING\$ statement the numerical day (D%) is converted to a string (STR\$(D%)) so it can be manipulated. Then subtract the length of the day string (LEN[STR\$(D%)]) from three to determine whether to insert a zero before a single-digit day (05). The value 48 in the last STRING\$ position is the character code for a zero.

Subtract the length of the day string from three because, under the conditions of the program, the maximum length of any string day number is three. All numbers in the computer have a space preceding the actual value that is reserved for a negative sign, if the number is negative. Therefore, a single-digit number is actually two characters long when converted to a string by the STR\$ statement, while a two-digit number is three characters long.

For the single-digit day, the STRING\$ statement returns one zero. For the two-digit day, the number of zeros returned is zero or a null string, so no zeros will be placed before the day string.

The next statement, RIGHT\$(STR\$(D%),LEN[STR\$(D%)]-1), links the

day number to the date. The statement returns a one-character string of a single-digit day and a two-character string of a two-digit day, beginning with the rightmost character. Starting at the right character position eliminates the first left position, which is reserved for the sign. A slash character (CHR\$(47)) is then added before the year is concatenated. The date format at this point is AUG/05/.

The last statement converts the year number to a string and links the last two characters from the right (the year number) to the date. As stated above, the right characters are taken because the first blank position is reserved for the sign. After the year is added the final result is AUG/05/82.

Line 180 is where the DEFFN is evoked, passing the numerical date entries (M%, D%, and Y%) to the function, and assigning the formatted date (MMM/DD/YY) to the string variable DATES.

DEFFN Function Advantages

Although the date format DEFFN statement is complicated, it demonstrates what you can do with one line

of code that would otherwise require many lines of program statements to achieve the same objective. In the demonstration program presented here, only three numerical entries are required for inputting a date. Without the DEFFN statement, the same date format took 15 lines of code in my old program. I saved nearly 500 bytes of memory!

Another important advantage is program documentation. Defining frequently used variable routines in the DEFFN statement allows you and others to follow your program's logic flow with greater understanding. This is important when you are writing programs for others. Written instructions are clearer because the DEFFN functions are almost self-explanatory. You need not use as many remark statements within the program, thus avoiding longer execution times. Using DEFFN functions also improves your programming technique and gives your final work a professional appearance. ■

Ralph Rideout (3101 Morningside Drive, Raleigh, NC 27601) is a self-employed chemist.

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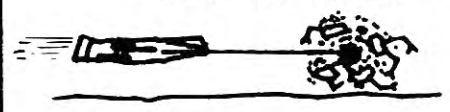
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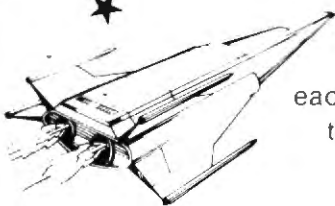


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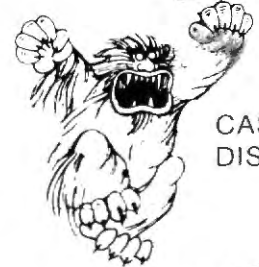
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CATEGORIES

by Glenn Collura

If you're tired of fighting space creatures, Categories may be for you. You can play it without your 80, but this program adds spice.

Caution! This game may be habit forming. No, it's not the latest offering from Atari. In fact it's not an arcade-type game. You don't even need a computer to play this game.

What Is It?

Categories can be played by any number of people. All you need is a pencil and a piece of paper for each

player. To start off, each player divides his paper into 20 squares as shown in Fig. 1. There are four columns and five rows. Each player then chooses a category (or categories, depending on the number of players) to enter onto the game sheet.

For example, you could use types of automobiles or the names of cities. Enter the categories on the left side of

the game sheet corresponding to the five rows. After the categories have been chosen, four letters are chosen, one for each column on the game sheet. Once this is done you are ready to play the game.

How to Play

The object of the game is to find four words for each category, one word starting with each of the four different

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Variable Name	Description
A\$	Alphabet
B\$	Categories
C1	Category 1
C2	Category 2
C3	Category 3
C4	Category 4
C5	Category 5
E\$	Input Variable
I\$	Input Variable
M	Minutes
N	One-Second Timer
P	Print Flag
Q	Print Loop Counter
R1	First Letter
R2	Second Letter
R3	Third Letter
R4	Fourth Letter
S	Seconds
T	Misc. For...Next Loop
X	Graphics Variable
Y	Graphics Variable
Z	Number of Game Sheets

Table 1. Variable List

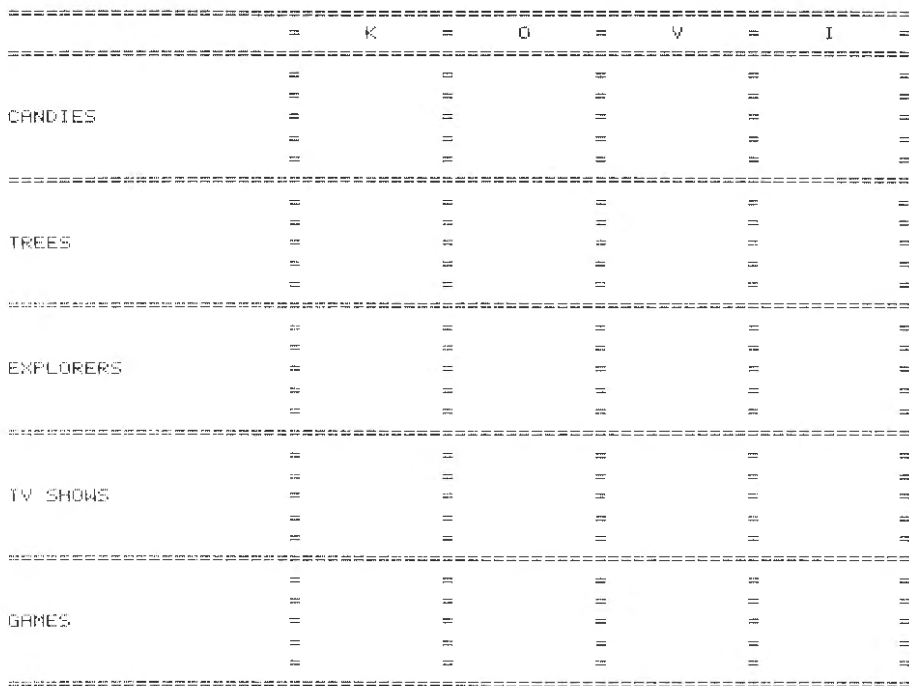


Figure 1

You Are Being Attacked by a Raging . . .

Caterpillar



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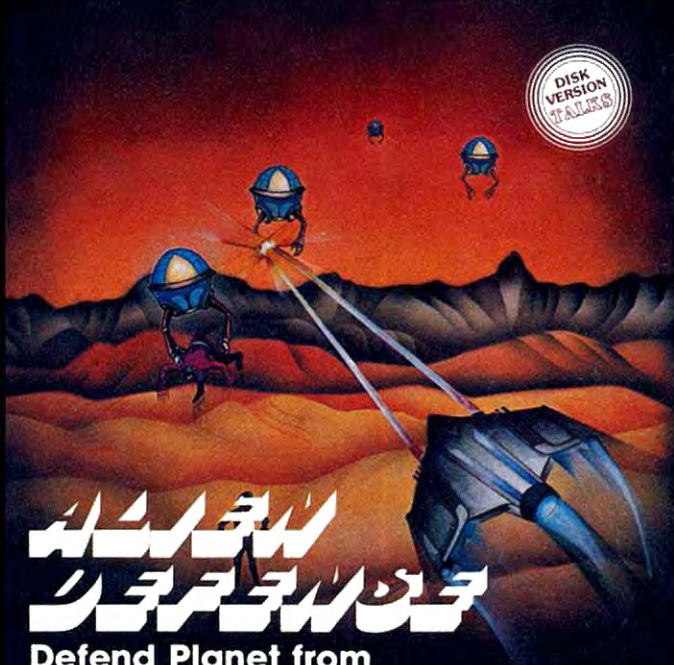
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NEW DEFENSE

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letters, in an allotted time period. If one of your categories was names of cities, you would enter the names of four cities each starting with the corresponding let-

ter for that column. Refer to Fig. 2 for a completed game sheet.

Each player continues to fill in his game sheet until the five-minute time

limit is reached, or until one player fills in his entire sheet before the five minutes is up. There will be times when there is no answer for a particular category/letter combination.

Scoring is very simple. Each correct answer scores one point. Any wrong answer or empty square counts as no point. The person receiving the highest score is the winner for that round. Since

	B	D	O	K
CITIES	BOSTON	DENVER	OKLAHOMA CITY	KALAMAZOO
DISC JOCKEYS	BILLY BASS	GARY DEE		KID LBC
MUSICIANS	JEFF BECK	AL DIMEOLA	SHUGGIE OTIS	E.B. KING
HOBBIES	BASEBALL	DRAG RACING		KNITTING
CARTOON CHARACTERS	BULLWINKLE	DAFFY DUCK	ODIE COLONEY	KING LEONARDO

Figure 2

“The object of the game is to find four words for each category, one word starting with each of the four different letters. . .”

there can be many correct answers for certain category/letter combinations, it is up to the players to check all answers and decide whether or not they are correct. The easiest way to do this is to start with the first category and the first letter and read the answer out loud. When all players have read their answers for that row, you can continue to the next, and so on through the entire game sheet. A game may consist of as many rounds as the players decide upon.


Why Use a Computer?

My wife and I have played this game for hours on end. It seems that after a few games we have a hard time thinking of categories to use. The microcomputer solves this problem quite easily.

I put as many categories as we could think of into the computer and then let the program generate five random categories and four random letters for each game. This also solves the problem of people choosing categories that they are more familiar with than are the other players. By randomly picking four letters of the alphabet, the computer prevents players from choosing letters that they know can be used with certain categories.

The computer also acts as a time keeper, notifying you when the time limit has expired. The last feature I added was the game-sheet printout option. The computer generates the game sheets for you if you have a printer. The program can be used without a printer, however. The main advantage of the printout option is that you can print any

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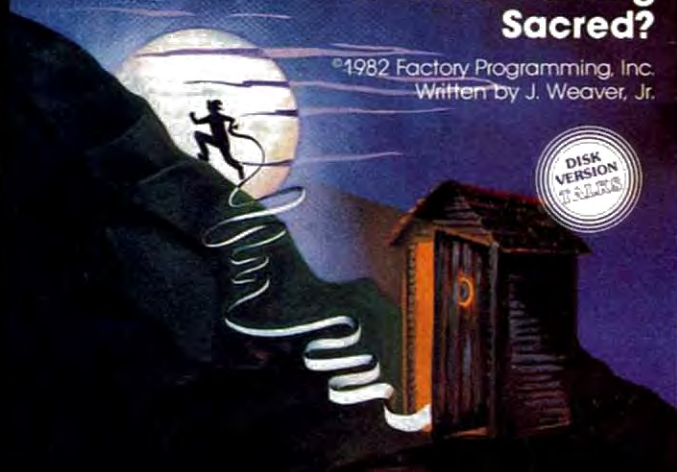
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number of game sheets at your convenience and have them available whenever you get the urge to play.

About the Program

The remark statements in the listing should point out any routines that you may want to modify. You may delete the remark statements without affecting program operation.

The first section of the program prints the instructions. The main program starts at line 1000. It checks for

duplicates after each category and letters are chosen.

You may have to adjust line 2090 to ensure an accurate timer. If the five-minute timer seems slow, use a number less than 476. If it runs fast use a number greater than 476.

Line 4000 keeps the time display in an orderly format. The first statement in this line, PRINT@ 50,M": 0," makes sure that four minutes and nine seconds appears as 4:09 rather than 4: 9. The TRS-80 always leaves a leading blank

Program Listing

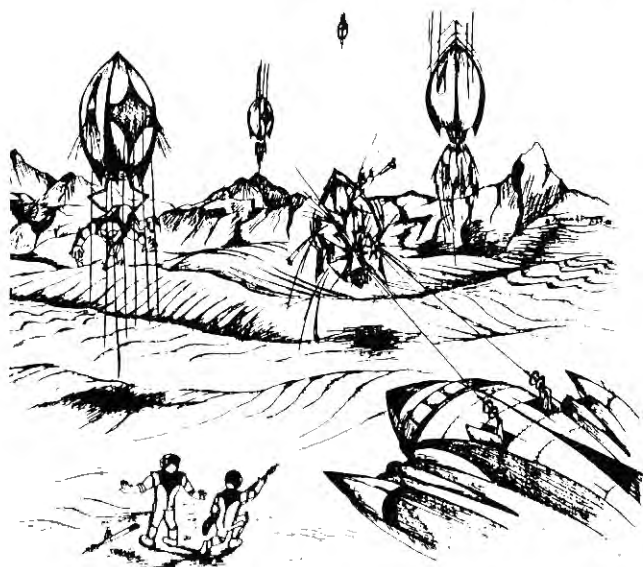
```
1 CLEAR100:DIMA$(25),B$(100)
2 RANDOM
3 DEFINTM,P,S,T,X,Y
10 REM ***** CATEGORIES *****
   * BY *
   ** GLENN COLLURA JR **
   ***** 03/01/80 *****
11 REM VERSION 2.0 03/12/82
100 CLS:PRINT@20,"C A T E G O R I E S"
110 PRINT:PRINT:INPUT"WOULD YOU LIKE INSTRUCTIONS";I$
120 I$LEFT$(I$,1)="N"THEN600
150 CLS:PRINT:PRINT:PRINT"CATEGORIES IS A GAME PLAYED BY TWO OR
MORE PEOPLE. IT IS PLAYED ON A PIECE OF PAPER DIVIDED INTO 20 SQ
UARES. YOU HAVE THE OPTION OF LETTING YOUR TRS-80 PRINT THE GAME
SHEET FOR YOU.
155 PRINT:PRINT"IF YOU DO NOT HAVE A PSINTER, OR IF YOU WISH TO
MAKE UP YOUR OWN GAME SHEETS, FOLLOW MY INSTRUCTIONS."
160 PRINT:PRINT"YOUR SHEET OF PAPER SHOULD BE DIVIDED INTO 20 SQ
UARES AS SHOWN:"
170 PRINT:PRINT:INPUT"                PRESS ENTER TO SEE DIAGRAM"
;E$
180 GOSUB5000
190 PRINT@256,"CATEGORY";:PRINT@384,"CATEGORY";:PRINT@576,"CATEG
ORY";
200 PRINT@704,"CATEGORY";:PRINT@832,"CATEGORY";
210 PRINT@78,"LETTER";:PRINT@89,"LETTER";:PRINT@100,"LETTER";:PR
INT@111,"LETTER";
220 PRINT@0,"PRESS ENTER TO CONTINUE";:INPUTE$;
230 CLS:PRINT:PRINT"FOR EACH GAME THE COMPUTER WILL GENERATE 5 R
ANDOM CATEGORIES AND FIVE RANDOM LETTERS. THE OBJECT OF THE GAME
IS TO PUT A WORD IN EACH COLUMN STARTING WITH THE LETTER FOR THE
T ROW.
240 PRINT:PRINT"LETS SAY FOR EXAMPLE THAT CATEGORY #1 IS SPORTS,
AND YOUR FOUR RANDOM LETTERS ARE B F G H.
250 PRINT:PRINT"THE TOP ROW OF YOUR SHEET WOULD LOOK SOMETHING L
IKE THIS:";
255 FOR T=1 TO 450:PRINT:GOTO 260
260 FOR X=2 TO 113:FOR Y=33 TO 40:STEP 7
270 SET(X,Y):NEXT Y:NEXT X
280 FOR X=25 TO 113:STEP 22:FOR Y=33 TO 40
290 SET(X,Y):NEXT Y:NEXT X
295 PRINT@657,"B";:PRINT@667,"F";:PRINT@678,"G";:PRINT@690,"H";
300 PRINT@769,"SPORTS";:PRINT@782,"BASEBALL";:PRINT@793,"FOOTBAL
L";:PRINT@806,"GOLF";:PRINT@816,"HOCKEY";
310 PRINT@980,"PRESS ENTER TO CONTINUE";:INPUTE$
320 CLS:PRINT"THE OBJECT OF THE GAME IS TO FILL IN ALL OF THE SQ
UARES. THERE IS A FIVE MINUTE TIME LIMIT PER GAME. IF ANY PLAYE
R FILLS IN ALL THE CATEGORIES BEFORE FIVE MINUTES, THE GAME IS OV
ER.
330 PRINT:PRINT"YOU SCORE ONE POINT FOR EACH CORRECT ANSWER. IT
IS UP TO YOU TO CHECK FOR CORRECT ANSWERS, SINCE THERE CAN BE M
ANY DIFFERENT ANSWERS FOR EACH QUESTION. ANY EMPTY SQUARE COUN
TS AS A WRONG ANSWER (NO POINTS). ";
335 PRINT"THERE MAY BE TIMES WHEN THERE IS NO ANSWER FOR A CERT
AIN LETTER. (EX. A COLOR WITH THE LETTER X.)
340 PRINT:PRINT"FOR YOUR CONVENIENCE, THE TIME LEFT WILL BE DIS
PLAYED IN THE UPPER RIGHT HAND CORNER OF THE SCREEN.
350 PRINT"PRESS ' 1 ' TO REVIEW THE INSTRUCTIONS,
OR ' 2 ' TO START PLAYING."
355 I$=INKEY$:IFI$=""THEN355ELSEIFI$="1"THEN150
360 IFI$<>"2"THEN350
600 P=0:Z=0:INPUT"WOULD YOU LIKE TO PRINT GAME SHEETS";I$:IFLEFT
$(I$,1)="Y"THENP=1
610 IFP=1THENINPUT"HOW MANY SHEETS";Z
```

Listing continues



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MULTI-DRIVE - True multi-drive operation is possible. POSTMAN will search all drives for address files and connect them together into one large file for the duration of that session. Once POSTMAN has found the data files on the disks, the operator sees just ONE CONTIGUOUS sorted list of addresses. The operator does not need to tell POSTMAN when to "switch" drives or manually "swap" sections of the data file in and out of the computer's memory. This is the foremost among the list of features because of its relative uniqueness among mail list handlers written for the TRS-80.

LARGE LIST SUPPORT - The multi-drive operation allows the user to access data files on ALL configured drives CONCURRENTLY (at the SAME time) for truly large mailing lists. Files need not be sectioned into smaller "byte size" chunks to fit into memory.

HARD DISK SUPPORT - (HARD DISK POSTMAN only) The FULL utilization of the space and speed of the new hard disk drives is possible with POSTMAN. For example, a 7.5 megabyte drive can be configured to hold almost 60,000 labels. Multiple hard drives can be accessed CONCURRENTLY allowing 200,000++ entry mailing lists.

FORM LETTER CAPABILITY - With the purchase of the separate POSTWRITER program, the user is provided with an easy to use form letter generator which will merge a generalized letter produced from a word processing system (i.e. LAZY WRITER, etc.) with the name and address information from the POSTMAN MASS MAILER data base. POSTWRITER allows the user to insert any field from a POSTMAN label entry anywhere in the letter.

MENU OPERATION - As you would in a restaurant, choose your dinner from a list (or MENU). POSTMAN will allow you to direct its actions by selecting from various menus that it will display. A complete discussion of each menu is presented in the manual.

INSERT - New names can be quickly added to your list at any time. The new addresses are placed into the file in their proper sorted order eliminating the need for a separate sort operation after entering a stack of new names. POSTMAN will allow the operator to enter a "batch" of labels without returning to the control menu between each label insertion, thus speeding entry and reducing the aggravation of extra menu control keystrokes.

DELETE - Names can be removed at any time when they are no longer needed.

EDIT - Information in any name entry can be quickly changed at will with "word processor" ease. A "transparent" cursor simply is moved to the label displayed on the computer screen and corrections are just typed over the existing label. If you happen to change a field which is also used as a sort key, POSTMAN will automatically move the changed label to its correct position in the list to maintain the sorted arrangement of the labels.

OVERLAY - When identical changes are needed on many addresses, the OVERLAY feature can make them with one keystroke. The needed changes which are common to many labels are entered into the "overlay mask". When you wish to apply these common changes to any label, one command will do it.

SORT - Arrange your list in any alphabetic or numeric order. The ordering may use one or more fields to control the sort. A machine language heap sort assures fast execution. The sort need only be performed once; the sorted list will stay sorted through all subsequent insertions, deletions, and changes to existing labels. NO NEED to leave the POSTMAN program to use a separate program to sort your data. Your data is sorted quickly and after sort completion, POSTMAN is ready for your next command.

SPECIAL STREET ADDRESS SORT - For the user with many addresses on the same street, POSTMAN will sort your entries by the house NUMBER after grouping those on the same street together. Local city lists can be quickly sorted to aid post office dispatching.

PURGE - Unwanted duplicate addresses can be removed from your list automatically or under operator control.

SEARCH - Any address in your list can be quickly found with fast search and positioning commands. Three different types of searches are provided. A "fast" search which uses a hashing technique; a "selective sequential" search for labels with common fields, and a "quick" positioning using the first or major sort field to get you into the general "ball park" of a label or sequence of labels.

LABEL PRINTING - One, a few or all addresses in your list can be printed on standard or non-standard label stock. Up to 6 labels across can be printed with a format YOU can easily control. TWO user definable "ATTN" lines are provided for any use. Labels can be printed from many of POSTMAN's menus, search, edit, or during label insertion.

EFFICIENCY - POSTMAN is written in the machine's native language to gain the full advantage of the microcomputer's speed. Extensive use of program segmentation reduces the amount of use RAM needed to hold the program, allowing a greater number of labels to be kept in core, resulting in faster operation. Little used routines need only be brought into memory when they are needed and once through with their task, release their space back to POSTMAN.

REPORT LISTINGS - A special program to produce columnar listings of address data from your label data base is provided. You can easily specify the information to be printed.

DATA DISK MERGING - Labels can be quickly transferred from one disk to another with the PSIMERGE program callable from the main POSTMAN SYSTEM menu. Source and destination drives need not be separate drives, prompts to exchange diskettes if the same drive is used, are provided.

DATA DISK PREPARATION UTILITY - Provided with POSTMAN is the DPREP program which allows the user to prepare a floppy/hard disk for use with POSTMAN. This easy to use utility can be told to prepare any portion of the available space on a disk.

DATA INTEGRITY - All data transfers to the disk files are made using special write commands which instructs the operating system to check the validity of EACH write to the disk.

DATA GUARD - Is a special programming technique only offered by Soft Sector Marketing, Inc. If by chance your machine resets while writing information to the disk, you only lose the information that you were writing. Your files are always protected from the danger of losing all the work that you have put in that day. NO OTHER PROGRAM ON THE MARKET OFFERS THIS PROTECTION. If you reset with ANYBODY'S MAILING PACKAGE DURING WRITING you would destroy your ENTIRE data disk. We can't stop your machine from failing but we can protect your data.

Description of Label Record Fields:

Length	Name	Description	Length	Name	Description
10	Code	User defined printable field	15	City	City, township, village
15	Last Name	Last name of addressee	5	State	State, province, territory
15	First Name	First name of addressee	9	Zip	Zip code, zone, route
26	Company	Name of company	2	Data 1	User definable field
26	Address	Street address	5	Data 2	User definable field

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Number Your Program Listings

by Joe Edwards

Here's a utility that will come in handy for you Basic programmers—a machine-code routine that numbers pages of multi-page listings.

This routine numbers pages of multi-page Basic program listings. I have used it with several utility programs; by relocating the program and

changing the jump instruction in line 250 to a halt instruction, you could use it in smaller systems without disk. (The expansion interface or some type of

parallel interface for the printer is still necessary.)

Here's the Plan

Using EDTASM, type the source code and dump the program to disk. Now, load the program in memory. When control returns to DOS, enter Basic. Use 65279 for memory size. With the printer on, set the print head six lines down from the top perforation. Now, run the following test program:

```
10 FOR I=1 TO 70
20 LPRINT I
30 NEXT
40 END
```

The program should print digits 1-54 down the left margin of the page, skip to the top of the next page, print PAGE 02 in the upper right corner, and then digits 55-70 down the left margin.

To reinitialize the page counter without reloading from disk, type LPRINT CHR\$(12). This feature is useful when running several copies of multi-page data. ■

Joe Edwards, 7130 Bronner Circle, Louisville, KY 40218, is retired. His hobbies are ham radio and flying.

Program Listing

```
00100 :PAGE NUMBERING FOR BASIC (FILESPEC: PAGE/CMD)
00110 :BY JOE EDWARDS, 7130 BRONNER CIRCLE
00120 :LOUISVILLE, KY. -- AUGUST 1, 1981
00130
00140 :FORM FEED (CHR*(12) IN BASIC) REINITIALIZES PROGRAM
00150 :WITHOUT RE-LOADING. RESET PAPER WITH PRINT HEAD
00160 :APPROXIMATELY SIX LINES DOWN FROM PERFORATION.
00170 :PAGE NUMBER 01 IS NOT NUMBERED.
00180 :THIS PROGRAM ALSO WORKS WITH NEWDOS EDTASM, DISASSEM.
00190 :AND RSM MONITOR
00200
FD00      00210      ORG      @FD00H
FD00 2124FD 00220 START  LD      HL,PRNTR :LOAD DRIVER ADR.
FD03 222640 00230      LD      (&026H),HL :STORE OUR ADDRESS
FD06 CD0CFD 00240      CALL     INIZ      :INITIALIZE COUNTERS
FD09 C32D40 00250      JP       402DH  :RETURN TO DOS
FD0E 3E4F    00260 INIZ  LD      A,79D  :SET CHARACTER COUNT
FD11 3E30    00270      LD      (&CHCNT),A :STORE IT
FD13 3297FD 00280      LD      A,30H  :1ST ASCII DIGIT OF NBR.
FD16 3E32    00290      LD      (&PGNBR1),A :STORE IT
FD18 3298FD 00300      LD      A,32H  :2ND ASCII DIGIT OF NBR.
FD1B DD212540 00310      LD      (&PGNBR2),A :STORE IT
FD1F DD360400 00320      LD      IX,4025H :INIZ DCB POINTER
FD23 C9      00330      LD      (&IX+4),0 :CLEAR LINE COUNTER
          00340      RET
          00350
FD24 ED7394FD 00360 PRNTR LD      (&STACK),SP :SAVE STACK PNTR.
FD28 DD212540 00370      LD      IX,4025H :INIZ DCB POINTER
FD2C 79      00380      LD      A,C    :RETURN IF 0
FD2D B7      00390      OR      A
FD2E C8      00400      RET      Z
FD2F FE0C    00410      CP      0CH   :SEE IF FORM FEED
FD31 28D9    00420      JR      Z,INIZ :YES, REINITIALIZE
FD33 FE0D    00430      CP      0DH   :CHECK FOR CR
FD35 282B    00440      JR      Z,CARRET:YES, DO IT
FD37 F5      00450 COUNT PUSH   AF      :SAVE ACCUM.
```

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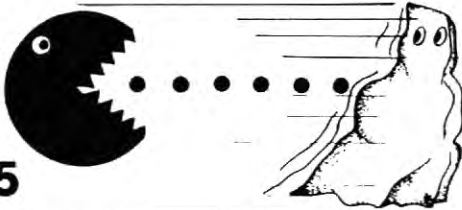
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Listing continued

FD38	2196FD	00460	LD	HL,CHCNT	:GET CHAR. COUNT
FD38	35	00470	DEC	(HL)	:DECREMENT IT
FD3C	2003	00480	JR	NZ,COUNT1	:NOT ZERO, JUMP
FD3E	CD62FD	00490	CALL	CARRET	:DO CAR. RETURN
FD41	F1	00500	POP	AF	:RESTORE ACCUM.
FD42	1833	00510	JR	PRINT	:PRINT CHARACTER
		00520			
FD44	C5	00530	TAB	PUSH	BC :SAVE REGISTER
FD45	F5	00540	PUSH	AF	:SAVE ACCUM.
FD46	3E0A	00550	LD	A,100	:SET COUNT
FD48	F5	00560	TAB1	PUSH	AF :SAVE COUNT
FD49	0E0D	00570	LD	C,0DH	:LOAD CR CODE
FD4B	CD24FD	00580	CALL	PRNTR	:PRINT IT
FD4E	F1	00590	POP	AF	:GET COUNT
FD4F	3D	00600	DEC	A	:DECREMENT IT
FD50	20F6	00610	JR	NZ,TAB1	:LOOP IF NOT DONE
FD52	CD99FD	00620	CALL	PAGE	:PRINT PAGE NO.
FD55	CD62FD	00630	CALL	CARRET	:PRINT CR
FD58	CD62FD	00640	CALL	CARRET	:PRINT CR
FD5B	DD360400	00650	LD	(IX+4),0	:CLEAR LINE CNTR.
FD5F	F1	00660	POP	AF	:RESTORE ACCUM.
FD60	C1	00670	POP	BC	:RESTORE REGISTER
FD61	C9	00680	RET		
		00690			
FD62	3E4F	00700	CARRET	LD	A,79D :SET CHAR. COUNT
FD64	3296FD	00710	LD	(CHCNT),A	:STORE IT
FD67	DD3404	00720	INC	(IX+4)	:INCR. LINE CNT.
FD6A	DD7E04	00730	LD	A,(IX+4)	:COMPARE
FD6D	FE37	00740	CP	55D	:IF 55 LINES
FD6F	28D3	00750	JR	Z,TAB	:DO VERTICAL TAB
FD71	3E0D	00760	LD	A,0DH	:LOAD CR
FD73	CD77FD	00770	CALL	PRINT	:PRINT IT
FD76	C9	00780	RET		
		00790			
FD77	4F	00800	PRINT	LD	C,A :SAVE A COPY
FD78	3AE837	00810	PRINT1	LD	A,(37E8H) :CHECK LP STATUS
FD7B	CB7F	00820	BIT	7,A	:CHECK BUSY BIT
FD7D	20F9	00830	JR	NZ,PRINT1	:LOOP IF HIGH
FD7F	79	00840	LD	A,C	:GET A CHARACTER
FD80	32E837	00850	LD	(37E8H),A	:SEND IT TO PRINTER
FD83	79	00860	LD	A,C	:GET CHARACTER AGAIN
FD84	CD3300	00870	CALL	33H	:PUT ON SCREEN
FD87	3A4038	00880	BREAK	LD	A,(3840H) :CHECK FOR BREAK KEY
FD8A	FE04	00890	CP	4	
FD8C	2001	00900	JR	Z,BREAK1	
FD8E	C9	00910	RET		
FD8F	ED7B94FD	00920	BREAK1	LD	SP,(STACK) :RESTORE ORIG STACK
FD93	C9	00930	RET		
		00940			
0002	00950	STACK	DEFS	2	:STACK PTR. STORAGE
FD96	4F	00960	CHCNT	DEFB	79D :CHAR. COUNTER
FD97	30	00970	PGNBR1	DEFB	30H :1ST DIGIT OF NUMBER
FD98	32	00980	PGNBR2	DEFB	32H :2ND DIGIT OF NUMBER
		00990			
FD99	F5	01000	PAGE	PUSH	AF :SAVE ACCUM.
FD9A	3E43	01010	LD	A,67D	:SET SPACE CNTR.
FD9C	F5	01020	PAGE1	PUSH	AF :SAVE COUNT
FD9D	0E20	01030	LD	C,20H	:LOAD SPACE CODE
FD9F	CD24FD	01040	CALL	PRNTR	:PRINT A SPACE
FDA2	F1	01050	POP	AF	:GET COUNT BACK
FDA3	3D	01060	DEC	A	:DECREMENT COUNT
FDA4	20F6	01070	JR	NZ,PAGE1	:LOOP IF NOT ZERO
FDA6	F1	01080	POP	AF	:RESTORE ACCUM.
FDA7	21D9FD	01090	LD	HL,STRING	:POINT TO TEXT
FDA8	E5	01100	LOOP	PUSH	HL :SAVE ADDRESS
FDA8	4E	01110	LD	C,(HL)	:LOAD A CHARACTER
FDA8	CD24FD	01120	CALL	PRNTR	:PRINT IT
FDAF	E1	01130	POP	HL	:RESTORE REGISTER
FDB0	23	01140	INC	HL	:LOOK AT NEXT ADDRESS
FDB1	7E	01150	LD	A,(HL)	:PUT CHAR. IN ACCUM.
FDB2	FE00	01160	CP	0	:SEE IF ZERO
FDB4	20F4	01170	JR	NZ,LOOP	:IF NOT, DO MORE
FDB6	3A97FD	01180	LD	A,(PGNBR1)	:LOAD 1ST DIGIT
FDB9	4F	01190	LD	C,A	:PUT IT IN C REG.
FDBA	CD24FD	01200	CALL	PRNTR	:PRINT IT
FDBD	3A98FD	01210	LD	A,(PGNBR2)	:LOAD 2ND DIGIT
FDC0	4F	01220	LD	C,A	:PUT IT IN C REG.
FDC1	CD24FD	01230	CALL	PRNTR	:PRINT IT
FDC4	3A98FD	01240	LD	A,(PGNBR2)	:PUT 2ND DIGIT IN ACCUM.
FDC7	3C	01250	INC	A	:INCREMENT IT
FDC8	FE3A	01260	CP	3AH	:IS IT MORE THAN NINE
FDCA	2009	01270	JR	NZ,AHEAD	:IF NOT, JUMP AHEAD
FDC8	3A97FD	01280	LD	A,(PGNBR1)	:LOAD 1ST DIGIT
FDCF	3C	01290	INC	A	:INCREMENT IT
FDD0	3297FD	01300	LD	(PGNBR1),A	:STORE IT
FDD3	3E30	01310	LD	A,30H	:LOAD NEW 2ND DIGIT
FDD5	3298FD	01320	AHEAD	LD	(PGNBR2),A :STORE IT
FDD8	C9	01330	RET		
FDD9	50	01340	STRING	DEFM	'PAGE '
FDDE	00	01350	DEFB	00	
FDE0	00	01360	END	START	
00000	TOTAL ERRORS				



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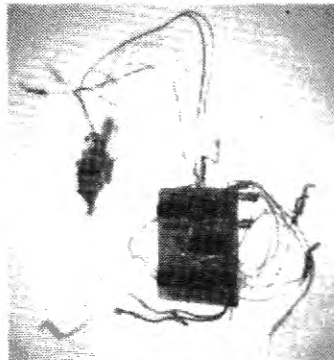
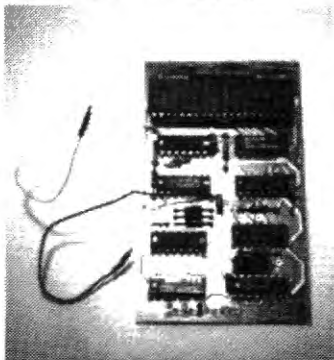
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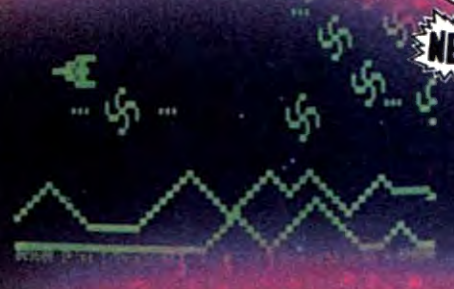
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Brainstorm

by Richard Ramella

If you like figuring out how to complete number sequences like those in IQ tests, you'll love Brainstorm. Just don't ask how it works.

It's 1955 and I'm sitting in a chalk-dusty, steam-heated classroom at Rockenroehl High School driving myself nuts over whether to choose A, B, C, D, or none of the above.

It's IQ test day.

Despite the frustrations, I loved IQ tests. I always hoped my many hare-brained guesses might by some miracle all be correct, producing a flood of scholarship offers. It never happened.

The type of question that most often led to my wild guesses was the number sequence. I wrote the program Brainstorm somewhat as a game for my children, but also to check whether my shortcoming in number sequences was a genetic flaw. Brainstorm generates number sequences like the ones in IQ tests.

Although the program was written in Level II, it will work in Level I with two line changes, which I will give later.

Brainstorm is simply written, but

don't let that lull you into a false sense of security. The problems range from the simple to some real brainbusters.

The classic number sequence of an IQ test is usually made up of a list of five numbers followed by four multiple-choice answers, one of which is correct. The elusive sixth number continues a logical pattern that can be understood by comparing the relationships of the first five numbers.

Brainstorm uses random number selections to branch to and set up 10 different logic schemes. Some of these 10 can go into subschemes. The result is that the variety of problems is limitless, though I think you'll fall by the wayside with brain fever or figure out all the patterns long before the number orders become repetitively boring.

At the start of the program, the computer randomly chooses one of the 10 logic schemes, branches to it, and prints a sequence of five numbers. It

prompts, "Next number in series?" and waits for your answer. Key the answer and tap enter. If you don't know the answer, just tap enter. If you're right, the computer says so and goes on to the next problem. If you're wrong, the computer gives you the answer. Then it gives you a chance to study the six numbers at leisure before tapping enter to continue.

No score is kept. The program does not test your intelligence in terms of assigning you a neat IQ score. It's a game.

The program will work in Level I with the following two line changes:

```
1180 IF (L=5)*(A=1)
    THEN F=F+X: GOTO 1210
1190 IF (L=5)*(A=2)
    THEN F=F-X: GOTO 1210
```

Because I felt a bit devilish when I wrote Brainstorm, I haven't included any explanations of the logic schemes. One could figure them out from the program, but it's probably more trouble than it's worth.

If any number sequence stumps you, send me the sequence in a stamped, self-addressed envelope, and I'll reply with the answer and the logic involved. Please, send five sequences or fewer. I'm still no good at number sequences, but I did write the program and know how it works.

And if I can't figure it out, my 9-year-old daughter can. Early results indicate my mental deficiencies were not passed on to my offspring. ■

Richard Ramella is 80 Micro's Fun House columnist. He can be reached at 1493 Mountain View Ave., Chico, CA 95926.

Program Listing

```
100 REM * BRAINSTORM: IQ NUMBER SEQUENCES *
110 CLS
120 A=RND(10)
130 ON A GOTO 140,210,320,420,530,640,740,830,960,1100
140 F=RND(10)
150 S=RND(10)
160 FOR L=1 TO 5
170 PRINT F;
180 F=F+S
190 IF L=5 GOTO 1210
200 NEXT L
210 G=RND(8)
220 S=RND(12)
230 IF S<=G GOTO 220
240 PRINT G;S;
250 FOR L=1 TO 4
260 F=G+S
```

Listing continues

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✓ 16

Listing continued

```
270 IF L=4 GOTO 1210
280 PRINT F;
290 G=S
300 S=F
310 NEXT L
320 F=RND(20)
330 S=RND(10)
340 T=RND(10)
350 FOR L=1 TO 6
360 N=N+1
370 IF N=1 F=F+S
380 IF N=2 F=F+T: N=0
390 IF L=6 GOTO 1210
400 PRINT F;
410 NEXT L
420 F=RND(10)+5
430 S=RND(6)
440 T=RND(10)
450 IF T<S GOTO 440
460 FOR L=1 TO 5
470 N=N+1
480 PRINT F;
490 IF N=1 F=F-S
500 IF N=2 F=F+T: N=0
510 IF L=5 GOTO 1210
520 NEXT L
530 S=RND(20)
540 F=RND(20)
550 T=RND(10)
560 FOR L=1 TO 6
570 N=N+1
580 IF N=1 S=S+T
590 IF N=2 F=F+T
600 IF L=6 GOTO 1210
610 IF N=1 PRINT S;
620 IF N=2 PRINT F;: N=0
630 NEXT L
640 T=RND(5)
650 S=RND(5)
660 PRINT T;S;
670 F=T+S
680 PRINT F;
690 FOR L=1 TO 3
700 F=F+F
710 IF L=3 GOTO 1210
720 PRINT F;
730 NEXT L
740 F=RND(4)
750 T=RND(4)+1
760 IF T=F GOTO 750
770 PRINT F;
780 FOR L=1 TO 5
790 F=F*T
800 IF L=5 GOTO 1210
810 PRINT F;
820 NEXT L
830 T=RND(5)
840 S=RND(8)+4
850 IF S<T GOTO 1020
860 A=RND(2)
870 PRINT T;S;
880 FOR L=1 TO 4
890 IF A=1 F=T+S-1
900 IF A=2 F=T+S+1
910 IF L=4 GOTO 1210
920 PRINT F;
930 T=S
940 S=F
950 NEXT L
960 G=RND(3)
970 S=RND(7)
980 IF S<G GOTO 970
```

Listing continues

Listing continued

```

990 T=RND(9)
1000 IF T<S GOTO 990
1010 PRINT G;S;T;
1020 FOR L=1 TO 3
1030 F=G+S+T
1040 IF L=3 GOTO 1210
1050 PRINT F;
1060 G=S
1070 S=T
1080 T=F
1090 NEXT L
1100 F=RND(1000)+60
1110 IF F/32<>INT(F/32) GOTO 1100
1120 X=RND(3)
1130 A=RND(2)
1140 FOR L=1 TO 6
1150 IF A=1 PRINT F+X;
1160 IF A=2 PRINT F-X;
1170 F=F/2
1180 IF L=5 AND A=1 THEN F=F+X: GOTO 1210
1190 IF L=5 AND A=2 THEN F=F-X: GOTO 1210
1200 NEXT L
1210 PRINT
1220 PRINT
1230 INPUT "NEXT NUMBER IN SERIES";B
1240 PRINT
1250 IF B=F PRINT "RIGHT": GOTO 1290
1260 PRINT "NO, ANSWER IS";F
1270 PRINT
1280 INPUT "ENTER TO CONTINUE";X: GOTO 110
1290 FOR T=1 TO 500
1300 NEXT T
1310 GOTO 110

```

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✓537

More Memory for Peanuts

by James Schaefer

Adding memory to your Model III is not as hard as it seems, so don't be intimidated. But, remember that you may void your warranty.

If you dream about installing more memory in your Model III computer but haven't done it yet because you think it's too difficult or expensive, just put aside your fears and follow this step-by-step guide.

First you need to buy some memory chips. These chips are sold in sets of eight for about \$20 per set. Each set adds 16K to the computer. The Model III uses 4116 chips with a speed of 200 nanoseconds.

Photo 1 shows a single memory chip and an inexpensive tool (\$5) that holds the chip. The chip has 16 connector pins, eight on each side. The insertion tool holds the pins straight as you plug in the chips. You can install the memory chips without the insertion tool, but the tool makes the job easier.

When you are ready to install the memory chips spread a soft cloth on a large table. This protects your computer case from scratches. Find the screw on the back of the case and remove it. Next turn the computer over and remove the screws from the bottom of the case. These are of different

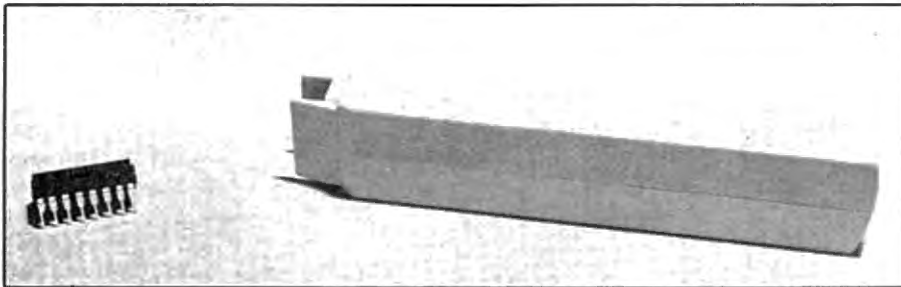


Photo 1

The Key Box

**Model III
16K RAM**

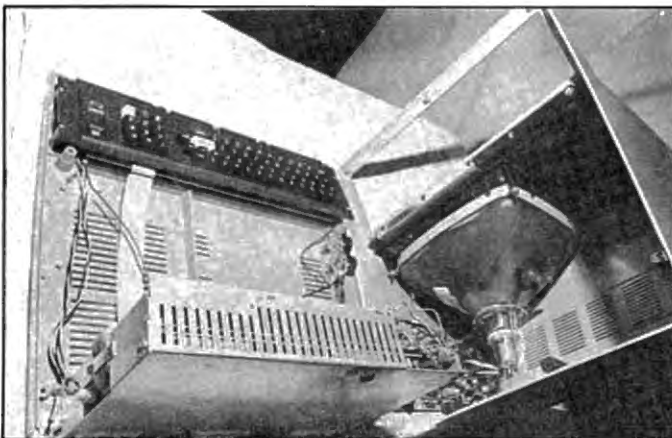


Photo 2

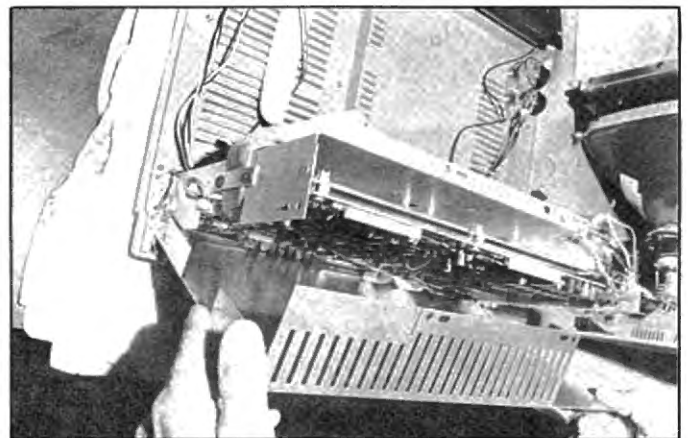


Photo 3

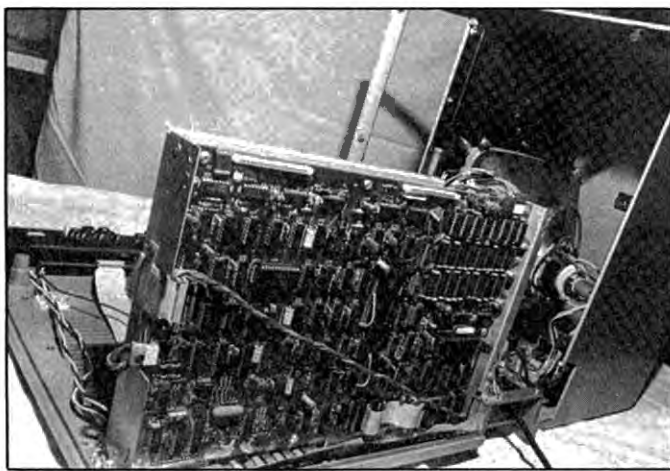


Photo 4

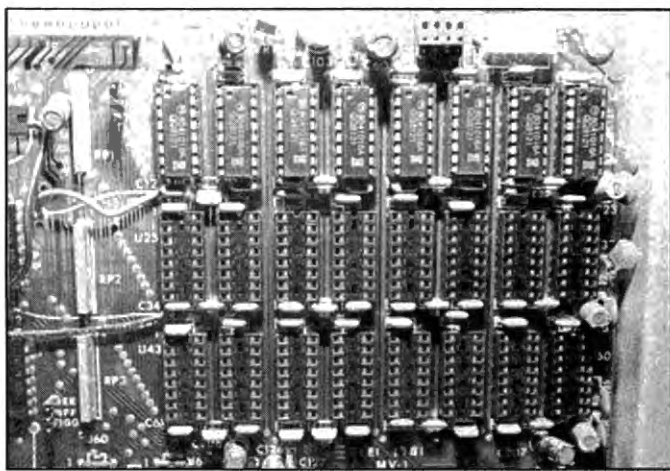


Photo 5

lengths, so remember where each one came from. Hold the top and bottom of the computer together and turn it right side up.

Look at the metal chassis at the rear of the bottom half of the computer in Photo 2. The small end of the picture tube fits into the narrow portion of the chassis on the right side. There is only about 1/2 inch of clearance between the picture tube and the chassis. You must carefully lift the top half of the computer straight up. After the picture tube has cleared the top of the chassis place the top half of the computer to the side as in the photo.

Remove the metal shield (Photo 3). This shield helps reduce EMI radiation levels which cause interference in your home radio and tv. Some of the first Model III computers did not have this shield installed.

Photo 4 shows the main circuit board.

Photo 5 shows an enlarged view of the top right corner of the circuit board. Here you see three rows of eight sockets each. The top row is filled with memory chips. If you have a 16K com-

puter they are filled with 4116 chips. Now look at the top of each chip in the first row. There is a small dot at the top of each chip. These dots help tell you how to plug in the chip. If the chips you buy do not have a marker on one end then put the chips in so the writing goes in the same direction as the chips in the first row.

In Photo 6 I am using the insertion tool to put in a memory chip in the second row. If you want to add only 16K of memory to a 16K computer, then fill the second row with memory chips. Use the third row when you want to add the third set of 16K memory chips to bring the RAM up to 48K.

After each chip is inserted make sure it is fully seated in the socket by pressing it with your thumb (Photo 7). Use a little caution! You want to seat the chip, not crack the main circuit board. Also, make sure that all pins on the memory chip have gone into the socket holes. If one pin bends under the chip pull it out and try again.

When you have installed all the memory, plug in the computer. Turn it on and test the computer with ? MEM.

It will take a little longer for the memory size to come back because there is more memory for the computer to look at. In a 48K Model III you should get 48082 and in a 32K machine you should get 32768. If everything looks correct turn off the computer and unplug it.

You are now ready to put the computer back together. Start by replacing the metal shield. Make sure the braided ground strap lug goes under one of the screws at the top of the narrow portion of the chassis. Carefully lift the top half of the computer over the bottom half and gently lower it into place. Remember the back of the picture tube has a clearance of only 1/2 inch. Hold both halves together and turn the computer upside-down. Replace the screws that hold the two halves together. Turn the computer right side up. Then resecure the screw at the back of the case. ■

James Schaefer (33 Jackson Road, Berlin, NJ 08009) is a computer consultant for two schools.

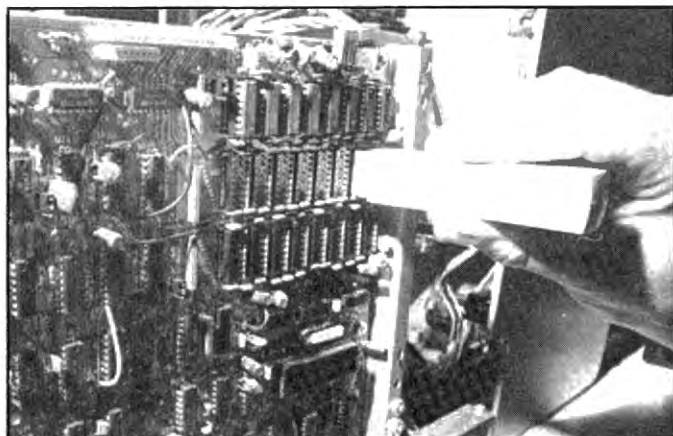


Photo 6

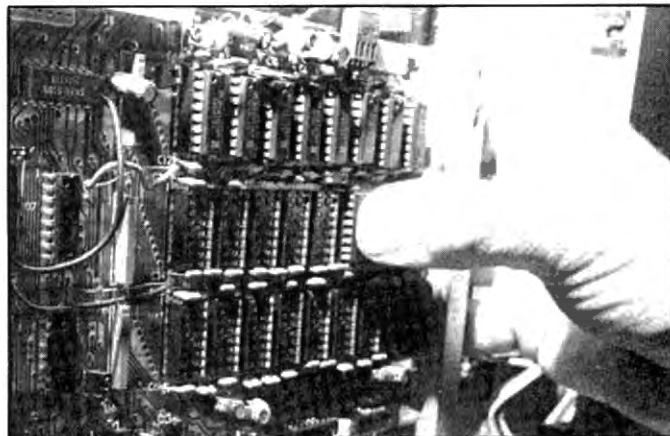


Photo 7

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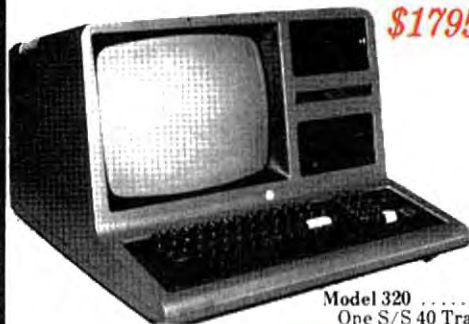
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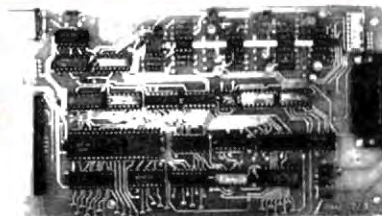
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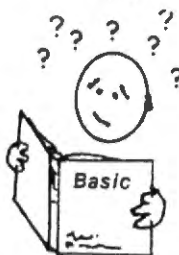
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Fast Tape Operating System

by Michael Pollard

Fast Tape Operating System, FTOS, is an Assembly-language program that replaces the tape operating system in ROM with one in RAM that is faster and more powerful.

Here's what FTOS can do:

- Load and save an entire array with one command.
- Input and output at 1,800 baud.
- Save Assembly-language routines.
- CLOAD Basic and Assembly-language programs.
- Find the beginning of the program or array on the tape, so you don't have to position the tape on a blank spot to load.
- Display the six-character file name of a program or array.
- Load and run Assembly-language programs with a single command.
- Allow the break key to stop the cassette during a load.

FTOS completes all these tasks with less than 1K of memory. It resides at the top of 16K, or anywhere you wish to relocate it, and uses the disk commands, making it incompatible with a disk system.

The Disk Commands

To understand how FTOS uses the disk commands, type save and hit enter. You get an L3 error. Now type POKE 16800,195: POKE 16801,0: POKE 16802,0 and hit enter. Type in "save" and enter again and you get the memory-size prompt.

Save is a disk command and if you use it without a disk, you normally get an L3 error. When the Basic interpreter in ROM sees the instruction Save, it calls (like a GOSUB in Basic) the address 16800. There is usually a jump to the L3 error routine there, but those three POKEs put a JP 00 (GOTO 00), which is where the power-up routine starts, and you get the memory-size

FTOS lets you use disk commands to increase the speed of storage time in your cassette system.

prompt instead of an L3 error.

FTOS has patches at Save and at the other disk commands it uses. These patches don't jump to 00 but to specific routines in FTOS. That is how FTOS is hooked up.

Fast Input/Output

Using ROM I/O, programs and data are sent to and from the cassette, one byte at a time. Each byte is composed of 8 clock bits and 8 data bits. A pulse between clock bits represents 1, and a 0 is represented by lack of a pulse. To increase I/O speed FTOS outputs (and inputs) 1 clock bit followed by the 8 bits of the byte. This means that there are only 9 bits (1 clock, 8 data) per byte instead of 16 bits (8 clock, 8 data). This creates faster code and decreases loading errors, since the output is about half its usual length.

To further increase speed, the spaces between pulses as well as the pulses themselves, are shortened. As a result of these modifications, the speed of I/O will be about 3 1/2 times faster than that of normal cassette I/O.

Added Reliability

To increase reliability, the tape formats of ROM have been replaced by one format (see Fig. 1). This format is not only more reliable, but also more flexible. It is similar to ROM's tape format, but it does have two major differences. One is the synchronization code.

ROM uses a one-byte synchronization code to point to the beginning of valid data. Unless the tape head is positioned over a blank spot, ROM will probably find a false sync code, leading to a bad load. To solve this problem, FTOS has a two-byte sync code. The tape can be positioned anywhere, even in the middle of data, and FTOS still finds the beginning of the next program. The block header code is also two bytes long to help recover data in the event of a bad read.

The other major difference is the addition of a type code. A 0 code is for Assembly language, a 1 code is for Basic, and a 2 code is for arrays. This tells FTOS which data type is being loaded. The type code is necessary since FTOS uses only one tape format.

If you get a checksum error (CE next to the asterisks) while loading, but loading still completes, probably only a small part of the program is incorrect. If the asterisks disappear, however, the program being read has an irrecoverable error. FTOS is looking for another program, so rewind the tape, adjust the volume, and try again.

Array I/O Made Easy

The most powerful statements of FTOS are the array commands: Open and Close. These commands input and output whole arrays to and from the cassette recorder. Figure 2 shows two

The Key Box

Model I
16K RAM
Assembly Language
Cassette Basic

programs for outputting a 100-element array, one with FTOS and one without. The listings show how much easier it is to program, since the formatting is an automatic function. The time difference between the two shows how much faster FTOS is than the ROM system. If you wish to output only part of an array, it can be put into a smaller array and then output to tape.

Tape Directory

FTOS can read anything it puts on tape. If you have ever mixed System, Basic, and PRINT# data, as well as EDTASM source code on the same tape, you know that separating them is almost impossible. If a name is specified when loading an FTOS tape, all the programs and arrays read before the specified tape will have their names printed. This allows you to see what is stored on a cassette.

Commands

Save name: Position tape and put recorder in record mode. Type save and a name of up to six characters. Hit enter and the resident Basic program will be stored on tape. If no name is specified, the name field will contain blanks.

Put name: Position tape and put recorder in record mode. Type put and a name of up to six characters. Press enter, and the program asks you to enter the four-digit hexadecimal starting address of the program. After the fourth digit is entered, enter the ending ad-

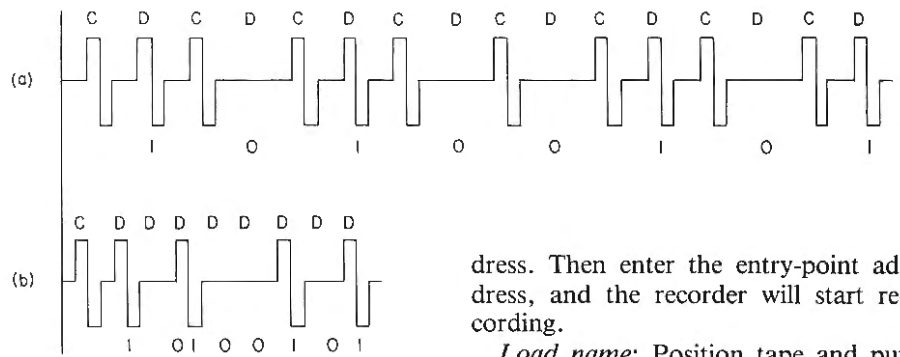


Fig. 1. Comparison between the ROM format (a) for A5 hexadecimal and the FTBS format (b) for A5H (C = clock, D = data)

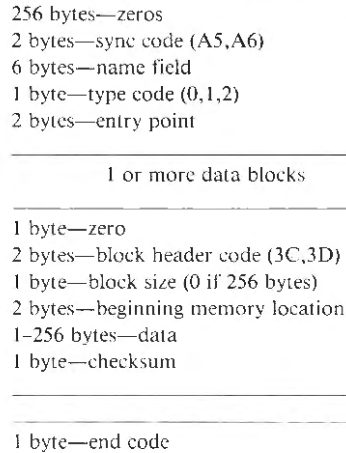


Fig. 2. FTOS Tape Format

dress. Then enter the entry-point address, and the recorder will start recording.

Load name: Position tape and put recorder in play mode. The tape need not be positioned on a blank spot to find the beginning of the program. If no name is specified, the first program read is loaded. If a name is specified, FTOS displays the names of all the programs it reads until the specified program is loaded. If the program loaded is an Assembly-language program, you are prompted to enter an entry-point address in hexadecimal. You can enter a starting-point address, or hit the break key, which brings you back to Ready, or you may hit enter, which jumps to the entry point specified on the tape.

Get name: This is the same as Load. However, if an Assembly-language program is loaded, control automatically jumps to the program's entry point.

CMD name: This command functions the same as CLOAD, but it also checks Assembly-language programs.

Close name: This saves an entire array on tape. The first two characters in the name must match those of an existing array in memory.

Open name: This loads an entire array. The data loaded in must go into an array of the same type and size as that from which it was saved. Since Basic only recognizes the first two characters, different sets of data may be used in a single array by having two different names with the same first two characters. ■

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```

Program Listing
00100 ; (C) "FTOS" - A CASSETTE ROUTINE
00110 ; BY M. RODNEY POLLARD
00120 ; MAY 1982
3C40 00121 ORG 3C40H
3C40 46 00123 DEFM 'FTOS - 7CA3H-7FFFH '
400F 00130 ORG 400FH ;RST 30H
400F C3037D 00140 JP CPl
4173 00150 ORG 4173H ;CMD
4173 C3F37C 00160 JP CMD
417F 00170 ORG 417FH ;GET
417F C3D77E 00180 JP GET
4182 00190 ORG 4182H ;PUT
4182 C3887D 00200 JP PUT
4188 00210 ORG 4188H ;LOAD
4188 C3DB7E 00220 JP BR
41A0 00230 ORG 41A0H ;SAVE
41A0 C3087E 00240 JP BW
4185 00250 ORG 4185H ;CLOSE
4185 C3C97D 00260 JP PR
4179 00270 ORG 4179H ;OPEN
4179 C3D57D 00280 JP INP
7CA3 00290 ORG 7CA3H ;BEGINNING OF FTOS
7CA3 AF 00292 CKA XOR A
7CA4 32D77F 00294 LD (NAME+1),A
7CA7 E5 00300 CK PUSH HL ;LOAD NAME
7CA8 D9 00310 EXX
7CA9 E1 00320 POP HL
7CAA 2B 00321 DEC HL
7CAB CDC77E 00330 CALL BLANK ;BLANK NAME FIELD
7CAE 0606 00335 LD B,6
7CB0 11D67F 00340 LD DE,NAME
7CB3 D7 00350 CK1 RST 10H ;CHECKS CHARACTERS
7CB4 2809 00360 JR 2,CK2 ;EXIT
7CB6 FE2F 00370 CP 2FH
7CB8 38F9 00380 JR C,CK1
7CBA 12 00390 LD (DE),A
7CBB 13 00400 INC DE
7CBC 04 00405 INC B

```

Listing continues

```

10 DIM AC(100)
20 FOR J=1 TO 10
30 FOR I=1 TO 10:PRINT#-1,AC(I),
AC(I+1),AC(I+2),AC(I+3),AC(I+4),
AC(I+5),AC(I+6),AC(I+7),AC(I+8),
AC(I+9):NEXT I
40 NEXT J

(TIME = 48 SECONDS)

10 DIM AC(100)
20 CLOSE AC

(TIME = 4 SECONDS)

```

Figure 3

Listing continued

```

7CBD 18F4 00410 JR CK1
7CBF E5 00420 CK2 PUSH HL
7CC0 D9 00430 EXX
7CC1 E1 00440 POP HL
7CC2 D9 00450 EXX
7CC3 C9 00460 RET
7CC4 B7 00470 TS OR A ;TABLE SEARCH
7CC5 2AFB40 00480 LD HL,(40FBH) ;TOP OF ARRAY TABLE
7CC8 ED4BFD40 00490 LD BC,(40FDH) ;BOTTOM OF ARRAY TABLE+1
7CCC 23 00540 TS1 INC HL
7CCD ED5BD67F 00550 LD DE,(NAME)
7CD1 7E 00560 LD A,(HL)
7CD2 BA 00570 CP D
7CD3 2006 00580 JR NZ,TS2
7CD5 23 00590 INC HL
7CD6 7E 00600 LD A,(HL)
7CD7 BB 00610 CP E
7CD8 2813 00620 JR Z,TS3
7CDA 2B 00630 DEC HL
7CDB 23 00640 TS2 INC HL
7CDC 23 00650 INC HL
7CDD 5E 00660 LD E,(HL)
7CDE 23 00670 INC HL
7CDF 56 00680 LD D,(HL)
7CE0 23 00690 INC HL
7CE1 19 00700 ADD HL,DE
7CE2 E5 00710 PUSH HL
7CE3 B7 00720 OR A
7CE4 ED42 00730 SBC HL,BC
7CE6 E1 00740 POP HL
7CE7 FAC7C 00750 JP M,TS1
7CEA E1 00760 POP HL
7CEB D9 00770 EXX
7CEC C9 00780 RET
7CED 23 00790 TS3 INC HL
7CEE 5E 00800 LD E,(HL)
7CEF 23 00810 INC HL
7CF0 56 00820 LD D,(HL)
7CF1 23 00830 INC HL
7CF2 C9 00840 RET ;HL HAS START, DE HAS LENGTH
7CF3 F5 00850 CMD PUSH AF
7CF4 3EF7 00860 LD A,0F7H ;RST 30H
7CF6 32487F 00870 LD (BR7),A
7CF9 CDD87E 00880 CALL BR
7CFC 3E77 00890 LD A,77H ;FIX IT
7CFE 32487F 00900 LD (BR7),A
7D01 F1 00910 POP AF
7D02 C9 00920 RET
7D03 BE 00930 CP1 CP (HL)
7D04 C8 00940 RET Z
7D05 21FB7F 00950 LD HL,BAD
7D08 3E0D 00960 LD A,0DH
7D0A CD3300 00970 CALL 33H ;DISPLAY CONTENTS OF A
7D0D CDA728 00980 CALL 28A7H
7D10 E1 00990 POP HL
7D11 C3727F 01000 JP BR5
7D14 AF 01010 LEAD XOR A
7D15 CD1202 01020 CALL 212H
7D18 0600 01030 LD B,0
7D1A AF 01040 XOR A
7D1B CD8A7E 01050 Z11 CALL WRITE
7D1E 10FB 01060 DJNZ Z11
7D20 C9 01070 RET
7D21 0604 01080 SYNC LD B,4
7D23 3E20 01090 LD A,20H
7D25 113C3C 01100 LD DE,3C3CH
7D28 12 01110 SY1 LD (DE),A
7D29 13 01120 INC DE
7D2A 10FC 01130 DJNZ SY1 ;BLANK ASTERISK AREA
7D2C AF 01140 XOR A

```

```

7D2D CD1202 01150 CALL 212H ;TURN ON CASSETTE
7D30 CDA67F 01160 R1 CALL READ
7D33 FEA5 01170 L1 CP 0A5H ;FIRST BYTE OF SYNC CODE
7D35 20F9 01180 JR NZ,K1
7D37 CDA67F 01190 M1 CALL READ
7D3A FEA6 01200 CP 0A6H ;SECOND BYTE OF SYNC CODE
7D3C C8 01210 RET Z
7D3D 18F4 01220 JR L1
7D3F CD487D 01230 HEX CALL IN8
7D42 60 01240 LD H,B
7D43 CD487D 01250 CALL IN8
7D46 68 01260 LD L,B
7D47 C9 01270 RET
7D48 CD5E7D 01280 IN8 CALL INCH
7D4B 07 01290 RLCA
7D4C 07 01300 RLCA
7D4D 07 01310 RLCA
7D4E 07 01320 RLCA
7D4F 47 01330 LD B,A
7D50 79 01340 LD A,C
7D51 CD3A03 01350 CALL 33AH
7D54 CD5E7D 01360 CALL INCH
7D57 80 01370 ADD A,B
7D58 47 01380 LD B,A
7D59 79 01390 LD A,C
7D5A CD3A03 01400 CALL 33AH
7D5D C9 01410 RET
7D5E CD8403 01420 INCH CALL 384H
7D61 FE01 01430 CP 1
7D63 281D 01440 JR Z,IN2
7D65 FE0D 01450 CP 0DH
7D67 2006 01460 JR NZ,IN4
7D69 2ADD7F 01470 LD HL,(ENTRY)
7D6C F1 01480 POP AF
7D6D F1 01490 POP AF
7D6E C9 01500 RET
7D6F 4F 01510 IN4 LD C,A
7D70 D630 01520 SUB 30H
7D72 FA5E7D 01530 JP M,INCH
7D75 FE0A 01540 CP 0AH
7D77 F8 01550 RET M
7D78 D607 01560 SUB 7
7D7A FA5E7D 01570 JP M,INCH
7D7D FE10 01580 CP 10H
7D7F F8 01590 RET M
7D80 18DC 01600 JR INCH
7D82 E1 01610 IN2 POP HL
7D83 E1 01620 POP HL
7D84 E1 01630 IN3 POP HL
7D85 C35A7E 01640 JP BWA
7D88 CDA77C 01660 PUT CALL CK
7D8B 3E0D 01670 LD A,0DH
7D8D CD3300 01680 CALL 33H
7D90 21E67F 01690 LD HL,ST
7D93 CDA728 01700 CALL 28A7H ;DISPLAY
7D96 CD3F7D 01710 CALL HEX ;CONVERT ASCII TO HEX
7D99 22E17F 01720 LD (START),HL
7D9C 21ED7F 01730 LD HL,ED
7D9F CDA728 01740 CALL 28A7H
7DA2 CD3F7D 01750 CALL HEX
7DA5 22E37F 01760 LD (END),HL
7DA8 CDBA7D 01770 CALL EN
7DAB 3E0D 01780 LD A,0DH
7DAD CD3300 01790 CALL 33H
7DB0 2AE37F 01800 LD HL,(END)
7DB3 ED5BE17F 01810 LD DE,(START)
7DB7 AF 01820 XOR A ;0 FOR ASSEMBLY LANGUAGE
7DB8 1860 01840 JR BWD
7DBA 21F37F 01850 EN LD HL,ENT
7DBD CDA728 01860 CALL 28A7H
7DC0 D1 01870 POP DE

```

Listing continues

7DC1	CD3F7D	01880	CALL	HEX		7E60	3E00	02632	LD	A,0	
7DC4	D5	01890	PUSH	DE		7E62	CD8A7E	02634	CALL	WRITE	
7DC5	22DD7F	01900	LD	(ENTRY),HL		7E65	3E3C	02640	LD	A,3CH	;BLOCK HEADER CODE
7DC8	C9	01910	RET			7E67	CD8A7E	02650	CALL	WRITE	
7DC9	CDA37C	01920	CALL	CKA		7E6A	3E3D	02652	LD	A,3DH	;BLOCK HEADER CODE
7DCC	CDC47C	01930	CALL	TS		7E6C	CD8A7E	02654	CALL	WRITE	
7DCP	EB	01960	EX	DE,HL		7E6F	78	02660	LD	A,B	
7DD0	19	01970	ADD	HL,DE		7E70	CD8A7E	02670	CALL	WRITE	
7DD1	3E02	01980	LD	A,2	;TYPE CODE FOR ARRAYS	7E73	7D	02680	LD	A,L	
7DD3	1845	01990	JR	BWD		7E74	CD8A7E	02690	CALL	WRITE	
7DD5	CDA37C	02000	CALL	CKA		7E77	7C	02700	LD	A,H	
7DD8	CDC47C	02010	CALL	TS		7E78	CD8A7E	02710	CALL	WRITE	
7DDB	11F17D	02020	LD	DE,INP1		7E7B	0E00	02720	LD	C,0	
7DDE	ED53437F	02030	LD	(BRP+1),DE		7E7D	7E	02730	LD	A,(HL)	BW9
7DE2	E5	02040	PUSH	HL		7E7E	CD8A7E	02740	CALL	WRITE	
7DE3	DDE1	02050	POP	IX		7E81	81	02750	ADD	A,C	
7DE5	11F77D	02060	LD	DE,INP2		7E82	4F	02760	LD	C,A	
7DE8	ED537C7F	02070	LD	(BRJ+1),DE		7E83	23	02770	INC	HL	
7DEC	0600	02080	LD	B,0		7E84	10F7	02780	DJNZ	BW9	
7DEE	C3DE7E	02090	JP	BRI		7E86	CD8A7E	02790	CALL	WRITE	
7DF1	DDE5	02100	PUSH	IX		7E89	C9	02800	RET		
7DF3	DD24	02120	DEFW	24DDH	;INC HX	7E8A	E5	02810	PUSH	HL	
7DF5	E1	02160	POP	HL		7E8B	F5	02820	PUSH	AF	
7DF6	C9	02170	RET			7E8C	C5	02830	PUSH	BC	
7DF7	11737F	02180	LD	DE,BRR		7E8D	D5	02840	PUSH	DE	
7DFA	ED53437F	02190	LD	(BRP+1),DE		7E8E	57	02850	LD	D,A	
7DFE	11BA7D	02200	LD	DE,EN		7E8F	CDAE7E	02860	CALL	OUT	
7E01	ED537C7F	02210	LD	(BRJ+1),DE		7E92	00	02870	NOP		
7E05	E1	02220	POP	HL		7E93	00	02880	NOP		;TIMING
7E06	1852	02230	JR	BWA		7E94	0E08	02890	LD	C,8	
7E08	CDA77C	02250	CALL	CK		7E96	7A	02900	LD	A,D	E1
7E0B	21191A	02260	LD	HL,1A19H	;RETURN TO BASIC	7E97	07	02910	RLCA		
7E0E	22DD7F	02270	LD	(ENTRY),HL		7E98	57	02920	LD	D,A	
7E11	ED5BA440	02280	LD	DE,(40A4H)	;BEGINNING ADDR OF BASIC	7E99	300B	02930	JR	NC,F	
7E15	2AF940	02290	LD	HL,(40F9H)	;ENDING ADDRESS OF BASIC	7E9B	CDAE7E	02940	CALL	OUT	
7E18	3E01	02295	LD	A,1	;TYPE CODE FOR BASIC	7E9E	0D	02950	DEC	C	
7E1A	ED53E17F	02300	LD	(START),DE		7E9F	20F5	02960	JR	NZ,E1	
7E1E	22E37F	02310	LD	(END),HL		7EA1	D1	02970	POP	DE	
7E21	32DC7F	02330	LD	(TYPE),A		7EA2	C1	02980	POP	BC	
7E24	B7	02340	OR	A		7EA3	F1	02990	POP	AF	
7E25	ED52	02350	SBC	HL,DE		7EA4	E1	03000	POP	HL	
7E27	23	02360	INC	HL		7EA5	C9	03010	RET		
7E28	22DF7F	02370	LD	(COUNT),HL		7EA6	0649	03020	F	B,49H	
7E2B	21D47F	02380	LD	HL,HEAD		7EA8	10FE	03030	H1	DJNZ	HL
7E2E	CD147D	02390	CALL	LEAD	;WRITE LEADER	7EAA	00	03040	NOP		
7E31	060B	02400	LD	B,0BH		7EAB	00	03050	NOP		
7E33	7E	02410	LD	A,(HL)		7EAC	18F0	03060	JR	G	
7E34	23	02420	INC	HL		7EAE	3E05	03070	OUT	A,5	
7E35	CD8A7E	02430	CALL	WRITE		7EB0	D3FF	03080	OUT	(0FFH),A	
7E38	10F9	02440	DJNZ	BW4		7EB2	0604	03090	LD	B,04H	
7E3A	2AE17F	02450	LD	HL,(START)		7EB4	10FE	03100	B1	DJNZ	B1
7E3D	11E07F	02460	LD	DE,COUNT+1		7EB6	3E06	03110	LD	A,6	
7E40	1A	02470	LD	A,(DE)		7EB8	D3FF	03120	OUT	(0FFH),A	
7E41	B7	02480	OR	A		7EBA	0604	03130	LD	B,04H	
7E42	2808	02490	JR	Z,BW6		7EBC	10FE	03140	C1	DJNZ	C1
7E44	3D	02500	DEC	A		7EBE	3E04	03150	LD	A,4	
7E45	12	02510	LD	(DE),A		7EC0	D3FF	03160	OUT	(0FFH),A	
7E46	AF	02520	XOR	A		7EC2	0638	03170	LD	B,38H	
7E47	CD5F7E	02530	CALL	BW8		7EC4	10FE	03180	A1	DJNZ	A1
7E4A	18F4	02540	JR	BW5		7EC6	C9	03190	RET		
7E4C	3ADP7F	02550	LD	A,(COUNT)		7EC7	C5	03430	BLANK	PUSH	BC
7E4F	B7	02560	OR	A		7EC8	E5	03440	PUSH	HL	
7E50	2803	02570	JR	Z,BW7		7EC9	3E20	03450	LD	A,20H	;BLANK
7E52	CD5F7E	02580	CALL	BW8		7ECB	21D67F	03460	LD	HL,NAME	
7E55	3E23	02590	LD	A,23H	;END CODE	7ECE	0606	03470	LD	B,6	
7E57	CD8A7E	02600	CALL	WRITE		7ED0	77	03480	LD	(HL),A	
7E5A	CDP001	02610	CALL	1F0H	;TURN OFF CASSETTE	7ED1	23	03490	INC	HL	
7E5D	D9	02614	EXX			7ED2	10FC	03500	DJNZ	BW1	
7E5E	C9	02620	RET		;GO BACK TO BASIC	7ED4	E1	03510	POP	HL	
7E5F	47	02630	LD	B,A		7ED5	C1	03520	POP	BC	
						7ED6	C9	03530	RET		

Listing continued

7ED7 AF 03540	GET	XOR	A			7F72 D9 04160	BR5	EXX	
7ED8 32E57F 03550		LD	(IMM),A		;RUN IMMEDIATELY	7F73 C9 04170	BRR	RET	
7EDB CDA77C 03570	BR	CALL	CK			7F74 3AE57F 04180	BRG	LD	A,(IMM)
7EDE 3E06 03580	BRI	LD	A,6		;CODE FOR 'LD B,N'	7F77 FE00 04190	CP	0	
7EE0 32987F 03590		LD	(SWITCH),A			7F79 2803 04200	JR	Z,BRH	
7EE3 21003C 03592		LD	HL,3C00H			7F7B CDBA7D 04210	BRJ	CALL	EN
7EE6 222040 03594		LD	(4020H),HL			7F7E 2ADD7F 04220	BRH	LD	HL,(ENTRY)
7EE9 21DC7F 03600		LD	HL,TYPE			7F81 3E01 04230	LD	A,1	
7EEC B8 03610		CP	B		;B<6 IF NAME IS SPECIFIED	7F83 32E57F 04240	LD	(IMM),A	
7EED 2005 03620		JR	NZ,BR6			7F86 228A7F 04250	LD	(BRF+1),HL	
7EEF 3EC9 03630		LD	A,0C9H		;CODE FOR 'RET'	7F89 C30000 04260	BRF	JP	0
7EF1 32987F 03640		LD	(SWITCH),A			7F8C E1 04270	BRB	POP	HL
7EF4 CD217D 03650	BR6	CALL	SYNC		;FIND SYNC CODE	7F8D C3F47E 04280	JP	BR6	;WRONG NAME FIND NEW SYNC
7EF7 3E2A 03660		LD	A,2AH			7F90 214345 04290	ERR	LD	HL,4543H
7EF9 323E3C 03670		LD	(3C3EH),A			7F93 223C3C 04300	LD	(3C3CH),HL	
7EFC 323F3C 03680		LD	(3C3FH),A		;ASTERISKS	7F96 188A 04310	JR	BR3	
7EFF 3E20 03690		LD	A,20H			7F98 0606 04320	SWITCH	LD	B,6
7F01 ED5B2040 03710		LD	DE,(4020H)		;CURSOR POSITION	7F9A 21D67F 04330	LD	HL,NAME	
7F05 12 03711		LD	(DE),A			7F9D 1A 04340	BRA	LD	A,(DE)
7F06 13 03713		INC	DE			7F9E BE 04350	CP	(HL)	
7F07 D5 03715		PUSH	DE			7F9F 20EB 04360	JR	NZ,BRB	
7F08 0606 03720		LD	B,6			7FA1 23 04370	INC	HL	
7F0A CDA67F 03730	BR1	CALL	READ			7FA2 13 04380	INC	DE	
7F0D 12 03744		LD	(DE),A			7FA3 10F8 04390	DJNZ	BRA	
7F0E 13 03746		INC	DE			7FA5 C9 04400	RET		;RIGHT NAME FOUND
7F0F 10F9 03750		DJNZ	BR1			7FA6 3A4038 04410	READ	LD	A,(3840H)
7F11 ED532040 03752		LD	(4020H),DE			7FA9 FE04 04412	CP	4	
7F15 D1 03755		POP	DE			7FAB CA191A 04414	JP	Z,1A19H	
7F16 CD987F 03760		CALL	SWITCH			7FAE E5 04416	PUSH	HL	
7F19 0603 03770		LD	B,3			7FAF C5 04420	PUSH	BC	
7F1B CDA67F 03780	BR2	CALL	READ			7FB0 3E04 04430	LD	A,4	
7F1E 77 03790		LD	(HL),A			7FB2 D3FF 04440	OUT	(0FFH),A	
7F1F 23 03800		INC	HL			7FB4 DBFF 04450	PI	IN	A,(0FFH)
7F20 10F9 03810		DJNZ	BR2			7FB6 17 04460	RLA		
7F22 CDA67F 03820	BR3	CALL	READ			7FB7 30FB 04470	JR	NC,PI	
7F25 FE23 03830		CP	23H		;END CODE	7FB9 0621 04480	LD	B,21H	
7F27 2830 03840		JR	Z,BRC			7FBB 10FE 04490	RI	DJNZ	RI
7F29 FE3C 03850		CP	3CH		;BLOCK HEADER CODE	7FBD 0608 04500	LD	B,8	
7F2B 20F5 03860		JR	NZ,BR3			7FBF 3E04 04510	S	LD	A,4
7F2D CDA67F 03870		CALL	READ			7FC1 D3FF 04520	OUT	(0FFH),A	
7F30 FE3D 03872		CP	3DH		;BLOCK HEADER CODE	7FC3 60 04530	LD	H,B	
7F32 20C0 03874		JR	NZ,BR6			7FC4 0626 04540	LD	B,26H	
7F34 CDA67F 03876		CALL	READ			7FC6 DBFF 04550	Q	IN	A,(0FFH)
7F37 47 03880		LD	B,A			7FC8 10FC 04560	DJNZ	Q	
7F38 CDA67F 03890		CALL	READ			7FCA 17 04570	RLA		
7F3B 6F 03900		LD	L,A			7FCB CB15 04580	W	RL	L
7F3C CDA67F 03910		CALL	READ			7FCD 44 04590	LD	B,H	
7F3F 67 03920		LD	H,A			7FCE 10EF 04600	DJNZ	S	
7F40 0E00 03930		LD	C,0			7FD0 7D 04610	LD	A,L	
7F42 CD737F 03940	BRP	CALL	BRR			7FD1 C1 04620	POP	BC	
7F45 CDA67F 03950	BR4	CALL	READ			7FD2 E1 04630	POP	HL	
7F48 77 03960	BR7	LD	(HL),A			7FD3 C9 04640	RET		
7F49 23 03970		INC	HL			7FD4 A5A6 04650	HEAD	DEFW	0A6A5H
7F4A 81 03980		ADD	A,C			0006 04660	NAME	DEFS	6
7F4B 4F 03990		LD	C,A			0001 04670	TYPE	DEFS	1
7F4C 10F7 04000		DJNZ	BR4			0002 04680	ENTRY	DEFS	2
7F4E CDA67F 04010		CALL	READ			0002 04690	COUNT	DEFS	2
7F51 B9 04020		CP	C			0002 04700	START	DEFS	2
7F52 203C 04030		JR	NZ,ERR			0002 04710	END	DEFS	2
7F54 CD2C02 04040		CALL	22CH		;BLINK ASTERISKS	7FE5 01 04720	IMM	DEFB	1
7F57 18C9 04050		JR	BR3			7FE6 53 04740	ST	DEFM	'START '
7F59 2B 04060	BRC	DEC	HL			7FEC 00 04750	ED	DEFB	0
7F5A CDF801 04070		CALL	1F8H		;TURN OFF CASSETTE	7FED 20 04760	ED	DEFM	'END '
7F5D 3ADC7F 04080		LD	A,(TYPE)			7FF2 00 04770	ENT	DEFB	0
7F60 FE01 04090		CP	1			7FF3 20 04780	ENT	DEFM	'ENTRY '
7F62 2010 04100		JR	NZ,BRG			7FFA 00 04790	BAD	DEFB	0
7F64 22F940 04110		LD	(40F9H),HL			7FFB 42 04800	BAD	DEFM	'BAD '
7F67 21E942 04120		LD	HL,42E9H			7FFF 00 04810	DEFB	0	
7F6A 22A440 04130		LD	(40A4H),HL			3C54 04830	ORG	3C54H	
7F6D 3E0D 04140		LD	A,0DH			3C54 47 04832	DEFM	'GOOD LOAD	
7F6F CD3300 04150		CALL	33H			1A19 04834	END	1A19H	
						00000	TOTAL ERRORS		

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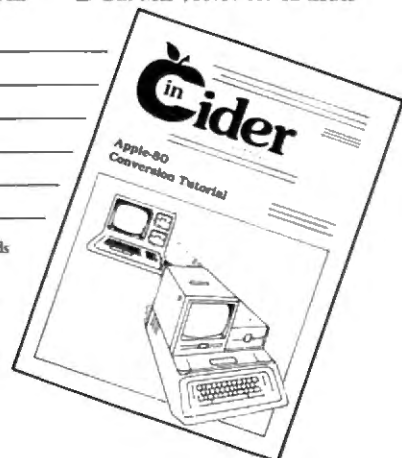
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The Glamour of Grammar

by George Stone

So your students don't appreciate the finer points of grammar? This program will let them learn the rules and have fun at the same time.

Kids are fascinated by video displays. They enjoy telling the computer to do something, then watching it get done. I wrote Sentence Patterns with the hope that this fascination would get my students interested in learning grammar.

The program drills students on sentence patterns by mimicking what I do in the classroom. First, it makes up a sentence. Then, it asks directed questions about the sentence to lead the kids to the sentence pattern. By using this program, the students learn the sequence of thoughts needed to determine sentence patterns.

Why even learn sentence patterns? To pass the test, of course. Besides that, knowing how to find the pattern helps in understanding the meaning of long, involved sentences found in literature, especially poetry. It also helps my students proofread their writing for complete sentences.

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Computers Are Motivating

The results met my expectations. But then other factors popped up that proved even more motivating than the video appeal. The kids see the questions as a challenge, a dare. They don't like being outsmarted by the machine, so they think twice and try harder for the correct answer.

They also enjoy the absurd nature of the sentences being presented (more about this later). To see the next weird sentence, they have to answer all the questions about the one being displayed. Not only that, but the higher the level (i.e., the more complicated the sentence), the more absurd the sentence becomes. Since the students can't advance

to higher levels without passing (above 85 percent) the lower ones, this encourages achievement.

But the biggest motivator of all turned out to be the kids themselves. When I let two or three kids at a time use the computer, they taught each other. They argued and haggled and debated over which answer to choose. They were giving reasons. They were using rules I had taught in class to defend their answers. They were really learning. All because of a few words displayed on a screen.

Although I didn't have strict control or experimental groups, the kids who used the computer more often averaged higher scores on the test than the ones who didn't.

Evolution of the Program

When I was learning Basic, two features appealed to me: the random-number generator and string variables. Since grammar is logic imposed on lan-

SENTENCE GENERATOR LEVELS OF COMPLEXITY

Line number	Level	
209	8	Complex sentence using a level 4 dependent clause and a level 3 main clause
210	7	Complex sentence using a level 3 dependent clause and a level 4 main clause
211	6	Complex sentence using a level 3 dependent clause and a level 3 main clause
212	5	Complex sentence using a level 2 dependent clause and a level 3 main clause
215	4	Level 3 plus an adjective phrase or clause
220	3	Level 2 plus another adjective and a prepositional phrase
225	2	Level 1 plus an adjective and an adverb
230	1	Simple sentence pattern with no modifiers

Table 1. Levels of complexity

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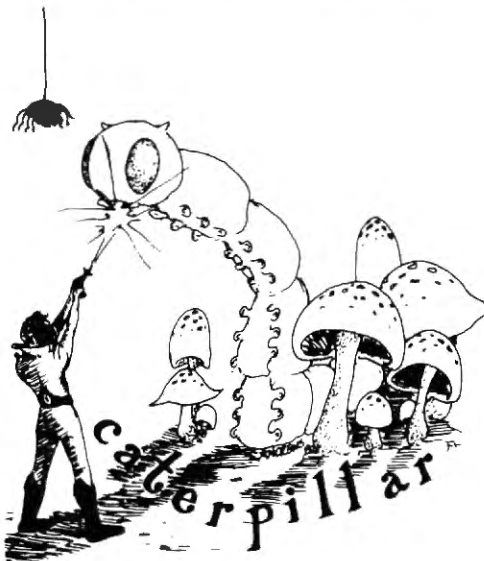
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guage, why couldn't a computer start with the logic and insert the language?

Time out for some grammar review. Any sentence can be classified as one of four patterns: subject-verb, subject-verb-direct object, subject-linking verb-adjective, or subject-linking verb-noun. (Some grammar systems are more complex, but for my students this is enough.)

For example, in a sentence like, "Suzy is pretty," the sentence pattern is S-LV-Adj. "Is" links "Suzy" to "pretty." Almost any noun can be substituted for "Suzy," almost any linking verb can be substituted for "is," and almost any adjective can take the place of "pretty." Example: "The hunchback looked ugly." (Someday the Basic software people will invent an If...Then...Except operation for language strings.)

The point is that the computer can create its own sentences by picking subjects, verbs, adjectives, and other parts of speech from arrayed word lists, then arranging them according to English syntax rules.

Making up sentences this way has its faults and advantages. Since only a part of a sentence's meaning comes from its structure, and since the computer (obviously) has no idea what

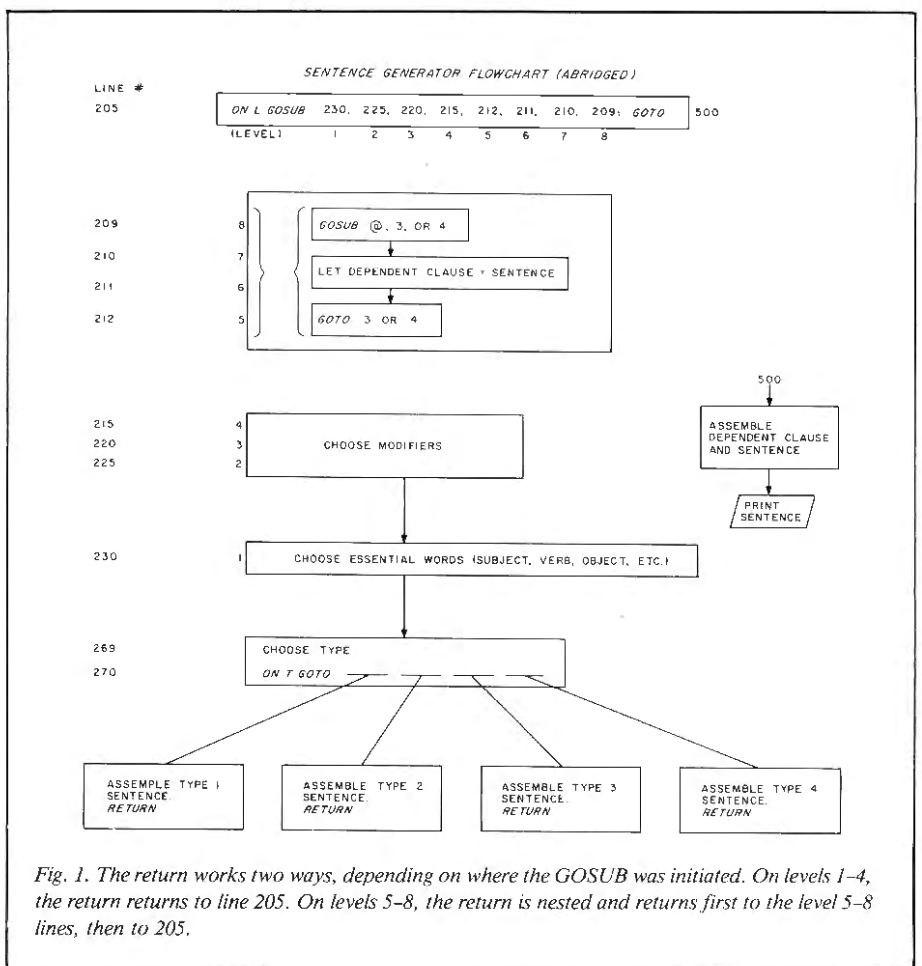
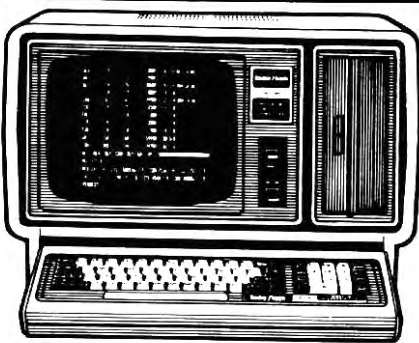


Fig. 1. The return works two ways, depending on where the GOSUB was initiated. On levels 1-4, the return returns to line 205. On levels 5-8, the return is nested and returns first to the level 5-8 lines, then to 205.

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words it's using, it can create such monstrosities as:

"The cute dog smelled a robot on the lawn since a weird girl later tricked the fish around the tree."

"Because Albert, too tired to laugh, foolishly smelled a fat man around the tree, a fat mouse, feeling gay, finally threw a foolish mouse on the lawn."

As it turned out, the kids were entertained by the bizarre and fantastical nature of these sentences. The absurdity of the meaning seems to make the pattern a little more obvious.

As I was developing the sentence generator, it occurred to me that since the program started with the answer (the sentence pattern) and came up with an example, why not turn this into a learning exercise? Hence the question-and-answer part of the program.

Program Explanation

The sentence-generating part of the program, lines 1-91 and lines 200-500, creates four types (patterns) of sentences at eight different levels of difficulty. (See Table 1.)

The levels of difficulty are possible because when a string is never defined, it will not cause an error when concatenated in a longer string. The null string is ignored. This allows the program to "choose" which words it will or will not use by simply putting a number or a zero in the subscript.

For example, AJ\$(0) is null but AJ\$(1) is "fat." Level 1 sentences use only the key words in the sentence pattern. The modifiers are left out by giving them all zero subscripts. But level 3 sentences have adjectives, adverbs, and prepositional phrases.

To build a complex sentence (levels 5-8), the program assembles a sentence (CSS\$), adds a subordinating conjunction (see data line 21; I'm not going to explain subordinating conjunctions), calls it a dependent clause [DC\$ = D\$(D) + CS\$], then passes through the building sequence again to create a main clause. This all starts in line 200, and the two clauses are concatenated in line 501.

Lines 504 to 515 keep the words from wrapping around the screen by breaking the sentence up into pieces that will fit on a line. It's messy, but it works.

The sentence is first printed in the loop in line 518. It is printed on every other line to leave space for subroutine 6000 (more on this later).

The question-and-answer part of the program runs between 520 and 999. For each question, the question (Q\$),

String Variables

A\$	Student's answer
AA\$()	Correct answer statement
AJ\$(AJ)	Adjective list
BI\$, B2\$	Graphics for eater's bottom half
CA\$	Correct answer
CS\$	Complete sentence or main clause
CS\$()	Chunks of CS\$ less than 64 characters long
DS(D)	Subordinating conjunction list
DC\$	Dependent clause
F1\$(), F2\$()	Graphics for word eater's mouth
LV\$(LV)	Linking verb list
ND\$(ND)	Noun determiner list
NME\$	Student's name
NOS(NO)	Object noun list
NSS\$	Subject of current sentence
NS\$(NS)	Subject noun list
OS\$	Used after INPUT
PS\$	Predicate complement of current sentence
PAS(PA)	Predicate adjective list
PH\$(PH)	Adjective phrase or clause
PN\$(PN)	Predicate noun list
PP\$(PP)	Prepositional phrase list
Q\$	Current question
QCS\$	Question clarifier
QYN\$	Answer choices for yes/no type of questions
SS\$()	Stores names of students
US\$, Z\$, ZL\$, ZR\$	Graphics for worm
VS\$	Verb of current sentence
VI\$(VI)	Intransitive verb list
VT\$(VT)	Transitive verb list

Numerical Variables

L	Level
LN	LEN(CS\$)
LS	Number of chunks CS\$ is broken into
P	Percent of right answers
Q	Question number
R	Number of questions right
S	Number of students who have used the computer
SL()	Stores student's level
SP()	Stores percent of right answers
ST()	Stores total (T1)
T1	Number of questions attempted
TP()	Stores total number of points (L x R)
U	PEEK variable
W	Timing loop
M, N, X, Y	Loop variables

Table 2

Program Listing

```

1 CLS:PRINT@215,"SENTENCE PATTERNS:";CHR$(232);"AN INTERACTIVE L
EARNING PROGRAM";:PRINT@478,"BY";CHR$(249);"GEORGE STONE";CHR$(2
45);"MAY, 1982"
8 CLEAR1200:RANDOM:T1=0:R=0:DIMNSS$(15):POKE16396,165
9 DATA "THE","A"
10 DATA "HORSE","DOG","HIPPO","MONKEY","FERRET","MAN","BO
Y","GIRL","MOUSE","TEACHER","MYRA","HERMAN","ALBERT","GER
ALDINE","SUZYCREAMCHEESE"
11 DATA "BELCHED","SAT","LEANED","RAN","CRAWLED","WALKED","
LOOKED","SQUIRMED","YAWNED","DANCED"
12 DATA "THREW","ATE","SAW","SMELLED","TRICKED"
13 DATA "ROBOT","MAN","MOUSE","RHINOCEROS","FISH"
14 DATA "FAT","FOOLISH","CURIOUS","WEIRD","CUTE","CRAZY","
SMART","LAZY","SLEEPY","BEAUTIFUL"
15 DATA "NEAR THE TREE","OVER THE HILL","ACROSS THE FIELD","
UNDER WATER","ON THE LAWN"
16 DATA "TOO TIRED TO LAUGH","FEELING GAY","WHO DAVE LIKE
D","WHO JUST RETURNED FROM THE MOON","HOPELESSLY CONFUSED,"

```

Listing continues



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Listing continued

```

17 DATA " MERRILY", " FOOLISHLY", " IMMEDIATELY", " FINALLY", " LATE
R", " SUDDENLY", " QUICKLY", " USUALLY"
18 DATA " WAS", " BECAME", " IS", " WAS", " HADBEEN", " LOOKED", " SEEM
ED", " FELT", " BECAME", " WAS"
19 DATA " JOCK", " LOUDMOUTH", " RATFINK", " FOOL", " CLOWN"
20 DATA " GOOD", " BAD", " LONELY", " FINE", " NERVOUS", " HAPPY", " BL
UE", " STINKY", " GAWKY", " BEAUTIFUL"
21 DATA " IF", " WHEN", " SINCE", " AS", " BECAUSE", " SINCE", " WHILE"
, " ALTHOUGH", " BEFORE", " BECAUSE"
50 F1$(1)="":F2$(1)=CHR$(190)+STRING$(2,188)+STRING$(2,176)+STRI
NG$(2,128)+STRING$(2,176)+STRING$(2,188)+CHR$(189)
55 F1$(2)=CHR$(176)+CHR$(180)+STRING$(6,128)+CHR$(184)+CHR$(176)
:F2$(2)=CHR$(190)+STRING$(3,191)+CHR$(188)+CHR$(144)+CHR$(160)+C
HR$(188)+STRING$(3,191)+CHR$(189)
60 F1$(3)=CHR$(176)+CHR$(180)+STRING$(6,128)+CHR$(184)+CHR$(176)
:F2$(3)=CHR$(190)+STRING$(3,191)+CHR$(188)+CHR$(144)+CHR$(160)+C
HR$(188)+STRING$(3,191)+CHR$(189)
65 F1$(4)=CHR$(176)+STRING$(2,188)+STRING$(4,191)+STRING$(2,188)
+CHR$(176):F2$(4)=CHR$(190)+STRING$(10,191)+CHR$(189)
70 B1$=CHR$(175)+STRING$(9,191)+CHR$(188)+CHR$(159):B2$=CHR$(128
)+CHR$(131)+STRING$(2,143)+STRING$(4,191)+STRING$(2,143)+CHR$(13
1)+CHR$(128)
75 Z$=STRING$(7,176):ZL$=CHR$(140)+CHR$(176)+CHR$(158)+CHR$(131)
+CHR$(173)+CHR$(176)+CHR$(194)
76 U$=CHR$(195)+CHR$(191)+CHR$(195):ZR$=STRING$(4,24)+CHR$(199)+
CHR$(176)+CHR$(158)+CHR$(131)+CHR$(173)+CHR$(176)+CHR$(140)
79 FORN=1TO2:READND$(N):NEXT
80 FORN=1TO15:READNS$(N):NEXT
81 FORN=1TO10:READVI$(N):NEXT
82 FORN=1TO5:READVT$(N):NEXT
83 FORN=1TO5:READNO$(N):NEXT
84 FORN=1TO10:READAJ$(N):NEXT
85 FORN=1TO5:READPP$(N):NEXT
86 FORN=1TO5:READPH$(N):NEXT
87 FORN=1TO8:READAV$(N):NEXT
88 FORN=1TO10:READLV$(N):NEXT
89 FORN=1TO5:READPN$(N):NEXT
90 FORN=1TO10:READPA$(N):NEXT
91 FORN=1TO10:READD$(N):NEXT
149 PRINT@960,:FORN=1TO9:PRINT:FORW=1TO70:NEXT:NEXT
150 CLS:PRINT@256,"(<ENTER> FOR SCORES)":;PRINT@5,"S E N T E N C
E P A T T E R N P R A C T I C E":PRINT:NME$="":INPUT"WHAT I
S YOUR NAME":NME$
155 IFNME$=""THEN160ELSEFORN=1TO5:IFLEFT$(NME$,15)=SS$(N)THEN170E
LSENEXT:GOTO181
160 CLS:PRINT" NAME","LEVEL","SCORE","TOTAL POINTS":FORN=1TO5:P
RINTSS$(N),SL(N),SP(N),TP(N):NEXT
165 PRINT@910,"HIT <ENTER>":INPUTO$:GOTO150
170 T1=ST(N):L=SL(N):R=INT(T1*SP(N)/100):PRINT"I REMEMBER YOU, "
:NME$:PRINT:PRINT"DO YOU WANT YOUR OLD SCORE (Y/N)":;GOSUB1000
:INPUTO$
175 IFOS$="N"THENR=0:T1=0:GOTO186ELSECLS:GOTO200
181 PRINT:PRINT"DO YOU WANT DIRECTIONS, ";NME$," (YES/NO)":;I
NPUTO$:IFLEFT$(O$,1)="N"THEN186
182 PRINT"DIRECTIONS:":PRINT:PRINT" A SENTENCE WILL BE DISPL
AYED AT THE TOP OF THE SCREEN. YOUR JOB, SHOULD YOU CHOOSE T
O ACCEPT IT, IS TO CORRECTLY ANSWERTHE QUESTIONS ABOUT THAT SENT
ENCE."
183 PRINT:PRINT" TO ANSWER A QUESTION, MOVE THE ARROW (";CHR
$(91);") BACK AND FORTH USING THE RIGHT AND LEFT ARROW KEYS
ON THE KEYBOARD":PRINTTAB(18)"THEN HIT <ENTER>"
186 L=0:INPUT"WHAT LEVEL DO YOU WANT?(1-6)":L
187 IF(L>6)+(L<1)THENCLS:PRINTCHR$(23):PRINT"NO, NO, NO, YOU IDI
OTIC IDIOT!! ":PRINT"**** A NUMBER BETWEEN 1 (ONE) AND 6
(SIX)":PRINT:PRINT"###"($($)%$#1111$&$'6($&))'$S##":PRINT:GOTO186
200 DC$="":D=RND(10):AJ2=0:AJ=0:PP=0:PH=0:AV=0:CLS:PRINT"HOLD ON
WHILE I THINK UP A GOOD ONE"
205 ONLGOSUB230,225,220,215,212,211,210,209:GOTO500
209 GOSUB215:DC$=D$(D)+CS$:GOTO215
210 GOSUB220:DC$=D$(D)+CS$:GOTO215
211 GOSUB220:DC$=D$(D)+CS$:GOTO220
212 GOSUB225:DC$=D$(D)+CS$:GOTO220
215 PH=RND(5)
220 PP=RND(5):AJ2=RND(10)
225 AJ=RND(10):AV=RND(8)
230 ND=RND(2):DN=RND(2):NS=RND(15):VI=RND(10):VT=RND(5):NO=RND(5
):LV=RND(5):PN=RND(5):PA=RND(10)
235 IFNS>10THENND=0:AJ=0
269 T=RND(4):IFT=3THENLV=LV+5
270 ONTGOTO300,350,400,450
300 REM *** S---V-
310 CS$=ND$(ND)+AJ$(AJ)+NS$(NS)+PH$(PH)+AV$(AV)+VI$(VI)+PP$(PP)
315 NS$=MID$(NS$(NS),2):V$=MID$(VI$(VI),2):P$="":RETURN
350 REM *** S--V--DO
360 CS$=ND$(ND)+AJ$(AJ)+NS$(NS)+PH$(PH)+AV$(AV)+VT$(VT)+ND$(DN)+

```

Listing continues

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question clarifier (QC\$, if there is one), correct answer (CA\$), yes/no answer (QYN\$, if there is one), and complete answer (AA\$) are defined. Then the answer subroutine (3000) is called. Subroutine 4000 prints the sentence again, and the next set of questions is prepared for subroutine 3000.

Five or six questions are asked about each sentence, thus getting the students to look at each part of the sentence. The whole point of this exercise is in the last question (line 900). Using the information the program has suggested about the sentence, the students have to decide what the sentence pattern is.

The Subroutines

Subroutine 3000 prints all the previous correct answers, prints the current question, calls subroutine 6000 for the answer (A\$), compares the answer with the correct answer, gives a prompt (QC\$) if needed, and adds to the score if the answer is right. (Whew!)

Subroutine 1000 prints the cumulative score and current level.

Subroutine 1100 keeps track of who has been using the computer and sorts the students according to their scores. A screen print of this information can be accessed from the beginning of the program (lines 155-160) when it asks for the next student's name.

Subroutines 5000 and 5500 are graphics treats or tricks to relieve tedium and reinforce correct answers. They can be canceled by pressing the space bar.

Now to explain subroutine 6000. The first version of this program had the students typing in the answers. But they spent most of their time hunting and pecking rather than thinking about subjects and verbs. Having them give the first letter didn't work because sometimes the wrong word had the same first letter as the right one. Subroutine 6000 evolved after watching the advanced computer students design their own games.

Line 6020 prints an up arrow under the sentence. Lines 6030-6060 let the students move the arrow back and forth using the right and left-arrow keys. When they've found an answer, they press enter, which causes the program to jump to line 6100. Lines 6100-6180 PEEK the video memory locations above the arrow and then build an answer word (A\$) based on the spaces between words. The formula in line 6180 resets the cursor to the space after the last question displayed.

Listing continued

```

PA$(AJ2)+NO$(NO)+PP$(PP)
365 NS$=MID$(NS$(NS),2):V$=MID$(VT$(VT),2):P$=MID$(NO$(NO),2):RE
TURN
400 REM ***S-LV-A
410 CS$=ND$(ND)+AJ$(AJ)+NS$(NS)+PH$(PH)+LV$(LV)+PA$(PA)+PP$(PP)
415 NS$=MID$(NS$(NS),2):V$=MID$(LV$(LV),2):P$=MID$(PA$(PA),2):RE
TURN
450 REM *** S--LV--N
460 CS$=ND$(ND)+AJ$(AJ)+NS$(NS)+PH$(PH)+LV$(LV)+ND$(DN)+PA$(AJ2)
+PN$(PN)+PP$(PP)
470 NS$=MID$(NS$(NS),2):V$=MID$(LV$(LV),2):P$=MID$(PN$(PN),2):RE
TURN
500 Q=1:
501 IFLN(IFLN(DC$)>0ANDRND(2)=1)THENCS$=DC$+" "+CS$+" ".ELSECS$=CS$+DC
$+" "
504 LN=LEN(CS$):IFLN>191THEN200
505 IFLN<64THENLS=1:CS$(1)=CS$:GOTO518
508 LS=2:FORM=63TO50STEP-1:IFMID$(CS$,M,1)=" "THENCS$(1)=LEFT$(C
S$,M):CS$(2)=MID$(CS$,M+1):GOTO510ELSENEXTM
510 N=LN+1:IFLN>M+63THENLS=3:FORN=M+63TOM+50STEP-1:IFMID$(CS$,N,
1)=" "THEN515ELSENEXTN
515 CS$(2)=MID$(CS$,M,N-M):CS$(3)=MID$(CS$,N)
518 CLS:FORN=1TOLS:PRINTCS$(N):PRINT:NEXT
520 Q$=" WHAT IS THE SUBJECT OF THIS SENTENCE?"
530 CA$=NS$:QC$=" WHO OR WHAT IS THIS SENTENCE ABOUT?":AA$(1)="
THE SUBJECT IS "+NS$+" "
540 GOSUB3000:GOSUB4000
600 CA$=V$:Q$=" WHAT IS THE VERB OF THIS SENTENCE?":QC$=" WHI
CH WORD SHOWS AN ACTION OR STATE OF BEING?":AA$(2)="THE VERB IS
"+V$+" "
610 GOSUB3000
620 GOSUB4000
650 Q$=" WHAT TYPE OF VERB IS "+V$+" "?:QYN$="ACTION LINKING"
660 IFT<=2THENCA$="ACTION":AR$="N"
665 IFT>=3THENCA$="LINKING":AR$=""
670 AA$(3)=" "+V$+" " IS A"+AR$+" "+CA$+" VERB"
680 GOSUB3000:GOSUB4000
690 ONTGOTO700,700,800,800
700 Q$=" IS THERE A DIRECT OBJECT? ":QYN$="YES NO"
705 IFT=1 THENCA$="NO":AA$(Q)="THERE IS NO DIRECT OBJECT":GOSUB3
000:GOSUB4000:GOTO750
710 IFT=2THENCA$="YES":AA$(Q)="THERE IS A DIRECT OBJECT"
720 GOSUB3000:GOSUB4000
730 Q$="WHAT IS THE DIRECT OBJECT?":QC$="WHAT WORD IS GETTING TT
HE ACTION OF THE VERB?":CA$=P$:AA$(Q)=P$+" IS THE DIRECT OBJECT"
740 GOSUB3000:GOSUB4000
750 GOTO900
800 Q$="WHAT IS "+NS$+" BEING LINKED TO?":QC$="IN OTHER WORDS,
THE "+NS$+" "+V$+" WHAT?":CA$=P$:AA$(Q)=" "+P$+" " IS THE SUBJEC
T COMPLEMENT"
810 GOSUB3000:GOSUB4000
840 QYN$="NOUN ADJ":Q$="IS "+P$+" A NOUN OR AN ADJECTIVE?"
850 IFT=4THENCA$="NOUN":AA$(Q)=" "+P$+" IS A NOUN"
860 IFT=3THENCA$="ADJECTIVE":AA$(Q)=" "+P$+" IS AN ADJECTIVE"
870 GOSUB3000:GOSUB4000
900 Q$="LAST QUESTION.....WHAT IS THE SENTENCE PATTERN OF THIS
SENTENCE? (1)S-V (2)S-V-DO (3)S-LV-ADJ (4)S-LV-NOUN
PRESS A NUMBER"
910 QC$="":ONTGOTO912,914,916,918
912 CA$="1":AA$(Q)=" S-V":GOTO920
914 CA$="2":AA$(Q)=" S-V-DO":GOTO920
916 CA$="3":AA$(Q)=" S-LV-ADJ":GOTO920
918 CA$="4":AA$(Q)="S-LV-NOUN":GOTO920
920 AA$(Q)=AA$(Q)+" "+NS$+"--"+V$+"--"+P$:PRINT@768,"":GOSUB3
000
950 CLS:PRINT:PRINT:PRINT" YOUR SCORE SO FAR IS ",INT(R/T1*1
00);"% ON LEVEL ";L:PRINT
952 IF(L>1)*(R/T1<.5)THENL=L-1:PRINT"YOU HAVE JUST MOVED DOWN TO
LEVEL ";L;" THIS SHOULD BE EASIER"
956 IF(L=8)*(R/T1>.95)THENCLS:FORN=1TO60:PRINT"!!WOW!!";(R*100/T
1);"%!";:FORW=1TO30:NEXT:NEXT:CLS:PRINTCHR$(23):PRINT:PRINT:PRI
NTR*100/T1,"% ON LEVEL ";L:PRINT:PRINT"NICE WORK,";NME$:PRINT
" I'M DONE WITH YOU ";FORW=1TO1500:NEXT:OS="N":GOTO970
957 IF(L<8)*(R/T1>.85)THENL=L+1:PRINT"YOU HAVE JUST MOVED UP TO
LEVEL ";L
960 PRINT:INPUT "DO YOU WANT TO TRY ANOTHER ONE (Y/N)";OS
970 IFLFT$(OS,1)="N"THENCLS:PRINT@278,"GOOD - BYE,";NME$;PRIN
T@406,"NEXT PERSON, PLEASE":GOSUB1100:R=0:T1=0:CLS:GOTO150
992 GOTO200
999 END
1000 PRINT@370,"LEVEL ";L;:PRINT@434,"S C O R E :";:PRINT@497,R
;"OUT OF";:PRINT@508,T1;
1010 RETURN
1100 S=S+1:NME$=LEFT$(NME$,15):P=INT(R/T1*100):TP=P*L:IFS>10THEN

```

Listing continues

As Easy As...



TRS-80 Disk & Other Mysteries

by H.C. Pennington

This book is the definitive authority on data recovery for the TRS-80 Model I disk system. In almost every case, lost data can be recovered and this book tells you how to do it. From clobbered directories to parity errors, this profusely illustrated data recovery cookbook includes examples and step-by-step instructions for both beginners and professionals.

132 pages. \$22.50

Microsoft BASIC Decoded & Other Mysteries

by James Farvour

This book is the only one of its kind. You will learn how the TRS-80 Model I BASIC interpreter works from power-up to power-down. It has the complete disassembled Microsoft BASIC Level II interpreter with over 13,000 lines of detailed comments in one volume. The math, arithmetic and utility routines are fully explained with examples on how to use them. An incredible learning aid for the beginner and a valuable reference for the professional.

312 pages. \$29.95

The Custom TRS-80 & Other Mysteries

The Custom TRS-80 & Other Mysteries

by Dennis Bathory Kitsz.

A complete hardware/software how-to-do-it like reverse video, high res graphics, audible keystrokes, 8-track mass storage music synthesizer, and real time clock. Dozens of project hints, tips, and fixes complete with the interface software. If you are a beginner, there are chapters on wire-wrap, soldering and construction methods. If you are a professional, there is a wealth of technical detail.

332 pages. \$29.95

BASIC Faster and Better & Other Mysteries

BASIC Faster and Better & Other Mysteries

by Lewis Rosenfelder

BASIC is not nearly as slow as you think! This book shows you how to make it faster and better with techniques and tricks that you never dreamed of for Model I, II and III disk systems. You won't find trivial, poorly designed "check-book" programs here - only useful BASIC techniques and code ready for use in YOUR programs. Tutorial for the beginner, instructive for the advanced, and invaluable for the professional. All routines are available on disk.

290 pages. \$29.95

Learn about your TRS-80 computer - it's as easy as 1-2-3-4. These books are easy to read and understand because they are written for you by people just like you. Here are answers and solutions without jargon. There are no end of chapter "tests" - no incomprehensible math formulas - no textbook explanations - just straightforward, plain English.

You will learn how to recover "lost data" on disk, how the BASIC interpreter works, how to make BASIC run faster and better, and how to modify and interface your TRS-80. In other words, you will learn how to make your computer do all the things you want it to do. It's as easy as 1-2-3-4.

Available at computer stores, B. Dalton Booksellers and independent book dealers. **BASIC Faster and Better** is also available at all RADIO SHACK Computer Centers and selected RADIO SHACK stores. (Cat. No. 62-1002) If your dealer is out of stock, order direct. Include \$4.00 for shipping and handling. Foreign residents add \$11.00 plus purchase price, in U.S. funds.

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Subroutine 6500 is similar but it is used for yes and no questions.

Letting students answer questions this way saves them time and ensures accurate spelling. It also gives them something to play with while they're debating about the right answer.

Other Possibilities

This is a flexible program; many parts can be changed without forcing you to rewrite other parts.

For example, the word lists can be changed or made longer by changing the appropriate data, read, and RND() lines. If you want to play with the sentence generator, put a remark at the beginning of line 187 so you can choose any level, and add this line: 519 GOTO 186.

Other types of sentence patterns can be added by changing line 270 and adding more lines similar to lines 350-365. These lines could be added anywhere since they end in a return. Of course, you would also have to change the last question (lines 900-918).

The program can be modified to do other grammar exercises. For example, if you wanted to work on parts of speech, you would need to rewrite lines 315, 365, 415, and 470 because the answers are pulled out of the sentences at this point. The lines that define the questions and answers (520-950) would also have to be changed so subroutine 3000 would ask the right questions and check the correct answers, but the rest of the program can be left intact.

Drills on dependent clauses and subordinating conjunctions would be even easier. I'll let you figure that one out.

If your students get tired of the graphics, you could write your own in subroutines 5000 and 5500. You could even add a graphics game subroutine that could be called from around line 960. Playing time could be based on a certain amount of achievement.

Practical Suggestions

I've found that the optimum time students work with this program is 15 to 30 minutes per group in groups of two or three students. It works well to put high and low-ability students together in the same group. They need at least 15 minutes to start working their way up through the levels, but unless they're really dedicated, they start playing with it after a half hour or so. ■

George Stone can be reached at 5089 Deer Creek Lane, West Bend, WI 53095.

Listing continued

```
S=10
1110 FORN=1TOS:IFP<SP(N) THEN1130
1120 FORY=S-1TONSTEP-1:SS(Y+1)=S$(Y):SP(Y+1)=SP(Y):ST(Y+1)=ST(Y)
:SL(Y+1)=SL(Y):TP(Y+1)=TP(Y):NEXT:SS(N)=NME$:SP(N)=P:ST(N)=T1:SL
(N)=L:TP(N)=TP:GOTO1160
1130 NEXT
1160 PRINT@916,"PRESS <ENTER> TO START";:INPUTO$:RETURN
3000 REM *** CHECK ANSWER SUB
3010 PRINT:PRINTCHR$(94);Q;" ";Q$;:GOSUB1000:T1=T1+1:IFLEN(QC$)
>0THENGOSUB6000:PRINTA$:GOTO3030
3020 IFLEN(QYN$)>0GOSUB6500:GOTO3030
3025 A$=INKEY$:IFAS$="" THEN3025
3026 IFVAL(A$)<1ORVAL(A$)>4 THEN3025ELSEPRINT@64,STRING$(4,153);
3030 IFAS=CA$ THENR=R+1:PRINT"RIGHT,";NME$;" ";:GOTO3060
3035 IFLEN(QC$)=0 THEN3050ELSEPRINT"WRONG,";QC$;:GOSUB6000
3045 IFAS=CA$ THENR=R+.5:PRINT"RIGHT,";NME$;" ";:GOTO3060
3050 PRINT"WRONG,";AA$(Q);:GOSUB1000:GOSUB5500:GOTO3065
3060 PRINTAA$(Q):GOSUB1000:GOSUB5000
3065 QC$=""
3070 RETURN
3999 END
4000 REM*** GET READY FOR NEXTQUESTION
4010 CLS
4030 FORN=1TOLS:PRINTCS$(N):PRINT:NEXT:FORN=1TOQ:PRINTN;" ";AA$
(N):NEXT
4050 Q=Q+1:RETURN
5000 ONRND(6) GOTO5100,5100,5200,5100,5300,5300
5099 REM *** PAC MAN EATS
5100 FORN=1TO30:NEXT:X=RND(50):FORN=768+XTO64+XSTEP-64:FORX=1TO4
:PRINT@N-63,F1$(X);:PRINT@N,F2$(X);:PRINT@N+64,B1$;:PRINT@N+128,
B2$;:PRINT@N+192,STRING$(12,128);
5110 FORW=RTOL5:IFPEEK(14400)=128 THENRETURNELSENEXT:NEXT:NEXT:PR
INT"BURP";FORW=1TO50:NEXT:RETURN
5199 REM *** SNAKE ***
5200 X=510:X1=511:X2=X1:X3=X2:X4=X3:Y1=448:Y=RND(60)+Y1
5210 IFY1=0 THENY=-5
5220 I=SGN(Y-X)
5230 IFX<0 THEN5240ELSEPRINT@X,"***";
5240 IFX4<0 THENRETURNELSEPRINT@X4," ";X4=X2:X2=X
5250 IFX=YORX=Y+1 THENX=X-64:Y1=Y1-64:Y=RND(35)+Y1:GOTO5210
5260 X=X+I*2:IFPEEK(14400)=128 THENRETURNELSEGOTO5230
5299 REM *** WORM ***
5300 X=4:Y1=4:Y=Y1+RND(56)
5310 FORW=RTOL5:IFPEEK(14400)=128 THEN5350ELSENEXT:IFX>447 THEN535
0ELSEPRINT@X,Z$;:FORW=1TO25:NEXT
5320 IFX=Y THENPRINT@X,U$;:FORW=1TO25:NEXT:X1=X:X=X+64:IFX>447 THE
N5350ELSEPRINT@X,U$;:FORW=1TO25:NEXT:Y1=Y1+64:Y=Y1+RND(56):PRINT
@X1,CHR$(200);:GOTO5310
5330 IFX<Y THENPRINT@X,ZR$;:X=X+3:GOTO5310
5340 IFX>Y THENPRINT@X,ZL$;:X=X-2:GOTO5310
5350 PRINT"BYE-BYE";FORW=1TO50:RETURN
5500 REM *** PAC-MAN DIES
5505 CLS:FORN=1TO10:X=RND(640):PRINT@X," NO WAY,";NME$;" ";:
NEXT:PRINT@724,AA$(Q);
5510 N=768:FORX=4TOLSTEP-1:PRINT@N-63,F1$(X):PRINT@N,F2$(X):PRIN
T@N+64,B1$;PRINT@N+128,B2$;FORWAIT=1TO100:NEXT:NEXT:PRINT@705,ST
RING$(11,128);FORWAIT=1TO100:NEXT
5520 FORN=1TO150:X=RND(24)-1:Y=RND(6)+38:RESET(X,Y):RESET(X+1,Y)
:IFPEEK(14400)=128 THEN5800ELSENEXT
5800 RETURN
6000 REM *** MOVE ARROW ***
6020 Y=65:X=65:PRINT@X,"[";
6030 U=PEEK(14400):IFU=64 THENX=X+1:GOTO6040ELSEIFU=1 THEN6100ELSE
IFU=32 THENX=X-1:GOTO6040ELSEIFU=16 THENX=X+128:GOTO6040ELSEGOTO60
30
6040 IFX<64 THENX=64ELSEIFX>LS*128-64+LEN(CS$(LS)) THENX=64ELSEIFX
=128 THENX=192ELSEIFX=191 THENX=127ELSEIFX=256 THENX=320ELSEIFX=319
THENX=255ELSEIFX>383 THENX=64
6060 PRINT@Y," ";:PRINT@X,"[";:Y=X:GOTO6030
6100 X=X+15360-64
6110 X=X-1:U=PEEK(X):IFU=32GOTO6150ELSEGOTO6110
6150 A$=""
6160 X=X+1:U=PEEK(X):IFU=32GOTO6170ELSEA$=A$+CHR$(U):GOTO6160
6170 IFRIGHT$(A$,1)=", "ORRIGHT$(A$,1)=". THENA$=LEFT$(A$,LEN(A$)
-1)
6180 PRINTA$;:X=64*(2*LS+Q+2):PRINT@X,"";:RETURN
6500 REM *** YES & NO QUESTIONS ***
6510 A$="" :X=690:Y=697:PRINT@624,CHR$(166);:PRINT@688,CHR$(153);
:PRINT@626,QYN$;
6520 U=PEEK(14400):IFU=32 THENX=690:Y=697ELSEIFU=64 THENX=697:Y=69
0ELSEIFU=1GOTO6550
6530 PRINT@X,"[";:PRINT@Y," ";:GOTO6520
6550 X=X-64+15360
6555 U=PEEK(X):IFU=32 THEN6560ELSEA$=A$+CHR$(U):X=X+1:GOTO6555
6560 IFAS$="ADJ" THENA$="ADJECTIVE"
6570 QYN$="" :PRINT@64*(LS*2+Q+2),"":RETURN
```


Avoid the Dangers of Dirty Disks

by Dave Grimes

A clean disk drive runs best, but cleaning a disk drive is easier said than done. This program leads you by the hand through the job.

After reading about the merits of disk system cleanliness, I decided to buy a disk drive head-cleaning kit.

I bought the 3M 7440 kit for 5¼-inch disk drives. This kit includes two 5¼-inch cleaning disks, a four-ounce bottle of cleaning fluid, a spout for the cleaning fluid bottle, and an instruction sheet.

The instructions advise you to dispense cleaning fluid onto the provided disk and to insert the cleaning disk into a drive. You then activate the drive for approximately 30 seconds, remove the disk and write on the label that the disk has been used. After 15 uses, you discard the cleaning disk.

I contemplated this for a while; how was I to turn on a particular disk drive for 30 seconds? For my 40-track drives, how would I know that after 15 uses of the cleaning disk, I had used all 40 tracks equally? The instruction sheet failed to address these questions.

It seems to me that a 40-track disk drive should be able to use the cleaning disk 40 times if I could ensure that a new track were used each time. Also, it

would be convenient to turn on a specified disk drive for 30 seconds while the cleaning disk was in that drive.

My program CLEANER/BAS makes all these things possible. It allows you to specify which drive to clean, the track to use on the cleaning disk, and keeps the specified disk-drive motor on for 30 seconds with the read/write head loaded.

How to Use the Program

After entering and verifying the program, run it. The screen shows a banner, gives a brief description of its function, and asks which disk drive you want cleaned. Don't put the cleaning disk in any drive yet, just enter the requested drive number. Next, you're asked which track to use on the cleaning disk. Enter a number from zero to the highest track number on your disk drive, less 1 (zero through 39 for a 40-track drive). When you hit enter the disk drive steps to track zero, then out to the track you entered. The screen clears and a new screen requests that you prepare the cleaning disk for

use and insert it in the target drive. Insert the cleaning disk and hit enter, and the target disk drive turns on for 30 seconds. Next, a new screen appears informing you which disk drive you've cleaned, and which track was used on the cleaning disk. You're reminded to remove the cleaning disk so that inadvertently turning on the disk drive won't sweep the read/write head across tracks on the cleaning disk.

The Program

Lines 80-180 of the Program Listing do some housekeeping, and display instructions on the screen. Lines 190, 200, and 210 solicit the disk-drive number (DD) and convert DD from 0, 1, 2, or 3 to 1, 2, 4, or 8 respectively. The converted number is stored in variable DL and is used to select the proper disk drive by POKEing DL into RAM location 14304. Line 220 asks which track number to use on the cleaning disk, and stores the track number in variable CH. Line 230 turns on (selects) the desired drive, and line 240 moves the read/write head to track zero.

Line 270 plugs in the track number that you want to use, and line 290 tells the disk controller to go to that track. Line 310 checks the track register to see if the desired track was located.

After putting the cleaning disk in the targeted drive, as instructed by lines 340 and 350, try to determine that the cleaning disk is actually in the target drive. The simplest way to do this, is to look for write protect in the disk controller status. The cleaning disks don't

A	Response for "Hit enter to continue"
CH	Track to seek on cleaning disk
DD	Input drive #
DL	Delay variable in For...Next loop
DR	Value to POKE to select drive
EF	Error flag. If zero when checked, no error
H1\$	Screen heading line
LD	Delay variable in For...Next loop
S	Disk controller status byte
TB	Tab value to center heading on screen

Table 1. List of variables

The Key Box

Model I
32K RAM
Disk Basic
1 Disk Drive
Head-Cleaning Kit

have the notch cut out to allow attempts to write. Subroutine 540-590 makes this check. Subroutine 500-530 checks the status after all commands. If it is determined that a write-protected disk is in the target drive, assume that the disk is the cleaning disk and turn on the drive for 30 seconds with the head loaded against the disk. Lines 380-410 accomplish the 30-second turn on with a delay loop

that repeatedly selects the drive. If a drive isn't selected every two seconds or so, the drive shuts off.

This program allows the TRS-80 Model I disk user to control disk head cleaning efforts and keep his disk system clean. ■

Dave Grimes can be reached at 12949 W. Montana Drive, Lakewood, CO 80228. His hobbies include bicycling.

```

10 REM HEAD CLEANING UTILITY AND CLEANING DISKETTE MANAGER
20 REM DECEMBER 1981
30 REM
40 REM BY DAVE GRIMES
50 REM 12949 W. MONTANA DR.
60 REM LAKEWOOD, CO 80228
70 REM
80 DEFINT A-Z
90 H1$="DISKETTE HEAD CLEANING PROGRAM"
100 TB=(64-(LEN(H1$)))/2 :CLS
110 PRINT TAB(TB) H1$:PRINT
120 PRINT"THIS PROGRAM WILL MANAGE YOUR HEAD CLEANING DISKETTES, BY"
130 PRINT"ALLOWING YOU TO SPECIFY WHICH TRACK ON THE HEAD CLEANING"
140 PRINT"DISKETTE YOU WISH TO USE EACH TIME."
150 PRINT"IF YOU KEEP A RECORD OF WHICH UNUSED TRACK IS NEXT, YOU CAN"
160 PRINT"USE YOUR CLEANING DISKETTES 35, 40, 77, OR EVEN 80 TIMES"
170 PRINT"(DEPENDING ON YOUR DRIVES), AND USE A CLEAN AREA EACH TIME."
180 PRINT
190 INPUT"WHICH DISK DRIVE DO YOU WISH TO CLEAN (0,1,2,3)";DD
200 IF DD <> 0 AND DD <> 1 AND DD <> 2 AND DD <> 3 THEN 190
210 DR=INT(2/DD) 'NOTE EXPONENTIATION
220 INPUT"WHAT IS THE NEXT CLEAN TRACK ON YOUR CLEANING DISKETTE";CH
230 POKE 14304,DR 'SELECT DRIVE
240 POKE 14316,3 'RESTORE (TRACK 0)
250 GOSUB 500 'CHECK STATUS
260 POKE 14304,DR 'TURN ON DRIVE MOTOR
270 POKE 14319,CH 'PLUG IN TRACK #
280 GOSUB 500 'CHECK STATUS
290 POKE 14316,19 'SEEK TRACK
300 GOSUB 500 'CHECK STATUS
310 IF PEEK(14317) <> CH THEN PRINT"SEEK ERROR ON DRIVE";DD:END
320 CLS :PRINT TAB(TB) H1$:PRINT
330 PRINT"THE DISK DRIVE TO BE CLEANED WILL BE TURNED ON FOR 30 SECONDS."
340 PRINT:PRINT"PUT THE CLEANING DISKETTE IN DRIVE";DD;"NOW AND HIT <ENTER>";
350 INPUT A
360 GOSUB 540 'LOOK FOR WRITE PROTECT
370 IF EF=1 THEN PRINT"*** ERROR ***":GOTO340
380 FOR DL = 1 TO 85
390 POKE 14304,DR
400 FOR LD = 1 TO 100
410 NEXT LD,DL
420 CLS: PRINT TAB(TB) H1$:PRINT :PRINT
430 PRINT"DRIVE";DD;"CLEANED!":PRINT
440 PRINT"PLEASE MAKE A NOTE THAT TRACK";CH;"OF THE HEAD CLEANING"
450 PRINT"DISKETTE HAS BEEN USED AND SHOULD NOT BE USED AGAIN."
460 PRINT
470 PRINT"YOU SHOULD REMOVE THE HEAD CLEANING DISKETTE NOW."
480 PRINT
490 END
500 S=PEEK(14316)
510 IF S > 127 RETURN
520 IF (S AND 1) <> 0 GOTO 500
530 RETURN
540 POKE 14304,DR 'SELECT DRIVE
550 EF=1 'SET ERROR FLAG
560 FOR LD = 1 TO 10
570 IF PEEK(14316) > 63 THEN EF=0 :RETURN
580 NEXT LD
590 RETURN
600 END

```

Program Listing

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Making Labels

by William Nelson

Producing custom labels has never been easier. Written in Basic, this program can easily be modified to work with just about any printer.

The program uses just over 4K memory, and although written for disk, automatically switches to cassette mode if a disk controller is not present in your machine.

The program demonstrates a wide range of Basic routines including screen formatting, string handling, elementary graphics, logic testing, and single-dimensional arrays.

Program Description

When creating a new label, the program asks for height and width of the label, or you can choose several standard label sizes. Print spacing (characters per inch or cpi) is input and the program then draws a proportionally sized label on the screen. The maximum label size is limited by the size of the screen. The program contains many error-trapping routines.

Once the label's dimensions are established, the text lines are whited out and you type in text as with a word processor. If your text exceeds the maximum line length, the line is whited out again and you have to re-enter the text. When all lines are filled, you are asked if they are correct. If not, the editing module is accessed. Then the label can be printed or saved on disk or tape for future use.

The program is menu driven with the following options: create new label, edit label, check printer format, load from disk or tape, save to disk or tape, print label, and end.

The program was written for my Heath H-14 printer with its three print pitches (10, 12, and 16.5 cpi). It is easy to change the escape codes (decimal 27) in lines 710-750 to match your printer.

The program begins by initializing

print size to 10 cpi and line spacing to six lines per inch. When using larger labels with more than 10 lines of text, change line 5 by adding the statement DIM T\$(n), where n is the anticipated maximum number of lines. Most labels are not that large.

Because of the error-trapping routines, the only error likely to occur is File Not Found during loading from disk. The ON ERROR GOTO statement allows the program to continue even if this happens by returning to the menu. If you suspect other errors are occurring, remove this statement to retrieve Basic error codes.

The menu display and selection is handled by lines 30-60. Normal program exit is at lines 70-90. Each item in the menu is programmed in its own module and these are accessed with the statement in line 60.

Create New Label

Starting at line 100, a new menu is displayed allowing you to choose several standard label sizes or to enter the dimensions of any label desired. The program branches to the Format subroutine (lines 410-460) where variables are input for the number of lines per inch (L) and print pitch (P), which are necessary to calculate the proportions for the graphics label drawn on the screen. There is a branch at this point to the subroutine at line 160 to enter the height (H) and width (W) of the label. From these variables, the program calculates the maximum line length (ML) and the number of lines per label (NL)

Program Listing

```

5 CLEAR 1000:CS$=CHR$(176):Z=0:P=10:L=6:N=1:ONERRORGOTO3000
10 S=0:CLS
20 PRINT@25,"LABEL PROCESSOR";:PRINT@91,"Bill Nelson";:PRINT@153
  ,"February, 1982";
30 PRINT@286,"MENU";:PRINT@407,"1) CREATE NEW LABEL";:PRINT@471,
  "2) EDIT LABEL";:PRINT@535,"3) CHECK PRINT FORMAT";:PRINT@599,"4
  ) LOAD FROM DISK OR TAPE";:PRINT@663,"5) SAVE TO DISK OR TAPE";:
  PRINT@727,"6) PRINT LABEL";:PRINT@791,"7) END";
40 PRINT@896,"MAKE SELECTION";:INPUT S
50 IFS<LORS>7PRINT@896,"SELECTION OUT OF RANGE--TRY AGAIN!!!";:F
  ORX=1TO1000:NEXT:PRINT@896,STRING$(36," ");:GOTO40
60 ONSGOTO 100,340,400,500,600,700,70
70 PRINT@896,STRING$(64," ");:PRINT@896,"HAVE YOU SAVED YOUR DAT
  A";:INPUTA$:IFLEFT$(A$,1)<>"Y"PRINT@896,STRING$(64," ");:GOTO40
80 PRINT@896,STRING$(64," ");:PRINT@896,"**END OF SESSION**";:FO
  R X=1TO2000:NEXT:CLS
90 END
100 S=0:CLS:PRINT@24,"CREATE NEW LABEL";:PRINT@155,"LABEL SIZES"
  ;:PRINT@215,"1) 1 x 3.5 inches";:PRINT@279,"2) 1.75 x 2.75 inche
  s";:PRINT@343,"3) .75 x 2 inches";:PRINT@407,"4) Other";
110 PRINT@576,"MAKE SELECTION";:INPUTS:IFS<LORS>4PRINT@576,"SELE

```

Listing continues

The Key Box

**Level II or Disk Basic
Model III
16K RAM
Disk Drives optional
Printer**


```

CTION OUT OF RANGE--TRY AGAIN!!";:FORX=1TO1000:NEXT:PRINT@576,ST
RING$(36," ");:GOTO110
120 IFS=1H=1:W=3.5:GOTO170
130 IFS=2H=1.75:W=2.75:GOTO170
140 IFS=3H=.75:W=2:GOTO170
150 PRINT@704,"ENTER DIMENSIONS OF LABEL";:PRINT@847,"HEIGHT";:I
NPUTH:PRINT@867,"WIDTH";:INPUTW:GOTO170
160 ML=INT(W*P)-1:NL=INT(H*L):XS=62-ML:XF=2*ML+XS+5:IYS=5:YS=IYS
:YF=3+3*(NL+1):ICP=128+(64-ML)/2:CP=ICP:RETURN
170 GOSUB410:IFNL>10ORML>56PRINT@704,STRING$(25," ");:PRINT@847,
STRING$(28," ");:PRINT@704,"LABEL TOO LARGE FOR SCREEN--SELECT SM
ALLER SIZE";:FORX=1TO2000:NEXT:PRINT@704,STRING$(46," ");:GOTO100

200 CLS:GOSUB 1000
210 FOR J=1 TO NL
220   FOR X=XSTOXF:SET(X,YS+1):SET(X,YS+2):SET(X,YS+3):NEXT
230   T$(J)="":PRINT@CP-4,USING"##";J;:PRINT@CP,C$;
240   A$=INKEY$:IF A$="" THEN 240 ELSE IF A$=CHR$(8) PRINT A$;GOSUB 2000:
IFBS<1GOTO220ELSEGOTO240ELSE T$(J)=T$(J)+A$:IFLEN(T$(J))>ML,T$(J)
="":GOTO220ELSE IF A$<>CHR$(13) PRINT A$;:GOTO240
250   IF ZGOTO280
260   YS=YS+3:CP=CP+64
270   NEXT J
280   Z=1:CP=ICP+64*NL
290   PRINT@CP+64,"DO YOU WISH TO CHANGE ANY LINES? (Y/N) ";
300   INPUT A$:IFLEFT$(A$,1)<>"Y",340
310   PRINT@CP+56,STRING$(52," ")
320   PRINT@CP+64,"ENTER LINE NUMBER TO CHANGE";:INPUT J
325   IF J>NLOR J<1PRINT@CP+128,STRING$(30,32);:PRINT@CP+128,"SELECT
ION OUT OF RANGE--TRY AGAIN!!";:FORX=1TO1000:NEXT:PRINT@CP+128,
STRING$(36,32);:GOTO320
330   YS=YS+3*(J-1):CP=ICP+64*(J-1):GOTO220
340   CLS:Z=0
350   CP=ICP
360   FOR J=1TONL
365     PRINT@CP-4,USING"##";J;
370     PRINT@CP," ";T$(J)
380     CP=CP+64
390   NEXT J
395   GOSUB 1000
398   PRINT@CP+64,"DO YOU WISH TO EDIT LABEL (Y/N) ";:INPUT A$:IFLEFT
T$(A$,1)="Y",Z=1:CP=CP+1:GOTO310ELSEGOTO10
400   GOSUB410:GOTO10
410   CLS:PRINT@29,"FORMAT";:PRINT@158,"CURRENT          NEW";:PRI
NT@261,"PITCH (10,12,16.5 CPI)";:PRINT@325,"LINES PER INCH (6,8)
";:PRINT@389,"NO. LABELS TO BE PRINTED";:PRINT@290,P;:PRINT@302,
CHR$(32);:INPUT P
412   IF P<>10AND P<>12AND P<>16,5GOTO410
415   PRINT@302,STRING$(7,32);:PRINT@303,USING"##.#";P
420   PRINT@325,"LINES PER INCH (6,8)";:PRINT@355,L;:PRINT@366,CHR
$(32);:INPUT L
423   IF L<>6AND L<>8GOTO420
425   PRINT@367,STRING$(5,32);:PRINT@367,L
430   PRINT@389,"NO. LABELS TO BE PRINTED";:PRINT@419,N;:PRINT@430
,CHR$(32);:INPUT N
433   N=INT(N)
434   IF N<1PRINT@389,STRING$(50,32);:PRINT@389,"MUST BE GREATER TH
AN ZERO";:FORX=1TO1000:NEXT:PRINT@389,STRING$(25,32);:GOTO430
435   PRINT@433,STRING$(9,32);:PRINT@430,USING"###";N
440   PRINT@709,"ANY CHANGES (Y/N)";:INPUT A$
450   IFLEFT$(A$,1)<>"N"GOTO410
460   GOSUB160:RETURN
500   T=INP(240):IFT=255GOTO1400
505   CLS:PRINT"LOADING FROM DISK";:PRINT@768,"FILESPEC";:INPUT F$

510   IFLEN(F$)>8PRINT@768,STRING$(30,32);:PRINT@768,"FILESPEC TO
O LONG--TRY AGAIN!!";:FORX=1TO1000:NEXT:GOTO500
520   OPEN "I",1,F$
530   INPUT#1,P,L,H,W,NL,CP,N
540   FORJ=1TONL
550     LINEINPUT#1,T$(J)
560   NEXT
570   CLOSE
580   GOSUB160:GOTO340
600   T=INP(240):IFT=255GOTO1400
605   CLS:PRINT"SAVING TO DISK";:PRINT@768,"FILESPEC ";:INPUT F$
610   IFLEN(F$)>10PRINT@768,STRING$(30,32);:PRINT@768,"FILESPEC T
OO LONG--TRY AGAIN!!";:FOR X=1TO1000:NEXT:GOTO600
620   OPEN"O",1,F$
630   PRINT#1,P;L;H;W;NL;CP;N
640   FOR J=1TONL
650     PRINT#1,T$(J)
660   NEXTJ
670   CLOSE
680   GOTOL0
700   ST%=PEEK(14312)AND240:IFST%<48PRINT@960,"PRINTER NOT READY"
;:FORX=1TO1000:NEXT:GOTO10ELSEGOSUB410
710   IFP=10,D=1ELSE IFP=12,D=2ELSE IFP=16.5,D=40

```

Listing continues

as well as the X and Y axes, starting and finishing points, with the label centered at the top of the screen. The program then returns to the Create module.

The subroutine at lines 1000-1020 provides the graphics algorithm to draw the label outline on the screen. The loop from lines 210-270 prints a white bar across the current line and waits for text to be input via the INKEY statement at line 240. At this point the program checks for the left arrow, CHR\$(8), and adjusts the line length count accordingly. To prevent the possibility of backspacing farther than the left margin, the program restarts the entire line when the first space is reached.

Edit Module

When all text lines are filled you have the option to edit any lines. If so, the program jumps back to the appropriate text line by filling in the array subscript for T\$(J) and proceeds as before at line 220. The For . . . Next loop is bypassed at this point through the use of the logical true/false test at line 250. The variable Z is originally set to zero (logical false) for normal loop input. When in the present edit mode, Z is changed to one (logical true) in line 280.

After editing, the finished label is printed on the screen and you have one more chance to change it. You can access the Edit module (lines 310-398) from the main menu at any time. If no further editing is required, the program returns to the menu.

Format Module

The format module sets printer parameters for the Heath H-14 and asks for the number of identical labels to be printed. Modify lines 410-423 for different printers. The Print Using statement is used to provide uniform columns on the display. The Format module is accessed automatically during the Create module as previously explained, but can also be changed prior to printing.

Load and Save Modules

You can save text and format parameters to disk or tape for future use. The Model III's disk controller presence is tested through its input port in lines 500 and 600. If the port's status is 255 decimal, there is no disk controller present and the program branches to the cassette load or save routine.

Model I users must PEEK memory to use this technique, or use only the I/O routine appropriate for your system when typing in the program. Cassette users cannot use commas within the text as they are not accepted by the cassette

Listing continued

```
720 OUT 251,27:OUT 251,117:OUT251,D
730 IF L=6,D=120
740 IF L=8,D=121
750 OUT 251,27:OUT 251,D
760 CLS:PRINT@256,"DO YOU WISH A TEST LABEL";:INPUTA$:IFLEFT$(A$,
1)<>"Y"GOTO820
770 FORJ=1TONL
780 LPRINT"TEST LINE";J:OUT251,10
800 NEXTJ
805 IFH=1.75,OUT251,10:OUT251,10
810 GOTO760
820 FORJ=1TONL
830 FORJ=1TONL
835 V=LEN(T$(J)):FORQ=1TOV:IFMID$(T$(J),Q,1)=CHR$(13)THENMID$(T$(
J),Q,1)=CHR$(32):NEXT
840 LPRINTT$(J);:OUT 251,10
850 NEXTJ
855 IFH=1.75,OUT251,10:OUT251,10
860 NEXTX
870 GOTO10
1000 FOR X=XSTOXP:SET(X,IYS):SET(X,YF):NEXT
1010 FOR Y=IYSTOYP:SET(XS,Y):SET(XS+1,Y):SET(XF-1,Y):SET(XF,Y):N
EXT
1020 RETURN
1400 CLS:PRINT"LOADING DATA FROM TAPE";:PRINT@768,"READY CASSETT
E PLAYER--PRESS <ENTER> WHEN READY";:INPUTA$
1410 INPUT#-1,P,L,H,W,NL,CP,N
1420 FORJ=1TONL
1430 INPUT#-1,T$(J)
1440 NEXT
1450 GOSUB 160:GOTO340
1500 CLS:PRINT"SAVING DATA ON TAPE";:PRINT@768,"READY CASSETTE P
LAYER--PRESS <ENTER> WHEN READY";:INPUTA$
1510 PRINT#-1,P,L,H,W,NL,CP,N
1520 FOR J=1TONL
1530 PRINT#-1,T$(J)
1540 NEXTJ
1550 GOTO10
2000 BS=LEN(T$(J))-1:IFBS>0THENT$(J)=LEFT$(T$(J),BS):RETURNELSER
ETURN
3000 CLS:PRINT"NO LABEL EXISTS YET";:FOR X=1TO2000:NEXT:GOTO10
```

input routine. Disk users are not bothered by this because of the Disk Basic Line Input statement in line 550.

Printer Routine

The program checks for printer-ready status in line 700. The routine was taken directly from the Model III manual. Escape codes in lines 710-750 change the print size or line spacing in the Heath H-14. Since the printer driver in the Model III is ported rather than memory mapped, I use the port statement OUT 251,n to send these codes as well as line feeds after each line of print. Model I users should use the statement, LPRINT CHR\$(n) instead.

You can print a test label to ensure they are correct before multiple printing. To print lines of text, the program at line 835 first searches the text string and changes any carriage returns (decimal 13) to spaces (decimal 32). This way the printer inserts line feeds only at the necessary times. Consequently, it makes no difference whether the printer has an automatic line feed with each carriage return. ■

*William Nelson may be reached at
1354 Hackett Street, Beloit, WI 53511.*

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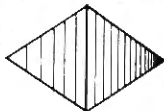
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Two-Person Space Bomber

by Dale Chermak

Do you tire of single-player games? Do you wish you could challenge a friend to a two-player game?

In Space Bomber, one player defends a planet from bombs dropped by the other. The screen is divided in half by two barriers that move in opposite directions. At the bottom of the screen is the planet's defense base. It is dotted with eight ammo cells and a moving nu-

In Space Bomber, one player defends his planet from bombs being dropped by his opponent.

clear reactor.

The planet is protected by a defending ship that fires missiles. However, the ship must be stationary while firing, and this makes it an easy target. The ship also defends the ammo cells and the reactor.

The bomber is a constant threat to the planet. It can move at three speeds, and it drops bombs that punch holes in the barriers. The bomber's objective is to destroy either the defending ship, the nuclear reactor, or all of the ammo cells.

Game Controls

The bomber is controlled by three keys: The A key moves the bomber two spaces at a time, the S key moves it three spaces at a time, and the D key drops bombs. Bombs can be dropped while the bomber is moving.

The defending ship is also controlled by three keys. Pressing the left arrow moves the defending ship to the left, while using the right arrow moves it to the right. Press enter to fire a missile.

Game Modification

The game can be modified to give handicaps to better players. If you don't want the defending ship's missiles to break through the barrier, delete line 3160. Deleting lines 4230-4270 prevents the bomb from destroying the missile when they are at the same screen position. Also, Model III owners might

Lines	Function
100-440	Initialization
450-500	Data storage area.
510-570	Subroutines to check if defending ship is at edge of screen.
580-1190	Data for base.
1200-1310	Data for bomber.
1320-1350	Data for defending ship.
1360-1470	Data for bomber explosion.
1480-1520	Data for ammo cell explosion.
1530-1570	Data to clear ammo cell after explosion.
1580-1710	Data for messages.
1720-1780	Subroutine to print the data in HL at the screen position in IX.
1790-1840	Subroutine to print barrier.
1850-2080	Subroutine to move the barriers.
2090-2140	Subroutine to print the defending ship.
2150-2490	Subroutine to move the bomber one space right, keep it on the second line, and wrap around if necessary.
2500-2620	Subroutine to move nuclear reactor one space right and wrap around if necessary.
2630-2680	Subroutine to clear screen.
2690-2740	Subroutine to compare HL to DE.
2750-2790	Delay subroutine.
2800-2890	Move barriers and check defending player's keys. Then check for bombing player's keys, move bomber, and do again.
2900-2960	Move defending ship one space right if ship not on edge and print it.
2970-3040	Move defending ship one space left if ship not on edge and print it.
3050-3280	Defending ship fire subroutine.
3290-3450	Print explosion and messages.
3460-3550	See if players want to play again.
3560-3620	Reset ammo count, bomber fire position, and restart.
3630-3760	See if bomber has already fired. If not then check bombing player's keys.
3770-3820	Subroutine to move bomber two spaces.
3830-3990	Check bomber movement keys. If neither hit then move bomber one space. Move nuclear reactor.
4000-4210	Bomber bombing subroutine.
4220-5040	Check bomb position for missile, barrier, ammo cell, nuclear reactor, and defending ship.

Table 1. Program Flow

The Key Box

Model I
16K RAM
Cassette or Disk Basic
Editor/Assembler

*"The bomber is a
constant threat to the planet."*

language for fast graphic displays. I use my own subroutines for clearing the screen, delaying, and comparing the HL register to the DE register. You may want to use ROM calls to save memory. Table 1 explains how the program runs. ■

want to change the bombs and missiles 3180, 4040, and 4230.

to characters other than the down and up arrows. The bomb is used in line 4100, and the missile is used in lines

The Program

Space bomber is written in machine

*Dale Chermak is in the 11th grade.
He lives at 18855 Kinbrace St.,
Northridge, CA 91326.*

Program Listing

6400	00100		ORG	6400H					
6400	CD1E68	00110	START	CALL	RCLS				
6403	DD21D73D	00120		LD	IX,15831				
6407	21F566	00130		LD	HL,STMS				
640A	CD4B67	00140		CALL	PFOS				
640D	3E02	00150		LD	A,2				
640F	F5	00160	DDA	PUSH	AF				
6410	010000	00170		LD	BC,0				
6413	CD3268	00180		CALL	DELAY				
6416	F1	00190		POP	AF				
6417	3D	00200		DEC	A				
6418	C20F64	00210		JP	NZ,DDA				
641B	CD1E68	00220		CALL	RCLS				
641E	DD21C03F	00230		LD	IX,16320				
6422	217464	00240		LD	HL,BASE1				
6425	CD4B67	00250		CALL	PFOS				
6428	110400	00260		LD	DE,4				
642B	DD19	00270		ADD	IX,DE				
642D	219364	00280		LD	HL,BASE2				
6430	CD4B67	00290		CALL	PFOS				
6433	DD21C03D	00300		LD	IX,15808				
6437	CD5867	00310		CALL	FLI				
643A	DD21003E	00320		LD	IX,15872				
643E	CD5867	00330		CALL	FLI				
6441	219F3F	00340		LD	HL,16287				
6444	225C64	00350		LD	(DSP),HL				
6447	21403C	00360		LD	HL,15424				
644A	225E64	00370		LD	(BSP),HL				
644D	CDA467	00380		CALL	PDS				
6450	08	00390		EX	AF,AF'				
6451	D9	00400		EXX					
6452	21DE3F	00410		LD	HL,16350				
6455	08	00420		EX	AF,AF'				
6456	D9	00430		EXX					
6457	C33968	00440		JP	INLP				
645A	00	00450	FPOL1	DEFB	0				
645B	00	00460	FPOL2	DEFB	0				
0002	00	00470	DSP	DEFS	2				
0002	00	00480	BSP	DEFS	2				
0002	00	00490	BFP	DEFS	2				
6462	08	00500	ACL	DEFB	8				
6463	11BD3F	00510	CRS	LD	DE,16317				
6466	CD2C68	00520	CHTD	CALL	HLDE				
6469	C0	00530		RET	NZ				
646A	C34E68	00540		JP	CBMB				
646D	C9	00550		RET					
646E	11803F	00560	CLS	LD	DE,16256				
6471	C36664	00570		JP	CHTD				
6474	BF	00580	BASE1	DEFB	191				
6475	BF	00590		DEFB	191				
6476	BF	00600		DEFB	191				
6477	BF	00610		DEFB	191				
6478	BF	00620		DEFB	191				
6479	BF	00630		DEFB	191				
647A	B0	00640		DEFB	176				
647B	B0	00650		DEFB	176				
647C	B0	00660		DEFB	176				
647D	B7	00670		DEFB	183				
647E	BB	00680		DEFB	187				
647F	B0	00690		DEFB	176				
6480	B0	00700		DEFB	176				
6481	B0	00710		DEFB	176				
6482	B7	00720		DEFB	183				
6483	BB	00730		DEFB	187				
6484	B0	00740		DEFB	176				
6485	B0	00750		DEFB	176				
6486	B0	00760		DEFB	176				
6487	B7	00770		DEFB	183				
6488	BB	00780		DEFB	187				
6489	B0	00790		DEFB	176				
648A	B0	00800		DEFB	176				
648B	B0	00810		DEFB	176				
648C	B7	00820		DEFB	183				
648D	BB	00830		DEFB	187				
648E	B0	00840		DEFB	176				
648F	B0	00850		DEFB	176				
6490	BE	00860		DEFB	190				
6491	BF	00870		DEFB	191				
6492	00	00880		DEFB	0				
6493	BF	00890	BASE2	DEFB	191				
6494	BD	00900		DEFB	189				
6495	B0	00910		DEFB	176				
6496	B0	00920		DEFB	176				
6497	B7	00930		DEFB	183				
6498	BB	00940		DEFB	187				
6499	B0	00950		DEFB	176				
649A	B0	00960		DEFB	176				
649B	B0	00970		DEFB	176				
649C	B7	00980		DEFB	183				
649D	BB	00990		DEFB	187				
649E	B0	01000		DEFB	176				
649F	B0	01010		DEFB	176				
64A0	B0	01020		DEFB	176				
64A1	B7	01030		DEFB	183				
64A2	BB	01040		DEFB	187				
64A3	B0	01050		DEFB	176				
64A4	B0	01060		DEFB	176				
64A5	B0	01070		DEFB	176				
64A6	B7	01080		DEFB	183				
64A7	BB	01090		DEFB	187				
64A8	B0	01100		DEFB	176				
64A9	B0	01110		DEFB	176				
64AA	B0	01120		DEFB	176				
64AB	BF	01130		DEFB	191				
64AC	BF	01140		DEFB	191				
64AD	BF	01150		DEFB	191				
64AE	BF	01160		DEFB	191				
64AF	BF	01170		DEFB	191				
64B0	BF	01180		DEFB	191				
64B1	00	01190		DEFB	0				
64B2	B0	01200	BMBR	DEFB	176				
64B3	B0	01210		DEFB	176				
64B4	9B	01220		DEFB	155				
64B5	8C	01230		DEFB	140				
64B6	B3	01240		DEFB	179				
64B7	BF	01250		DEFB	191				
64B8	B3	01260		DEFB	179				
64B9	8C	01270		DEFB	140				
64BA	A7	01280		DEFB	167				
64BB	B0	01290		DEFB	176				
64BC	B0	01300		DEFB	176				
64BD	00	01310		DEFB	0				
64BE	B4	01320	DFDS	DEFB	180				
64BF	8F	01330		DEFB	143				
64C0	B8	01340		DEFB	184				
64C1	00	01350		DEFB	0				
64C2	B8	01360	EXPB	DEFB	184				
64C3	AC	01370		DEFB	172				
64C4	89	01380		DEFB	137				
64C5	B2	01390		DEFB	178				
64C6	9E	01400		DEFB	158				
64C7	BA	01410		DEFB	186				
64C8	B2	01420		DEFB	178				
64C9	9A	01430		DEFB	154				
64CA	A7	01440		DEFB	167				
64CB	8E	01450		DEFB	142				
64CC	AC	01460		DEFB	172				
64CD	00	01470		DEFB	0				
64CE	BC	01480	EX2	DEFB	188				
64CF	BF	01490		DEFB	191				
64D0	BF	01500		DEFB	191				
64D1	BC	01510		DEFB	188				
64D2	00	01520		DEFB	0				

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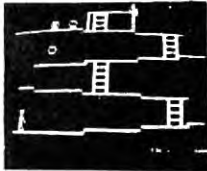
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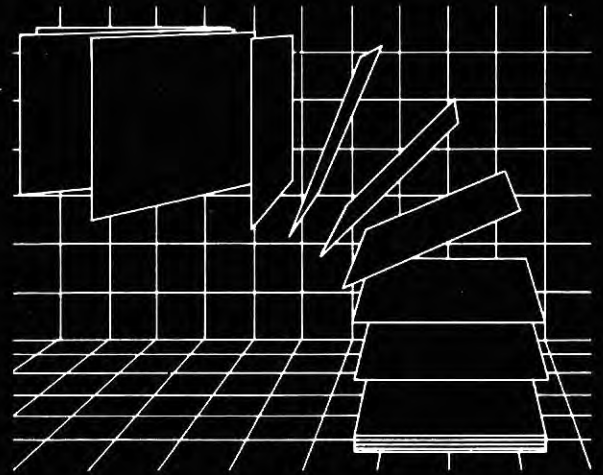
64D3 B0	01530	CEX2	DEFB	176	
64D4 B0	01540		DEFB	176	
64D5 B0	01550		DEFB	176	
64D6 B0	01560		DEFB	176	
64D7 00	01570		DEFB	0	
64D8 44	01580	BLSM	DEFM	'DEFENDING PLAYER WINS !!!!!	
				PLAY AGAIN <ENTER> ---> <---	
6532 00	01590		DEFB	0	
6533 42	01600	DLSM	DEFM	'BOMBING PLAYER WINS !!!!!	
				PLAY AGAIN <ENTER> ---> <---	
658D 00	01610		DEFB	0	
658E 57	01620	DSHB	DEFM	'WAY TO GO DEFENDING SHIP. YOU	
				WASTED THE BOMBER !!!!!'	
65E5 00	01630		DEFB	0	
65E6 57	01640	DAAC	DEFM	'WAY TO GO BOMBER. YOU WASTED	
				ALL OF THE AMMO CELLS !!!!!'	
6642 00	01650		DEFB	0	
6643 57	01660	YHDS	DEFM	'WAY TO GO BOMBER. YOU WASTED	
				THE DEFENDING SHIP !!!!!'	
669B 00	01670		DEFB	0	
669C 57	01680	YHNR	DEFM	'WAY TO GO BOMBER. YOU WASTED	
				THE NUCLEAR REACTOR !!!!!'	
66F4 00	01690		DEFB	0	
66F5 2A	01700	STMS	DEFM	'** SPACE BOMBER **	
				** BY DALE A. CHERMAK **	
674A 00	01710		DEFB	0	
674B 7E	01720	PFOS	LD	A, (HL)	
674C FE00	01730		CP	0	
674E C8	01740		RET	Z	
674F DD7700	01750		LD	(IX),A	
6752 DD23	01760		INC	IX	
6754 23	01770		INC	HL	
6755 C34B67	01780		JP	PFOS	
6758 0640	01790	FLI	LD	B,64	
675A DD3600BC	01800	FLIA	LD	(IX),188	
675E DD23	01810		INC	IX	
6760 05	01820		DEC	B	
6761 C25A67	01830		JP	NZ,FLIA	
6764 C9	01840		RET		
6765 DD21C03D	01850	USB	LD	IX,15808	
6769 DD7E00	01860		LD	A, (IX)	
676C 325A64	01870		LD	(FPOL1),A	
676F DD7E7F	01880		LD	A, (IX+127)	
6772 325B64	01890		LD	(FPOL2),A	
6775 0E3F	01900		LD	C,63	
6777 DD23	01910	DUSB	INC	IX	
6779 DD7E00	01920		LD	A, (IX)	
677C DD77FF	01930		LD	(IX+255),A	;READ +255 AS -1
677F 0D	01940		DEC	C	
6780 C27767	01950		JP	NZ,DUSB	
6783 3A5A64	01960		LD	A, (FPOL1)	
6786 DD7700	01970		LD	(IX),A	
6789 DD21403E	01980		LD	IX,15936	
678D 0E3F	01990		LD	C,63	
678F DD2B	02000	DUSC	DEC	IX	
6791 DD7EFF	02010		LD	A, (IX+255)	;READ +255 AS -1
6794 DD7700	02020		LD	(IX),A	
6797 0D	02030		DEC	C	
6798 C28F67	02040		JP	NZ,DUSC	
679B 3A5B64	02050		LD	A, (FPOL2)	
679E DD2B	02060		DEC	IX	
67A0 DD7700	02070		LD	(IX),A	
67A3 C9	02080		RET		
67A4 2A5C64	02090	PDS	LD	HL, (DSP)	
67A7 E5	02100		PUSH	HL	
67A8 DDE1	02110		POP	IX	
67AA 21BE64	02120		LD	HL,DPDS	
67AD CD4B67	02130		CALL	PFOS	
67B0 C9	02140		RET		
67B1 2A5E64	02150	MBR	LD	HL, (BSP)	
67B4 3620	02160		LD	(HL),32	
67B6 23	02170		INC	HL	
67B7 11763C	02180		LD	DE,15478	
67BA CD2C68	02190		CALL	HLDE	
67BD DAE667	02200		JP	C,PBS	
67C0 11803C	02210		LD	DE,15488	
67C3 CD2C68	02220		CALL	HLDE	
67C6 CAF367	02230		JP	Z,MUOL	
67C9 DD21B264	02240		LD	IX,BMBR	
67CD DD7E00	02250	DIA	LD	A, (IX)	
67D0 FE00	02260		CP	0	
67D2 CAFD67	02270		JP	Z,SBP	
67D5 77	02280		LD	(HL),A	
67D6 23	02290		INC	HL	
67D7 DD23	02300		INC	IX	
67D9 CD2C68	02310		CALL	HLDE	
67DC DACD67	02320		JP	C,DIA	
67DF 01C0FF	02330		LD	BC,-64	
67E2 09	02340		ADD	HL,BC	
67E3 C3CD67	02350		JP	DIA	

Listing continues

Listing continued

67E6	225E64	02360	PBS	LD	(BSP),HL
67E9	E5	02370		PUSH	HL
67EA	DDE1	02380		POP	IX
67EC	21B264	02390		LD	HL,BMBR
67EF	CD4B67	02400		CALL	PFOS
67F2	C9	02410		RET	
67F3	01C0FF	02420	MUOL	LD	BC,-64
67F6	09	02430		ADD	HL,BC
67F7	225E64	02440		LD	(BSP),HL
67FA	C3E667	02450		JP	PBS
67FD	2A5E64	02460	SBP	LD	HL,(BSP)
6800	23	02470		INC	HL
6801	225E64	02480		LD	(BSP),HL
6804	C9	02490		RET	
6805	08	02500	UNR	EX	AF,AF'
6806	D9	02510		EXX	
6807	3620	02520		LD	(HL),32
6809	11E13F	02530		LD	DE,16353
680C	CD2C68	02540		CALL	HLDE
680F	CA1868	02550		JP	Z,GNRP
6812	23	02560		INC	HL
6813	368C	02570	PR	LD	(HL),140
6815	08	02580		EX	AF,AF'
6816	D9	02590		EXX	
6817	C9	02600		RET	
6818	21DE3F	02610	GNRP	LD	HL,16350
681B	C31368	02620		JP	PR
681E	21003C	02630	RCLS	LD	HL,15360
6821	3620	02640		LD	(HL),32
6823	11013C	02650		LD	DE,15361
6826	01FF03	02660		LD	BC,1023
6829	EDB0	02670		LDIR	
682B	C9	02680		RET	
682C	7C	02690	HLDE	LD	A,H
682D	BA	02700		CP	D
682E	C0	02710		RET	NZ
682F	7D	02720		LD	A,L
6830	BB	02730		CP	E
6831	C9	02740		RET	
6832	0B	02750	DELAY	DEC	BC
6833	78	02760		LD	A,B
6834	B1	02770		OR	C
6835	C23268	02780		JP	NZ,DELAY
6838	C9	02790		RET	
6839	CD6567	02800	INLP	CALL	USB
683C	3A4038	02810		LD	A,(3040H)
683F	FE01	02820		CP	1
6841	CA7968	02830		JP	Z,EWH
6844	FE20	02840		CP	32
6846	CA6668	02850		JP	Z,LAH
6849	FE40	02860		CP	64
684B	CA5468	02870		JP	Z,RAH
684E	CD1B69	02880	CBMB	CALL	OTLP
6851	C33968	02890		JP	INLP
6854	2A5C64	02900	RAH	LD	HL,(DSP)
6857	CD6364	02910		CALL	CRS
685A	3620	02920		LD	(HL),32
685C	23	02930		INC	HL
685D	225C64	02940	SIT	LD	(DSP),HL
6860	CDA467	02950		CALL	PDS
6863	C34E68	02960		JP	CBMB
6866	2A5C64	02970	LAH	LD	HL,(DSP)
6869	CD6E64	02980		CALL	CLS
686C	110200	02990		LD	DE,2
686F	19	03000		ADD	HL,DE
6870	3620	03010		LD	(HL),32
6872	11FDFE	03020		LD	DE,-3
6875	19	03030		ADD	HL,DE
6876	C35D68	03040		JP	SIT
6879	2A5C64	03050	EWH	LD	HL,(DSP)
687C	11C1FF	03060		LD	DE,-63
687F	19	03070		ADD	HL,DE
6880	E5	03080		PUSH	HL
6881	FDE1	03090		POP	IY
6883	060D	03100		LD	B,13
6885	FD7E00	03110	LOOP	LD	A,(IY)
6888	FE20	03120		CP	32
688A	CA9968	03130		JP	Z,BLNK
688D	FEBC	03140		CP	188
688F	C2B568	03150		JP	NZ,HITB
6892	FD360020	03160		LD	(IY),32
6896	C34E68	03170		JP	CBMB
6899	FD36005B	03180	BLNK	LD	(IY),91
689D	C5	03190		PUSH	BC
689E	CD1B69	03200		CALL	OTLP
68A1	C1	03210		POP	BC
68A2	FD360020	03220		LD	(IY),32
68A6	11C0FF	03230		LD	DE,-64
68A9	FD19	03240		ADD	IY,DE
68AB	05	03250		DEC	B

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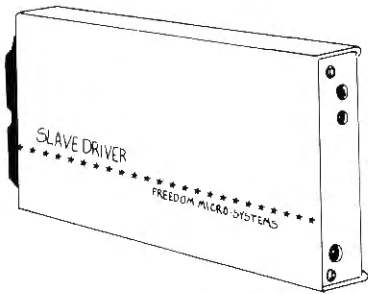


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68AC	CA3968	03260		JP	Z, INLP
68AF	CD6567	03270		CALL	USB
68B2	C38568	03280		JP	LOOP
68B5	2A5E64	03290	HITB	LD	HL, (BSP)
68B8	E5	03300		PUSH	HL
68B9	DDE1	03310		POP	IX
68BB	21C264	03320		LD	HL, EXPB
68BE	CD4B67	03330		CALL	PFOS
68C1	010000	03340		LD	BC, 0
68C4	CD3268	03350		CALL	DELAY
68C7	CD1E68	03360		CALL	RCLS
68CA	218E65	03370		LD	HL, DSHB
68CD	DD21533D	03380		LD	IX, 15699
68D1	CD4B67	03390		CALL	PFOS
68D4	010000	03400		LD	BC, 0
68D7	CD3268	03410		CALL	DELAY
68DA	21D864	03420		LD	HL, BLMS
68DD	DD21D33D	03430	PMAC	LD	IX, 15827
68E1	CD4B67	03440		CALL	PFOS
68E4	DD21293E	03450		LD	IX, 15913
68E8	DD360058	03460	KLP	LD	(IX), 88
68EC	3A4038	03470		LD	A, (3840H)
68EF	FE01	03480		CP	1
68F1	CA0769	03490		JP	Z, FXV
68F4	01C409	03500		LD	BC, 2500
68F7	CD3268	03510		CALL	DELAY
68FA	DD36002A	03520		LD	(IX), 42
68FE	01C409	03530		LD	BC, 2500
6901	CD3268	03540		CALL	DELAY
6904	C3E868	03550		JP	KLP
6907	3E08	03560	FXV	LD	A, 8
6909	326264	03570		LD	(ACL), A
690C	210000	03580		LD	HL, 0
690F	226064	03590		LD	(BFP), HL
6912	010000	03600		LD	BC, 0
6915	CD3268	03610		CALL	DELAY
6918	C30064	03620		JP	START
691B	2A6064	03630	OTLP	LD	HL, (BFP)
691E	7D	03640		LD	A, L
691F	FE00	03650		CP	0
6921	C2A469	03660		JP	NZ, BHF
6924	3A0138	03670		LD	A, (3801H)
6927	FE10	03680		CP	16
6929	CA8069	03690		JP	Z, DKH
692C	FE12	03700		CP	18
692E	CA8069	03710		JP	Z, DKH
6931	3A0138	03720	OTLP1	LD	A, (3801H)
6934	FE02	03730		CP	2
6936	CA3E69	03740		JP	Z, MB2
6939	FE12	03750		CP	18
693B	C25069	03760		JP	NZ, NEX
693E	CDB167	03770	MB2	CALL	MBR
6941	01C409	03780		LD	BC, 2500
6944	CD3268	03790		CALL	DELAY
6947	CDB167	03800		CALL	MBR
694A	01C409	03810		LD	BC, 2500
694D	C37969	03820		JP	JBTI
6950	3A0438	03830	NEX	LD	A, (3804H)
6953	FE08	03840		CP	8
6955	C27369	03850		JP	NZ, NEX1
6958	CDB167	03860		CALL	MBR
695B	017206	03870		LD	BC, 1650
695E	CD3268	03880		CALL	DELAY
6961	CDB167	03890		CALL	MBR
6964	017206	03900		LD	BC, 1650
6967	CD3268	03910		CALL	DELAY
696A	CDB167	03920		CALL	MBR
696D	017206	03930		LD	BC, 1650
6970	C37969	03940		JP	JBTI
6973	CDB167	03950	NEX1	CALL	MBR
6976	018813	03960		LD	BC, 5000
6979	CD3268	03970	JBTI	CALL	DELAY
697C	CD0568	03980		CALL	UNR
697F	C9	03990		RET	
6980	2A5E64	04000	DKH	LD	HL, (BSP)
6983	114500	04010		LD	DE, 69
6986	19	04020		ADD	HL, DE
6987	7E	04030		LD	A, (HL)
6988	FE5B	04040		CP	91
698A	C29769	04050		JP	NZ, PYB
698D	FD360020	04060	YHEM	LD	(Y), 32
6991	CD3169	04070		CALL	OTLP1
6994	C33968	04080		JP	INLP
6997	226064	04090	PYB	LD	(BFP), HL
699A	365C	04100		LD	(HL), 92
699C	E5	04110		PUSH	HL
699D	CD3169	04120		CALL	OTLP1
69A0	E1	04130		POP	HL
69A1	3620	04140		LD	(HL), 32

Listing continues

Listing continued

69A3	C9	04150	RET	
69A4	2A6064	04160	LD	HL, (BFP)
69A7	114000	04170	LD	DE, 64
69AA	19	04180	ADD	HL, DE
69AB	11FF3F	04190	LD	DE, 16383
69AE	CD2C68	04200	CALL	HLDE
69B1	D2CF69	04210	JP	NC, CFAR
69B4	7E	04220	LD	A, (HL)
69B5	FE5B	04230	CP	91
69B7	C2C369	04240	JP	NZ, OKKT
69BA	210000	04250	LD	HL, 0
69BD	226064	04260	LD	(BFP), HL
69C0	C38D69	04270	JP	YHEM
69C3	FE20	04280	CP	32
69C5	CA9769	04290	JP	Z, PYB
69C8	FEBC	04300	CP	188
69CA	C2D869	04310	JP	NZ, OKKT1
69CD	3620	04320	LD	(HL), 32
69CF	210000	04330	LD	HL, 0
69D2	226064	04340	LD	(BFP), HL
69D5	C33169	04350	JP	OTLP1
69D8	FEB7	04360	CP	183
69DA	C2076A	04370	JP	NZ, OKKT2
69DD	2B	04380	PEX2	HL
69DE	E5	04390	PUSH	HL
69DF	DDE1	04400	POP	IX
69E1	21CE64	04410	LD	HL, EX2
69E4	CD4B67	04420	CALL	PFOS
69E7	01C409	04430	LD	BC, 2500
69EA	CD3268	04440	CALL	DELAY
69ED	11FCFF	04450	LD	DE, -4
69F0	DD19	04460	ADD	IX, DE
69F2	21D364	04470	LD	HL, CEX2
69F5	CD4B67	04480	CALL	PFOS
69F8	3A6264	04490	LD	A, (ACL)
69FB	FE01	04500	CP	1
69FD	CA106A	04510	JP	Z, OACL
6A00	3D	04520	DEC	A
6A01	326264	04530	LD	(ACL), A
6A04	C3CF69	04540	JP	CFAR
6A07	FE8B	04550	CP	187
6A09	C22F6A	04560	JP	NZ, OKKT3
6A0C	2B	04570	DEC	HL
6A0D	C3DD69	04580	JP	PEX2
6A10	010000	04590	LD	BC, 0
6A13	CD3268	04600	CALL	DELAY
6A16	CD1E68	04610	CALL	RCLS
6A19	21E665	04620	LD	HL, DAAC
6A1C	DD21533D	04630	LD	IX, 15699
6A20	CD4B67	04640	CALL	PFOS
6A23	010000	04650	LD	BC, 0
6A26	CD3268	04660	CALL	DELAY
6A29	213365	04670	LD	HL, DLSM
6A2C	C3DD68	04680	JP	PMAC
6A2F	FE8C	04690	CP	140
6A31	C2506A	04700	JP	NZ, OKKT4
6A34	21C03D	04710	LD	HL, 15808
6A37	36BF	04720	LD	(HL), 191
6A39	11C13D	04730	LD	DE, 15809
6A3C	013F02	04740	LD	BC, 575
6A3F	EDB0	04750	LDIR	
6A41	018813	04760	LD	BC, 5000
6A44	CD3268	04770	CALL	DELAY
6A47	CD1E68	04780	CALL	RCLS
6A4A	219C66	04790	LD	HL, YHNR
6A4D	C31C6A	04800	JP	PMAA
6A50	FE8F	04810	CP	143
6A52	C2886A	04820	JP	NZ, OKKT5
6A55	2A5C64	04830	LD	HL, (DSP)
6A58	E5	04840	PUSH	HL
6A59	DDE1	04850	POP	IX
6A5B	DD3600BF	04860	LD	(IX), 191
6A5F	DD3601BF	04870	LD	(IX+1), 191
6A63	DD3602BF	04880	LD	(IX+2), 191
6A67	018813	04890	LD	BC, 5000
6A6A	CD3268	04900	CALL	DELAY
6A6D	DD360020	04910	LD	(IX), 32
6A71	DD360120	04920	LD	(IX+1), 32
6A75	DD360220	04930	LD	(IX+2), 32
6A79	010000	04940	LD	BC, 0
6A7C	CD3268	04950	CALL	DELAY
6A7F	CD1E68	04960	CALL	RCLS
6A82	214366	04970	LD	HL, YHDS
6A85	C31C6A	04980	JP	PMAA
6A88	FEB4	04990	CP	180
6A8A	CA556A	05000	JP	Z, PMAB
6A8D	FEB8	05010	CP	184
6A8F	CA556A	05020	JP	Z, PMAB
6A92	C3CF69	05030	JP	CFAR
6400		05040	END	START
00000	TOTAL ERRORS			

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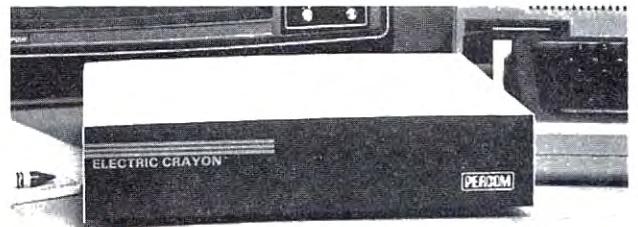
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Dual-Voice Music Synthesizer

by Lee Morgenstern

Those of you who are bored with your computer playing only one note at a time can learn how to get multiple notes through software.

Are you tired of hearing only single-note-at-a-time tunes from your TRS-80? This program demonstrates how to create musical pieces that play through the cassette port and have both treble and bass voices. Best of all, it requires no extra hardware.

Some musical pieces require two voices. Previously, hardware music syn-

thesizers, which are expensive, were the only way to produce multiple voices. Now, however, it is possible to produce them completely with software.

Theory of Operation

Other programs produce music by generating square waves with two ampli-

tudes, or voltage levels, and causing the cassette output to vibrate. This program creates a more advanced wave by controlling the three voltage levels available at the cassette port. With three levels, it produces a wave resulting from the amplitude addition of two separate square waves as in Fig. 1. When the program sends this wave through the cassette port, the output sounds like two independent tones played at the same time.

Programming amplitude addition is not as tricky as you might think. The cassette commands have an interesting pattern. Table 1 shows the binary command values that produce the three voltage levels at the cassette auxiliary output.

Bit 2 turns on the cassette motor and bits 0 and 1 control the voltage. Complementing either bit 0 or 1 produces a voltage change of one level by "vibrating" bit 1 to produce the treble notes and independently doing the same to bit 0 to produce the bass notes.

Program Features

The Dual-Voice Music Synthesizer is written in Basic and Assembly language. The Basic part creates and edits a list of treble and bass notes, and an Assembly-language USR subroutine plays the music. The program uses

command bit:	2 1 0
	1 1 0 = 0.00 volts
	1 1 1 = 0.46 volts
	1 0 0 = 0.46 volts
	1 0 1 = 0.85 volts

Table 1. Cassette-port Command Values for the Voltage Levels

Variable	Meaning
MS	USR machine code
NS	names of the notes
N	frequency counts of the notes
T()	treble note list
B()	bass note list
D()	dual-voice play buffer

Table 2. Important Basic Variables

Byte	Contents
1	note duration MSB
2	note duration LSB
3	treble note frequency count
4	treble note octave count
5	bass note frequency count
6	bass note octave count
7	treble note rest flag—2 if played, 0 if rest
8	bass note rest flag—1 if played, 0 if rest

Table 3. Play Buffer Format

The Key Box

Model I or III
16K, 32K RAM
Cassette or Disk Basic
Cassette Port Amplifier
Printer Optional

POKE statements to enter the USR machine code into a string.

The musical capabilities of the program are a 5-octave note range, whole note to 64th note timing, sharps, and rests. In a 16K TRS-80, there is room for 700 notes for treble and bass each. In a 48K machine, this expands to 3,400 notes each.

The music plays through an amplifier and speaker, or records on cassette tape, while a special feature changes the timing of the piece.

The file handling provides loading and saving of music files using either cassette or disk. The editing features consist of append, insert, delete, display, and print functions for both treble and bass note lists.

Entering the Program

Type Program Listing 1 exactly as it appears and it will work for Level II Basic or Disk Basic. You may, however, remove certain lines depending on your system.

For Level II Basic using a cassette, you may omit lines 1650-1800, 1880-2030, 3610-3650, and 3670-3710.

For Disk Basic using disks for file storage, you may omit lines 1650-1720,

1800-1840, 1880-1950, 2030-2070, 3610-3650, 3670, and 3720-3750.

For Disk Basic using cassette for file storage, you may omit lines 1650-1790, 1880-2020, 3610-3650, 3670, and 3720-3750.

Operating the Program

A typical procedure for creating and

playing music consists of the following steps:

- Enter the treble and bass notes using the editing functions.
- Save the note lists on disk or tape.
- Build the play buffer.
- Play the music.

● Change the timing if necessary.

Two menus contain all the program

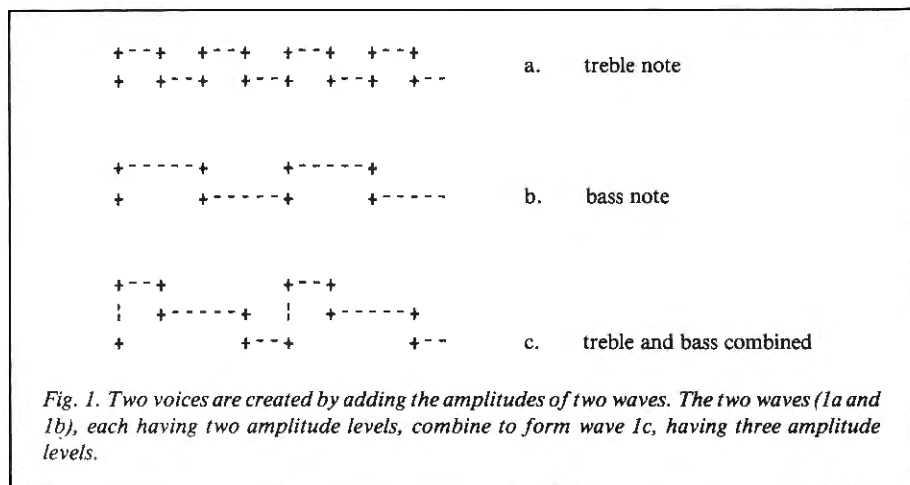


Fig. 1. Two voices are created by adding the amplitudes of two waves. The two waves (1a and 1b), each having two amplitude levels, combine to form wave 1c, having three amplitude levels.

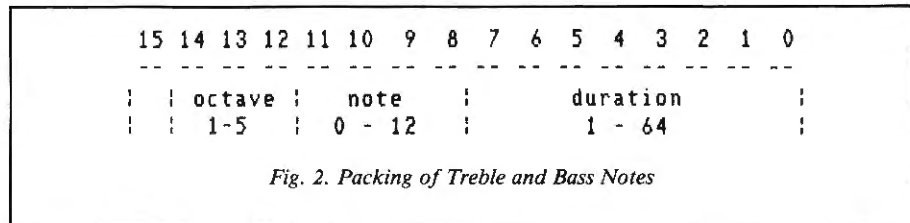


Fig. 2. Packing of Treble and Bass Notes

TRS-80[®] Model III/I

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WOBOS I for Model III BASIC		03 01 82 12:34:56
PROGRAM MENU UTILITIES		
1	Your Program A	11 Data List
2	B	22 Sort
3	C	33 Rename
4	D	44 Append
5	E	55 Memory Dump
6	Graphics Synthesis	66 Map
7	Special characters 0 31	77 Size
8	91-127	88 New Data Entry
9	192-255	99 Device I/O

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Program Listing 1

```

1000 'DUAL-VOICE MUSIC SYNTHESIZER
1010 'BY LEE MORGENSTERN, MAY, 1982
1020 '
1030 CLS: CLEAR 256: DEFINT A-Z
1040 PRINT"DUAL-VOICE MUSIC SYNTHESIZER"
1050 PRINT: PRINT"READING DATA:"
1060 E1$="TREBLE OR BASE LIST EMPTY"
1070 E2$="PLAY BUFFER NOT BUILT"
1080 E3$="NOTE LIST EMPTY"
1090 E4$="IMPROPER NOTE"
1100 E5$="IMPROPER OCTAVE"
1110 M$=STRING$(152,0)
1120 P!=PEEK(VARPTR(M$)+1) + 256*PEEK(VARPTR(M$)+2)
1130 IF P!>32767 THEN P!=P!-65536
1140 P=P!
1150 FOR X=1 TO 152: PRINT@141,152-X;
1160 READ Q: POKE P,Q: P=P+1: NEXT
1170 DATA 205,127,10,243,235,221,33,0,0,221
1180 DATA 25,221,78,0,221,70,1,221,35,221
1190 DATA 35,17,8,0,217,62,4,8,221,102
1200 DATA 0,221,110,1,221,78,2,221,70,3
1210 DATA 221,94,4,221,86,5,62,6,60,185
1220 DATA 48,72,187,56,28,121,147,79,125,147
1230 DATA 111,221,94,4,62,2,21,32,14,8
1240 DATA 221,174,7,211,255,8,221,86,5,62
1250 DATA 5,24,4,60,185,48,37,189,56,214
1260 DATA 121,149,79,123,149,95,221,110,1,62
1270 DATA 2,37,32,200,217,221,25,11,120,177
1280 DATA 200,217,6,1,22,1,221,102,0,221
1290 DATA 110,1,24,178,123,145,95,125,145,111
1300 DATA 221,78,2,62,3,5,32,170,8,221
1310 DATA 174,6,211,255,8,221,70,3,62,5
  
```

Listing 1 continues

```

1320 DATA 24,156
1330 DIM N$(12),N(12)
1340 FOR F=0 TO 12: READ N$(F),N(F): NEXT
1350 DATA R,255,B,50,A#,53,A,56,G#,59,G,63,F#,67,F,71,E,75
1360 DATA D#,79,D,84,C#,89,C,94
1370 PRINT:PRINT"ALLOCATING MEMORY"
1380 M=MEM/12-100
1390 DIM T(M),B(M),D(4*M)
1400 BF=0: T(0)=0: B(0)=0: TD=0: BD=0: TE=0: TF=0: BE=0: BF=0
1410 F$="": EM=0: L=0: D=0: E=0: N=0: T=0: B=0: M!=0
1420 C1=255: C2=256: C3=3840: C4=192: C5=4096
1430 '
1440 '**** MAIN MENU
1450 CLS
1460 PRINT"DUAL-VOICE MUSIC MAIN MENU"
1470 PRINT
1480 PRINT"<1> LOAD MUSIC FILE"
1490 PRINT"<2> SAVE MUSIC FILE"
1500 PRINT"<3> EDIT MUSIC"
1510 PRINT"<4> BUILD PLAY BUFFER"
1520 PRINT"<5> CHANGE TIMING"
1530 PRINT"<6> PLAY MUSIC"
1540 PRINT
1550 M=0: INPUT"SELECTION";M
1560 IF M<1 OR M>6 THEN 1550
1570 IF M=4 AND (T(0)=0 OR B(0)=0) THEN PRINT E1$: GOTO 1550
1580 IF M>=5 AND BF=0 THEN PRINT E2$: GOTO 1550
1590 ON M GOSUB 1630,1870,2100,3190,3520,3600
1600 GOTO 1450
1610 '
1620 '**** LOAD MUSIC FILE
1630 CLS
1640 BF=0
1650 PRINT"<1> LOAD FROM DISK"
1660 PRINT"<2> LOAD FROM CASSETTE"
1670 PRINT"<3> LOAD FROM CASSETTE WITH DISK BASIC"
1680 PRINT
1690 M=0: INPUT"SELECTION";M
1700 IF M<1 OR M>3 THEN 1690
1710 ON M GOSUB 1730,1810,1800
1720 RETURN
1730 INPUT"MUSIC FILE SPEC";F$
1740 OPEN"1",1,F$
1750 INPUT#1,T(0),B(0)
1760 IF T(0)>0 THEN FOR X=1 TO T(0): INPUT#1,T(X): NEXT
1770 IF B(0)>0 THEN FOR X=1 TO B(0): INPUT#1,B(X): NEXT
1780 CLOSE
1790 RETURN
1800 CMD"T"
1810 INPUT#-1,T(0),B(0)
1820 IF T(0)>0 THEN FOR X=1 TO T(0): INPUT#-1,T(X): NEXT
1830 IF B(0)>0 THEN FOR X=1 TO B(0): INPUT#-1,B(X): NEXT
1840 RETURN
1850 '
1860 '**** SAVE MUSIC FILE
1870 CLS
1880 PRINT"<1> SAVE TO DISK"
1890 PRINT"<2> SAVE TO CASSETTE"
1900 PRINT"<3> SAVE TO CASSETTE WITH DISK BASIC"
1910 PRINT
1920 M=0:INPUT"SELECTION";M
1930 IF M<1 OR M>3 THEN 1920
1940 ON M GOSUB 1960,2040,2030
1950 RETURN
1960 INPUT"MUSIC FILE SPEC";F$
1970 OPEN"0",1,F$
1980 PRINT#1,T(0),B(0)
1990 IF T(0)>0 THEN FOR X=1 TO T(0): PRINT#1,T(X): NEXT
2000 IF B(0)>0 THEN FOR X=1 TO B(0): PRINT#1,B(X): NEXT
2010 CLOSE
2020 RETURN
2030 CMD"T"
2040 PRINT#-1,T(0),B(0)
2050 IF T(0)>0 THEN FOR X=1 TO T(0): PRINT#-1,T(X): NEXT
2060 IF B(0)>0 THEN FOR X=1 TO B(0): PRINT#-1,B(X): NEXT
2070 RETURN
2080 '
2090 '**** EDIT MUSIC
2100 EM=0
2110 CLS: PRINT"DUAL-VOICE MUSIC EDITOR"
2120 IF EM=0 THEN PRINT"TREBLE:";T(0); ELSE PRINT"BASE:";B(0);
2130 PRINT"NOTES"
2140 PRINT
2150 PRINT"<0> TOGGLE TREBLE/BASE"
2160 PRINT"<1> APPEND TO END OF LIST"
2170 PRINT"<2> INSERT NOTES"
2180 PRINT"<3> DELETE NOTES"

```

Listing 1 continues

options—the main menu and the edit menu. The main menu has six options:

Dual-Voice Music Main Menu

- (1) Load Music File
- (2) Save Music File
- (3) Edit Music
- (4) Build Play Buffer
- (5) Change Timing
- (6) Play Music

Option 1 loads the treble and bass lists of a previously created music file from either cassette or disk to memory. Option 2 saves the treble and bass lists currently in memory to cassette or disk. Option 3 calls the edit menu to create or change music in memory. Option 4 builds a play buffer from the treble and bass lists in memory. Option 5 changes the timing of the play buffer. Option 6 calls the USR subroutine to play the music.

Option 3 of the main menu calls the edit menu:

Dual-Voice Music Editor

- Treble: XXX Notes
- (0) Toggle Treble/Bass
 - (1) Append to End of List
 - (2) Insert Notes
 - (3) Delete Notes
 - (4) Display Notes
 - (5) Print Notes
 - (6) Exit

The second line of the edit menu displays the current number of notes in the treble or bass list. Option 0 switches back and forth between the two lists. Options 1-5 act on the list currently selected. Option 1 adds notes to the end of a list or starts a new list. Option 2 inserts notes at the start or in the middle of an existing list. Option 3 deletes one note or a block of notes. Option 4 displays the note list on the screen. Option 5 prints the note list on a line printer, formatted in multiple columns. Option 6 exits back to the main menu.

Creating the Note Lists

When appending or inserting notes, follow the format of duration, octave-note as in 4,5F#. This means quarter-note duration, 5th octave and F sharp. Durations range from 1, for a whole note, to 64, for a 64th note. Octaves range from 1, for the lowest pitch, to 5, for the highest pitch. Notes are A-G with an optional #. To enter a rest, type the duration and then R as in 8,R. This means an 8th note rest. The range of notes is from 1C to 5B. To terminate the list, enter 0,0.

```

2190 PRINT"<4> DISPLAY NOTES"
2200 PRINT"<5> PRINT NOTES"
2210 PRINT"<6> EXIT"
2220 PRINT
2230 M=-1: INPUT"SELECTION";M
2240 IF M=6 THEN RETURN
2250 IF M=0 THEN EM=1-EM: GOTO 2110
2260 IF M<1 OR M>5 THEN 2230
2270 IF EM=0 THEN L=T(0) ELSE L=B(0)
2280 IF M>=2 AND M<=6 AND L=0 THEN PRINT E3$: GOTO 2230
2290 ON M GOSUB 2330,2540,2750,2860,3000
2300 GOTO 2110
2310 '
2320 '**** APPEND NOTES
2330 CLS
2340 PRINT"APPENDING ";
2350 IF EM=0 THEN PRINT"TREBLE"; ELSE PRINT"BASE";
2360 PRINT" NOTES"
2370 PRINT
2380 PRINT"DURATION,NOTE"
2390 L=L+1
2400 PRINT USING "####: ";L;
2410 D=-1: INPUT D,F$: IF D=0 THEN RETURN
2420 IF F$="R" THEN E=0: F=0: GOTO 2480
2430 IF LEN(F$)<2 THEN PRINT E4$: GOTO 2400
2440 E=VAL(LEFT$(F$,1)): IF E<1 OR E>5 THEN PRINT E5$: GOTO 2400
2450 F=1: F$=MID$(F$,2)
2460 IF F$<>N$(F) THEN F=F+1: IF F<13 THEN 2460
2470 IF F>12 THEN PRINT E4$: GOTO 2400
2480 IF EM=0 THEN T(0)=L ELSE B(0)=L
2490 P=4096*E + 256*F + D
2500 IF EM=0 THEN T(L)=P ELSE B(L)=P
2510 BF=0: GOTO 2390
2520 '
2530 '**** INSERT NOTES
2540 CLS
2550 N=0: INPUT"INSERT BEFORE WHICH NOTE";N
2560 IF N<1 OR N>L THEN 2550
2570 PRINT"DURATION,NOTE"
2580 PRINT USING "####: ";N;
2590 D=-1: INPUT D,F$: IF D=0 THEN RETURN

```

Listing 1 continues

The editor numbers all the notes. Use these numbers to refer to the notes when deleting or inserting. Enter the starting and ending note numbers to delete a series of notes. The starting and ending numbers would be the same number if you wanted to delete only one note. To insert notes, enter the number following the insert point; this allows insertion before the first note. Use the append option to insert notes at the end of the list.

To replace one or more notes, first delete them and then insert the replacements. The editor controls the numbers so that the first note number you delete becomes the note number to insert. For example, if you want to replace notes 33-40, select the delete option and enter 33,40. Then select the insert option and enter 33 as the insert point. Type the replacement notes and then 0,0.

The display option lists the notes on the screen in a single column. To freeze the list as it scrolls by, press shift, @. Press any key to resume scrolling.

If you have a printer connected to the parallel printer port, select the print option to produce a multiple-column listing of the notes. Each column is 16 characters wide. This permits five columns on an 80-character-per-line print-

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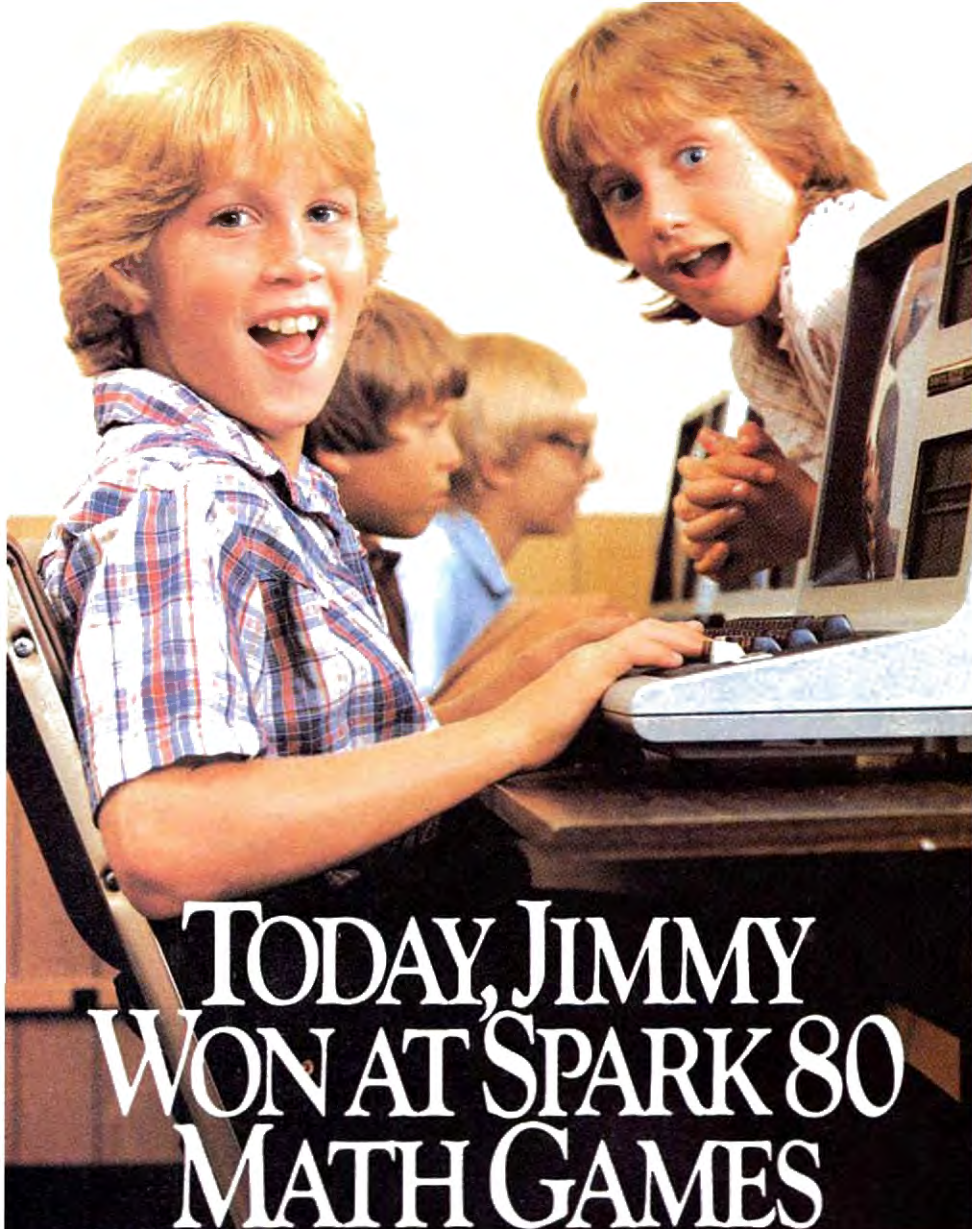


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er or eight columns on a 132-character-per-line printer.

Playing the Music

Before playing the piece, you must select the build-play-buffer option. This option creates a combined buffer from the treble or bass lists so the USR subroutine can efficiently create the dual-voice melodies. Once you have built the play buffer, you can play the music repeatedly without delay.

The musical piece can be played in two ways. The best way is to connect an amplifier and speaker to the auxiliary output of the cassette port. The extra hardware is not necessary for the second method. Just connect your cassette recorder in the standard way, set the cassette to record, select the play-music option, wait for the main menu to reappear on the screen, stop the recorder, rewind to the start point, unplug the cables, and press the cassette play button.

If the piece plays too fast or too slow, select the change-timing option. Enter a multiplier for the duration. Enter 2 if you want the piece to play slower, or enter 0.5 if you want the piece to play faster. The multiplier acts only on the play buffer, so the original treble and

Listing 1 continued

```

2600 IF F$="R" THEN E=0: F=0: GOTO 2660
2610 IF LEN(F$)<2 THEN PRINT E4$: GOTO 2580
2620 E=VAL(LEFT$(F$,1)): IF E<1 OR E>5 THEN PRINT E5$: GOTO2580
2630 F=1: F$=MID$(F$,2)
2640 IF F$<>N$(F) THEN F=F+1: IF F<13 THEN 2640
2650 IF F>12 THEN PRINT E4$: GOTO 2580
2660 IF EM=0 THEN T(0)=T(0)+1 ELSE B(0)=B(0)+1
2670 FOR X=L TO N STEP -1
2680 IF EM=0 THEN T(X+1)=T(X) ELSE B(X+1)=B(X)
2690 NEXT X
2700 P=4096*E + 256*F + D
2710 IF EM=0 THEN T(N)=P ELSE B(N)=P
2720 BF=0: L=L+1: N=N+1: GOTO 2580
2730 '
2740 '**** DELETE NOTES
2750 CLS
2760 P=0: Q=0: INPUT"DELETE FROM,TO";P,Q
2770 IF P<1 OR P>Q OR Q>L THEN 2760
2780 IF EM=0 THEN T(0)=T(0)-(Q-P+1) ELSE B(0)=B(0)-(Q-P+1)
2790 BF=0
2800 IF Q=L THEN RETURN
2810 FOR X=Q+1 TO L
2820 IF EM=0 THEN T(P)=T(X) ELSE B(P)=B(X)
2830 P=P+1: NEXT X: RETURN
2840 '
2850 '**** DISPLAY NOTES
2860 CLS
2870 IF EM=0 THEN PRINT"TREBLE" ELSE PRINT"BASE"
2880 PRINT
2890 PRINT"    DURATION,NOTE"
2900 FOR X=1 TO L: PRINT USING "####:";X;
2910 IF EM=0 THEN D=T(X) AND 255 ELSE D=B(X) AND 255
2920 IF EM=0 THEN E=T(X)/4096 ELSE E=B(X)/4096
2930 IF EM=0 THEN F=(T(X) AND 3840)/256
        ELSE F=(B(X) AND 3840)/256
2940 F$=N$(F)
2950 IF E>0 THEN PRINT USING "#####  %%" ;D;E;F$
        ELSE PRINT USING "#####  %%" ;D;F$
2960 NEXT X
2970 PRINT: INPUT"PRESS ENTER";M: RETURN
2980 '

```

Listing 1 continues

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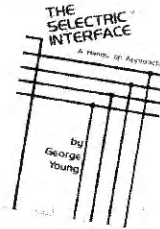


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Listing 1 continued

```

2990 '**** PRINT NOTES
3000 CLS
3010 M=0: INPUT"PRINT HOW MANY COLUMNS";M
3020 IF M<1 THEN 3010
3030 LPRINT:LPRINT
3040 IF EM=0 THEN LPRINT"TREBLE" ELSE LPRINT"BASE"
3050 LPRINT
3060 FOR X=1 TO M: LPRINT"  DURATION,NOTE";: NEXT
3070 LPRINT
3080 P=L/M: Q=L/M: IF P!>Q THEN Q=Q+1
3090 FOR X=1 TO Q
3100 FOR N=0 TO M-1: P=X+N*Q: IF P>L THEN 3160
3110 IF EM=0 THEN D=T(P) AND 255 ELSE D=B(P) AND 255
3120 IF EM=0 THEN E=T(P)/4096 ELSE E=B(P)/4096
3130 IF EM=0 THEN F=(T(P) AND 3840)/256
      ELSE F=(B(P) AND 3840)/256
3140 P$=N$(F)
3150 IF E>0 THEN LPRINT USING "#####  %% ";P;D;E;F$;
      ELSE LPRINT USING "#####  %% ";P;D;F$;
3160 NEXT N: LPRINT: NEXT X: RETURN
3170 '
3180 '**** BUILD PLAY BUFFER
3190 CLS
3200 PRINT"BUILDING PLAY BUFFER":PRINT
3210 PRINT"","TREBLE","BASE"
3220 PRINT "LENGTH",T(0),B(0)
3230 T=1: B=1: X=1: GOSUB 3440: GOSUB 3480
3240 D(X+1)=C2*2[(5-TE) + N(TF)]
3250 D(X+2)=C2*2[(5-BE) + N(BF)]
3260 D(X+3)=(P AND 2) + C2*(Q AND 1)
3270 PRINT@256,,T,B
3280 IF TD>=BD THEN 3320
3290 D(X)=TD: T=T+1: BD=BD-TD
3300 IF T<=T(0) THEN GOSUB 3440
3310 GOTO 3390
3320 IF TD=BD THEN 3360
3330 D(X)=BD: B=B+1: TD=TD-BD
3340 IF B<=B(0) THEN GOSUB 3480
3350 GOTO 3390
3360 D(X)=BD: B=B+1: T=T+1

```

Listing 1 continues

bass lists are not affected.

Understanding the Program

The most important variables in the Basic program, together with their meanings, are listed in Table 2.

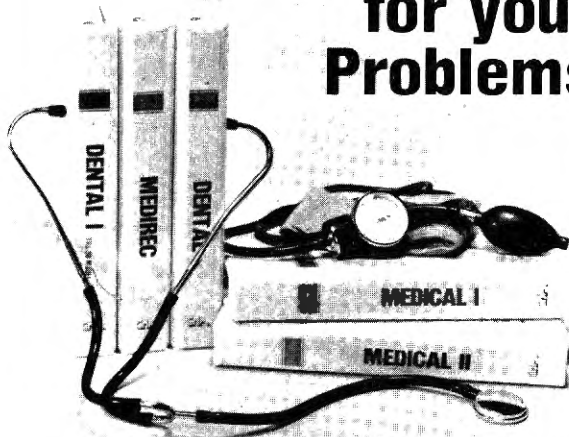
The parameters for each treble or bass note are packed into one integer by the formula: 4096 * octave + 256 * note + duration. Figure 2 shows this format.

The play buffer consists of a note count followed by 8-byte entries. The format for each entry is shown in Table 3. Each note change has a new entry.

The USR subroutine reads the play buffer to produce the tones. Listing 2 is an Assembly-language form of the USR subroutine. Line 130 gets the play buffer address. Lines 160-170 transfer this address into the IX register. The A' register maintains the current tone command value. Lines 330-370 and 580-620 count the treble, bass, and note duration values until one of them becomes due.

When the treble count becomes due, lines 890-980 reload the count and continue timing. When the treble octave count becomes due, lines 990-1050 change the tone level command value and resend the command. Lines

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400-560 update the bass note counts in the same way.

When the duration count becomes due, lines 750-860 advance IX to point to the next note entry in the play buffer, terminate the treble and bass octave counts, and continue timing, allowing the treble and bass timers to complete the current cycle. Control returns to Basic when all notes have been played.

Enhancing the Program

There are many ways to improve the program. Adding more editing features would make it easier to enter and modify the music—or including a sub-routine facility would make it possible to play longer pieces. The greatest improvement, however, would be a hardware change.

The TRS-80 clock is not fast enough to produce the high quality of sound that best enhances the dual-voice technique. Speeding it up would make the timing of each note more accurate and would enable the program to generate higher-quality notes and increase the range of tones.

This program is just one method for dual-voice synthesis. Another example is synthesizing voices out of the cassette port. With new innovations and experi-

Listing 1 continued

```

3370 IF T<=T(0) THEN GOSUB 3440
3380 IF B<=B(0) THEN GOSUB 3480
3390 D(X)=D(X)-C2: X=X+4
3400 IF T<=T(0) AND B<=B(0) THEN 3240
3410 D(0)=X/4: BF=-1: RETURN
3420 '
3430 '**** COMPUTE TREBLE PLAY BUFFER ENTRY
3440 TD=C4/(T(T) AND C1): TE=T(T)/C5
3450 TF=(T(T) AND C3)/C2: P=TF>0: RETURN
3460 '
3470 '**** COMPUTE BASE PLAY BUFFER ENTRY
3480 BD=C4/(B(B) AND C1): BE=B(B)/C5
3490 BF=(B(B) AND C3)/C2: Q=BF>0: RETURN
3500 '
3510 '**** CHANGE TIMING
3520 CLS
3530 M1=1: INPUT"TIMING MULTIPLIER";M!
3540 FOR X=1 TO D(0)*4 STEP 4
3550 D(X)=(D(X) AND 255)*M! - 256
3560 NEXT
3570 RETURN
3580 '
3590 '**** PLAY MUSIC
3600 CLS
3610 PRINT"<1> PLAY USING DISK BASIC"
3620 PRINT"<2> PLAY USING LEVEL II BASIC"
3630 PRINT
3640 M=0: INPUT"SELECTION";M
3650 IF M<1 OR M>2 THEN 3640
3660 CLS: Q=VARPTR(D(0))
3670 IF M=2 GOTO 3720
3680 P1=PEEK(VARPTR(M$)+1)+256*PEEK(VARPTR(M$)+2)
3690 IF P1>32767 THEN P1=P1-65536
3700 P=P1: DEFUSR0=P: M=USR0(Q)
3710 RETURN
3720 POKE 16526,P,PEEK(VARPTR(M$)+1)
3730 POKE 16527,P,PEEK(VARPTR(M$)+2)
3740 M=USR(Q)
3750 RETURN
3760 '
3770 'END OF PROGRAM

```

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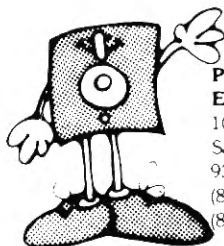
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mentation, perhaps someone will even discover a way to produce the sounds of an entire orchestra. ■

Lee Morgenstern can be reached at 14358 Dyer St., Sylmar, CA 91342.

Program Listing 2

```

00100 ;DUAL-VOICE MUSIC USR SUBROUTINE
00110 ; BY LEE MORGENSTERN, MAY, 1982
00120 ;
0000 CD7F0A 00130 CALL 0A7FH ;HL=NOTE LIST ADDRESS
0003 F3 00140 DI ;DISABLE INTERRUPTS
0004 EB 00150 EX DE,HL ;DE=NOTE LIST ADDRESS
0005 DD210000 00160 LD IX,0 ;
0009 DD19 00170 ADD IX,DE ;IX=NOTE LIST ADDRESS
000B DD4E00 00180 LD C,(IX) ;BC=NOTE LIST LENGTH
000E DD4601 00190 LD B,(IX+1) ;
0011 DD23 00200 INC IX ;
0013 DD23 00210 INC IX ;
0015 110000 00220 LD DE,8 ;NOTE LIST ENTRY LENGTH
0018 D9 00230 EXX ;
0019 3E04 00240 LD A,4 ;SET CASSETTE COMMAND
001B 08 00250 EX AF,AF' ;SAVE TONE LEVEL
001C DD6600 00260 LD H,(IX) ;GET NOTE DURATION
001F DD6E01 00270 LD L,(IX+1) ;
0022 DD4E02 00280 LD C,(IX+2) ;SET TREBLE COUNTER
0025 DD4603 00290 LD B,(IX+3) ;SET TREBLE OCTAVE
0028 DD5E04 00300 LD E,(IX+4) ;SET BASE COUNTER
002B DD5605 00310 LD D,(IX+5) ;SET BASE OCTAVE
002E 3E06 00320 MUSIC1 LD A,6 ;SET TIMING COUNTER
0030 3C 00330 MUSIC2 INC A ;UPDATE TIMING COUNTER
0031 B9 00340 CP C ;CHECK TREBLE DUE TIME
0032 3048 00350 JR NC,MUSIC6 ;JUMP IF DUE
0034 BB 00360 MUSIC3 CP E ;CHECK BASE DUE TIME
0035 381C 00370 JR C,MUSIC4 ;JUMP IF NOT DUE
;
;RELOAD BASE TIMER
0037 79 00400 LD A,C ;GET TREBLE TIMER
0038 93 00410 SUB E ;COMPUTE NEXT DUE TIME
0039 4F 00420 LD C,A ;
003A 7D 00430 LD A,L ;GET DURATION TIMER
003B 93 00440 SUB E ;COMPUTE NEXT DUE TIME
003C 6F 00450 LD L,A ;
003D DD5E04 00460 LD E,(IX+4) ;RELOAD BASE TIMER
0040 3E02 00470 LD A,2 ;SET TIMING COUNTER
0042 15 00480 DEC D ;DECREMENT OCTAVE COUNTER
0043 200E 00490 JR NZ,MUSIC4 ;JUMP IF NOT DONE
0045 08 00500 EX AF,AF' ;GET PREVIOUS TONE LEVEL
0046 DD4E07 00510 XOR (IX+7) ;TOGGLE BASE TONE LEVEL
0049 D3FF 00520 OUT (255),A ;COMMAND TONE LEVEL
004B 08 00530 EX AF,AF' ;SAVE TONE LEVEL
004C DD5605 00540 LD D,(IX+5) ;RELOAD OCTAVE COUNTER
004F 3E05 00550 LD A,5 ;SET TIMING COUNTER
0051 1804 00560 JR MUSIC5 ;CONTINUE
;
0053 3C 00580 MUSIC4 INC A ;UPDATE TIMING COUNTER
0054 B9 00590 CP C ;CHECK TREBLE DUE TIME
0055 3025 00600 JR NC,MUSIC6 ;JUMP IF TREBLE DUE
0057 BD 00610 MUSIC5 CP L ;CHECK NOTE DURATION
0058 38D6 00620 JR C,MUSIC2 ;JUMP IF NOT DUE
;
;RELOAD NOTE DURATION TIMER
005A 79 00650 LD A,C ;GET TREBLE TIMER
005B 95 00660 SUB L ;COMPUTE NEXT DUE TIME
005C 4F 00670 LD C,A ;
005D 7B 00680 LD A,E ;GET BASE TIMER
005E 95 00690 SUB L ;COMPUTE NEXT DUE TIME
005F 5F 00700 LD E,A ;
0060 DD6E01 00710 LD L,(IX+1) ;RELOAD DURATION TIMER
0063 3E02 00720 LD A,2 ;SET TIMING COUNTER
0065 25 00730 DEC H ;DECREMENT DURATION COUNT
0066 20C8 00740 JR NZ,MUSIC2 ;JUMP IF NOT DONE
0068 D9 00750 EXX ;
0069 DD19 00760 ADD IX,DE ;NEXT NOTE
006B 0B 00770 DEC BC ;
006C 78 00780 LD A,B ;
006D B1 00790 OR C ;
006E C8 00800 RET Z ;RETURN IF NO MORE NOTES
006F D9 00810 EXX ;
0070 0601 00820 LD B,1 ;TERMINATE TREBLE
0072 1601 00830 LD D,1 ;TERMINATE BASE
0074 DD6600 00840 LD H,(IX) ;GET NEXT NOTE DURATION
0077 DD6E01 00850 LD L,(IX+1) ;
007A 18B2 00860 JR MUSIC1 ;RESTART PLAY TIMING
;
;RELOAD TREBLE TIMER
007C 7B 00890 MUSIC6 LD A,E ;GET BASE TIMER
007D 91 00900 SUB C ;COMPUTE NEXT DUE TIME
007E 5F 00910 LD E,A ;
007F 7D 00920 LD A,L ;GET DURATION TIMER
0080 91 00930 SUB C ;COMPUTE NEXT DUE TIME
0081 6F 00940 LD L,A ;
0082 DD4E02 00950 LD C,(IX+2) ;RELOAD TREBLE TIMER
0085 3E03 00960 LD A,3 ;SET TIMING COUNTER
0087 05 00970 DEC B ;DECREMENT OCTAVE COUNTER
0088 20AA 00980 JR NZ,MUSIC3 ;JUMP IF NOT DONE
008A 08 00990 EX AF,AF' ;GET PREVIOUS TONE LEVEL
008B DD4E06 01000 XOR (IX+6) ;TOGGLE TREBLE TONE LEVEL
008E D3FF 01010 OUT (255),A ;COMMAND TONE LEVEL
0090 08 01020 EX AF,AF' ;SAVE TONE LEVEL
0091 DD4603 01030 LD B,(IX+3) ;RELOAD OCTAVE COUNTER
0094 3E05 01040 LD A,5 ;SET TIMING COUNTER
0096 189C 01050 JR MUSIC3 ;CONTINUE
;
0000 01070 END
00000 TOTAL ERRORS

```

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Aging Report 01 /31 / 81 Page 1

Account	Current	30-60 Days	60-90 Days	90+ Days	Total
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Old Co. Inc.	00.00	84.40	165.20	00.00	249.60
New Co. Inc.	97.75	00.00	00.00	00.00	97.75
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FlexCat, Your Basic DBM

by Lawrence A. Terre

Wouldn't it be nice to use one data-base manager for all your filing and retrieval needs? FlexCat is just what fills the bill.

Tired of rewriting your data-base program for each application? Forget keywords for a file created last year? FlexCat is a flexible text-oriented cataloging system able to search data using partial or limited information.

Before FlexCat, locating a specific record in a large file was tedious, especially if my recollection of that record was fragmented. FlexCat's search feature provides a method to extract a record or records based on partial information.

Initialization Program

This program creates a disk file according to parameters determined by your responses to prompts. The file created will contain heading, field, and data information to be used by the two remaining programs. A test record is also created.

The Key Box

**Disk Basic
Model I
48K RAM
TRSDOS
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The fixed-format screen layout displays one record at a time. Headings appear left-justified in columns 1-21, exactly as input, with trailing periods as fillers. When entered from the main program, the data appears in fields (columns 22-62). Each heading must have at least one field and the total number of fields cannot exceed 14.

The program next asks if the heading's information will be numeric or alphanumeric. Incorrectly responding to this question affects the way the data is evaluated in the sort program, so be careful.

You will then be given the option to redefine parameters or create a disk file. When creating, you can supply your own file name or use the default (INIT-DISK). For easy file identification in the directory, FlexCat automatically adds the extension /TXT to all file names. To prevent accidental destruction of a pre-existing file the program checks and informs you if a file with the same name already exists. You are given the option to create a new file under the old name or select a different name.

Main Program

The main program allows you to review, manipulate, print, and otherwise interact directly with the file data.

When this program runs, the load function executes first using the same default file name as the disk-initialization program (unless you assign a new default name).

The main program's four major routines are displayed on the menu: Add, List, Search, and Save. The legal options, available within a given routine, are displayed on the lines immediately preceding and following the displayed record.

Legal Options

The Add module is used to input additional file records. After selecting this function, the heading and field parameters input during disk initialization appear on the screen to cue you. The allotted field space is indicated by a series of graphic blocks. When the cursor appears at the beginning of the first field, enter that data. The cursor will not advance beyond the first field unless some data (even a space) is input.

Then it is possible to move to the next or any other field by pressing enter. To terminate this Add loop, type "end" at the beginning of any field. The current record will not be added to the file.

You can sequentially access records within a file by using the List routine. There are other options available using List. Pressing the up arrow permits you to access the previous record. Pressing shift, D graphically marks that record to indicate it will not be transferred to the new file during the save. You can salvage records marked for deletion by retyping the first field when in the update mode.

Also, deleted records can be located via the search. In a similar fashion, the

shift, U allows you to update the displayed record (only fields requiring modification need to be retyped) and shift, P prints the current record. The latter option is ignored if the printer is not ready. Pressing shift, S skips past the next nine records to display the tenth, and shift, L displays the last record of the file. Pressing E brings you back to the menu.

The Search option locates specific records within the file via a text search of any fields you choose. The text search scans all fields attached to a specific heading for the occurrence of a character, word, or phrase anywhere within the field. This routine permits you to carry out up to five concurrent text searches within individual or between multiple fields. In other words, you can implement any combination of tests ranging from five separate tests on one field to individual tests on each of five fields.

"You always have the option of exiting to the menu by pressing the E key."

A record displays only when it satisfies the requirements of all specified tests. Of course, you always have the option of performing fewer than five tests. If no search heading is entered for the first prompt, a default search of the records marked for deletion commences. Legal options available in this routine include update, print, delete, and escape.

Save transfers all records not marked for deletion to a file with either the default name (file name used to load data) or a new name.

The menu lists two additional options: enable auto print and end. The first allows the automatic printing of either the entire file or only records satisfying the search criteria. A command to print in the absence of a ready printer will not cause the system to hang up indefinitely. Within the auto-print operation, you always have the option of exiting to the menu by pressing the E

key. The end function displays the number of records in memory not marked for deletion and provides a final opportunity to return to the menu (possibly to save your data).

Sort Program

FlexCat's sort is an adaptation of D. Walker's "Beyond Shell Metzner" (80 Micro, September 1980). Although the

FlexCat sort program does not influence the operation of either the disk-initialization program or main program, it enhances the system by providing a method of organizing the file according to parameters you supply.

When running this program, it asks you to provide a file name. The program adds /TXT to the file name and informs you if the file is not on the disk.

Program Listing 1. Initialization

```

10 '-----
15 '
20 'FLEXCAT INITIALIZATION PROGRAM
25 '
30 'WRITTEN BY:
35 '      LAWRENCE A. TERRE
40 '      1100 RANDVILLE DRIVE #205
45 '      PALATINE, ILLINOIS 60067
55 '-----
100 CLEAR2000: DIMD$(500): DIMB$(14,3): FS="INITDISK"
110 D$="TEST RECORD FROM INITIALIZATION PROGRAM"
120 B$=STRING$(21,".")
130 CLS: A$="DISK INITIALIZATION PROGRAM": GOSUB570
140 TF=14: H=0: FORX=1TO500: NEXT
145 '---INPUT PARAMETERS
150 FORX=1TO14
160   CLS:
170     PRINT
180     A$="HEADINGS MUST NOT EXCEED 21 CHARACTERS.":
190     GOSUB570 :
200     PRINT
210     A$="AFTER HEADING # 1, ANY BLANK HEADING WILL":
220     GOSUB570
230     A$="TERMINATE THE ENTRY PROCESS":
240     GOSUB570
250 '---ENTER HEADING NAME
260   PRINT"HEADING #";X;" WILL BE ";:PRINT,";";
270   LINEINPUTB$(X,1):
280   L=LEN(B$(X,1))
290   IFL>21 OR (L=0ANDX=1)
300     GOTO200
310   IFL=0 AND X<>1
320     GOTO340
330   H=H+1
340   B$(X,1)=B$(X,1)+RIGHT$(B$,21-L)
350 '---ENTER DATA TYPE (NUMERIC/ALPHANUMERIC)
360   PRINT"NUMERIC OR ALPHA - ( N OR A )";:PRINT,";";
370   LINEINPUTB$(X,2):
380   B$(X,2)=LEFT$(B$(X,2),1)
390   IFB$(X,2)<>"N" AND B$(X,2)<>"A"
400     THEN250
410   PRINT"NUMBER OF FIELD OUT OF";TF;:PRINT,";";
420 '---ENTER NUMBER OF FIELDS FOR THIS HEADING
430   LINEINPUTB$(X,3)
440   IFVAL(B$(X,3))<1 OR VAL(B$(X,3))>TF
450     GOTO280
460   TF=TF-VAL(B$(X,3))
470   IFTF=0GOTO340
480 NEXT
490 CLS: A$="PRESS <D>ONE OR <R>DEFINE": GOSUB570 : GOSUB580
500 IFZZ$="R"GOTO130
510 IFZZ$="D"GOTO380
520 GOTO340
530 '---CREATE DISK FILE
540 CLS: A$="CREATE FILE ROUTINE": GOSUB570
550 PRINT: PRINT"DEFAULT FILE NAME IS <";F$; ">": PRINT
560 INPUT"IF DESIRED, ENTER NEW FILE NAME W/O EXTENSION ";F$
570 ON ERROR GOTO 490
580 '---TEST FOR EXISTING FILE WITH SAME NAME
590 OPEN"1",F$+"/TXT": CLOSE
600 PRINT
610 A$="FILE ALREADY EXISTS. PRESS <C> TO CREATE": GOSUB570
620 A$="OR <R> TO RENAME FILE": GOSUB570 : GOSUB580
630 IFZZ$="R"GOTO390
640 IFZZ$="C"GOTO490
650 GOTO460
660 '---FILE NAME SELECTED IS NOT ON DISKETTE

```

Listing 1 continues

After the entry of a valid file name, all headings read from the file are displayed on the screen. You are asked to rank in order from major to minor the headings and specify sort directions (ascending/descending).

The program automatically assigns the data type (numeric/alphanumeric) to all fields based on information supplied during the disk-initialization program. The data type you selected during initialization will now affect the collating sequence. You are asked for intermediate through minor headings until all have been entered or you input "stop."

Finally, a prompt asks you to insert the destination disk and press enter. As the file sorts in the specified order, the screen displays the field number being sorted as well as a graphic character for every swap made. The time required for the sort and the number of records sorted are displayed and the file is written on the disk under the same name that was used to read it.

The Program Listings

All programs are well documented with comments. When typing in the main and sort programs you can omit the comments and unnecessary spaces. Be sure to adjust the number in the Clear statement of the main program to ensure that all unallocated memory space gained is reserved for string storage.

The sizes of the main and sort programs without comments and unnecessary spaces are approximately 5K and 4K respectively. To facilitate program entry for those who use the Basic automatic line-numbering feature, I started all the necessary program lines at 100, incrementing by 10.

Compressing the code also results in the added benefit of faster execution time, which becomes especially important in search and sort operations.

Applications

I have used this program for a wide variety of applications ranging from keeping track of magazine articles to cataloging taped class lectures, video-cassettes, items for a home inventory, and recipes. The ability to perform multiple text searches on each record while retrieving only the one satisfying all criteria has been an especially helpful aid. You should have no difficulty finding uses for FlexCat. ■

Lawrence Terre lives at 1101 West Thatch # 16, Auburn University, AL 36849.

Listing 1 continued

```

490 RESUME500
500 ON ERROR GOTO 0      : F=14-TF: NR=1
510 OPEN"O",1,F$+"/TXT"
520 PRINT#1,NR;F;H
525 '---WRITE HEADINGS TO DISK
530 FORCC=1TOH:
      PRINT#1,
          CHR$(34);B$(CC,1);CHR$(34);
          CHR$(34);B$(CC,2);CHR$(34);
          CHR$(34);B$(CC,3);CHR$(34):
      NEXT
535 '---WRITE TEST DATA TO DISK
540 FORCC=1TOF
550 PRINT#1,CHR$(34);D$;CHR$(34)
560 NEXT: CLOSE: END
565 '---CENTER AND PRINT A$ ROUTINE
570 TB=.5 * LEN(A$): TB=32-TB: PRINTTAB(TB)A$: RETURN
575 '---INKEY$ ROUTINE
580 ZZ$=INKEY$:
      IFZZ$=""
          THEN580
      ELSE
          RETURN
590 END

```

Program Listing 2. Sort

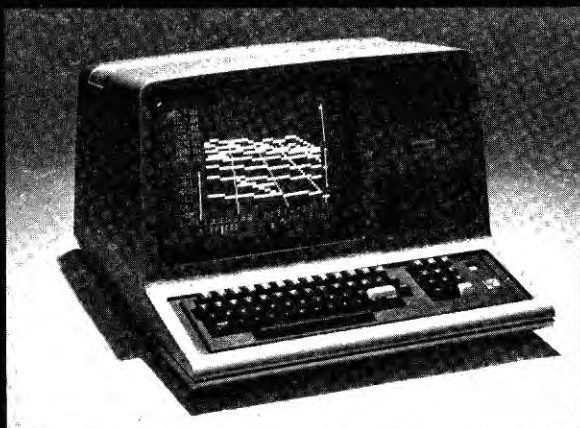
```

10 '-----
15 'FLEXCAT SORT PROGRAM
20 '
25 'WRITTEN BY:
30 '
35 '          LAWRENCE A. TERRE
40 '          1100 RANDVILLE DRIVE #205
45 '          PALATINE, ILLINOIS 60067
50 '-----
55 '---TO CONSERVE MEMORY SPACE, REMOVE ALL UNNECESSARY---
60 '---SPACES AND DELETE ALL REMARKS AS THERE ARE NO-----
65 '---BRANCHES TO THESE STATEMENTS.-----
80 '-----
100 CLEAR 26000
110 DEFINT B-Z
120 CLS: PRINTTAB(12)"INPUT DATA FROM DISK ROUTINE"
130 A1=0: A2=0: A3=0: A4=0
140 ON ERROR GOTO 1090
150 INPUT"ENTER FILE NAME ";F$: OPEN"I",1,F$+"/TXT"
160 ON ERROR GOTO 0
170 INPUT#1, NR, F, H
180 DIM C$(NR,F): DIM A$(F+1): DIM B$(F,3):
      DIM C1(F+1): DIM C2(F+1)
190 DIM D(F+1): Q=1: Y=1
200 FOR X=1 TO F+1:
      A$(X)="": C1(X)=-1: C2(X)=0: D(X)=0:
      NEXTX
205 '---PUT IMAGE OF HEADINGS IN ARRAY A$( )
210 FOR X=1 TO H
220 INPUT#1, B$(X,1), B$(X,2), B$(X,3)
230 A$(Y)= B$(X,1):
      Y= Y+VAL(B$(X,3))
240 NEXTX
245 '---PUT DATA IN ARRAY C$( , ) AND REMOVE SINGLE SPACES
250 FOR X=1 TO NR:
      FOR Y=1 TO F
260 INPUT#1, C$(X,Y)
270 IF C$(X,Y)= " " THEN C$(X,Y)= ""
280 NEXTY:
      NEXTX:
      CLOSE
285 '---DISPLAY HEADINGS ON CRT
290 CLS:
      FOR X=1 TO H STEP2:
          PRINT B$(X,1);:
          PRINTTAB(40) B$(X+1,1):
      NEXTX
300 PRINT STRING$(63,"-")
305 '---INPUT SORT FIELD HEADING
310 FOR XX=1 TO H
320 PRINT"ENTER HEADING OR <STOP>. PRIORITY #;" XX; "? ";
330 LINEINPUT S$
335 '---TEST FOR VALID FIELD HEADING

```

Listing 2 continues

Two great simulations for the "80s"...



T80-FS1

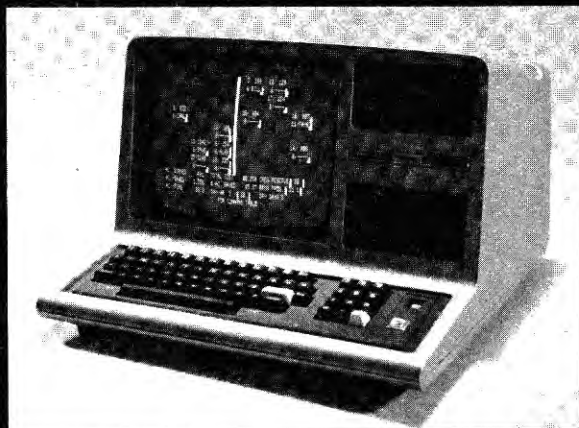
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subLOGIC

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Listing 2 continued

```

340   IF S$= "STOP" AND XX>1
      THEN450
350   L= LEN(S$):
      S$= S$ + STRING$(21-L, ".")
360   FOR X=1 TO H:
      IF S$= B$(X,1)
        GOSUB460 :
        GOTO390
370   NEXTX
380   PRINT"NON-EXISTANT HEADING":
      GOTO320
385 '---INPUT SORT DIRECTION (ASCENDING OR DECENDING)
390   PRINT"SORT ORDER <A>SCENDING OR <D>ECENDING ? ";
400   LINEINPUT D$:
      D$= LEFT$(D$,1)
410   IF D$ <> "A" AND D$ <> "D"
      THEN390
420   IF D$= "A"
      THEN AD= 1
      ELSE
        AD= 2
430   GOSUB490
440   NEXTXX
450   CLS:
      INPUT"INSERT DESTINATION DISKETTE, PRESS ENTER"; U$:
      GOTO 500
455 '---CHECK DATA TYPE. IF B$( ,2)= "N" THE DATA IS
456 '---NUMERIC ELSE DATA TYPE IS ALPHANUMERIC
460 IF B$(X,2)= "N"
      THEN AN= 1
      ELSE
        AN= 2
465 '---CHECK NUMBER OF FIELDS ASSIGNED TO HEADING
470 FL= VAL(B$(X,3))
480 RETURN
485 '---LOOK FOR SORT HEADING IN ARRAY A$( )
490 FOR V= 1 TO F
500   IF S$= A$(V) THEN 520
510 NEXT V:
      RETURN
515 '---FOUND IT. V= STARTING FIELD POSITION OF HEADING
516 '---BUILD PARAMETER TABLE. C1( )= FIELD SORT ORDER
517 '---WHEN THE FIRST (-1) IS FOUND IN C1( ), THE SORT
518 '---IS DONE. C2( )= 1 FOR NUMERIC AND 2 FOR A/N DATA
519 '---D( )= 1 FOR ASCENDING AND 2 FOR DECENDING SEQUENCE
520 FOR N= Q TO Q+FL-1
530   C1(N)= V:
      C2(N)= AN:
      D(N)= AD
540   V= V+1
550 NEXT N
560 Q= Q+FL
570 RETURN
580 Z6= 1: J= NR: A= NR: K= 1 :
      IF NR<2 THEN END
590 POKE &H4041, 00: POKE &H4042, 00: POKE &H4043, 00
594 '-----
595 '---THE FOLLOWING HAS BEEN ADAPTED FROM-----
596 '---D. WALKER, "BEYOND SHELL METZNER", 80 MICRO, 9/80-----
597 '-----
600 CLS

```

```

605 '---SORTS USING SHELL METZNER ALGORITHM
610 Z3= J
620 Z3= INT(Z3/2):
      IF Z3= 0
        THEN 720
630 CLS: PRINT@20, "SORTING FIELD #"; C1(Z6)
640 Z4= K: Z5= J-Z3
650 Z7= Z4
660 Z8= Z7+Z3
670 IF Z6 > 1 AND (Z7 < K OR Z7 > J OR Z8 < K OR Z8 > J )
      GOTO 710
680 GOSUB950
690 IF F1= 2
      GOTO 710
      ELSE
        GOSUB 1040
700 Z7= Z7-Z3:
      IF Z7 < 1
        THEN 710
      ELSE
        660
710 Z4= Z4+1:
      IF Z4 > 25
        THEN 620
      ELSE
        650
720 IF Z6= 1 THEN 740
730 IF Z6 > 1 AND M= A
      THEN 740
      ELSE
        760
735 '---SEE IF THERE IS ANOTHER FIELD TO SORT
740 Z6= Z6+1:
      IF C1(Z6)= -1
        THEN 890
745 '---SORT SEGMENT COMPUTATION ON INTERMEDIATE THRU
746 '---MINOR FIELDS
750 M= 1
760 Z7= M: Z8= M+1: J= 1: L= 0
770 FOR X1= Z6-1 TO 1 STEP -1
780   IF C2(X1)= 2:
      IF C$( Z7, C1(X1)) < > C$( Z8, C1(X1)):
        L= 1:
        GOTO 820
790   IF C2(X1)= 1:
      IF VAL( C$( Z7, C1(X1))) < > VAL( C$( Z8, C1(X1))):
        L= 1:
        GOTO 820
800 NEXT X1
810 J= J+1
820 IF L= 0 THEN 850
830 IF L= 1 AND J > 1
      THEN K= M:
        J= Z7:
        M= Z8:
        GOTO 610
840 L= 0: M= Z8
850 Z7= Z7+1: Z8= Z8+1
860 IF Z7 < A THEN 770
870 IF L= 0
      THEN K= M:
        M= Z7:

```

Listing 2 continues

```

      J= Z7:
      GOTO 610
880 GOTO 740
890 ZZ$= RIGHT$( TIMES$, 9):
      PRINT: PRINT"SORT TIME FOR"; NR; "RECORDS - "; ZZ$
900 OPEN"O",1,F$+"/TXT"
910 PRINT#1, NR; F; H
920 FOR CC= 1 TO H:
      PRINT#1, CHR$(34); B$(CC,1); CHR$(34);
          CHR$(34); B$(CC,2); CHR$(34);
          CHR$(34); B$(CC,3); CHR$(34):
      NEXT
930 FOR X= 1 TO NR:
      FOR Y= 1 TO F:
          PRINT#1, CHR$(34); C$(X,Y); CHR$(34):
          NEXTY:
      NEXTX
940 CLOSE: END
945 '---RECORD ADDRESS POINTER SWITCH CHECK
950 IF D(Z6)= 2 GOTO 990
960 IF C2(Z6)= 1GOTO 980
970 IF C$(Z7,C1(Z6)) > C$(Z8,C1(Z6)):
      GOTO 1020
      ELSE
          GOTO 1030
980 IF VAL(C$(Z7,C1(Z6))) > VAL(C$(Z8,C1(Z6)))
      GOTO 1020
      ELSE
          GOTO 1030
990 IF C2(Z6)= 1 THEN 1010
1000 IF C$(Z7,C1(Z6)) < C$(Z8,C1(Z6))
      GOTO 1020
      ELSE
          GOTO 1030
1010 IF VAL(C$(Z7,C1(Z6))) < VAL(C$(Z8,C1(Z6)))
      GOTO 1020
      ELSE
          GOTO 1030
1020 F1= 1: RETURN
1030 F1= 2: RETURN
1035 '---RECORD ADDRESS POINTER SWITCH
1040 PRINTCHR$(153);:
      FOR C= 1 TO F:
          FOR SZ= 0 TO 2
1050      A3= VARPTR(C$(Z7,C))+SZ:
          IF A3 > 32767:
              A1= (PEEK(A3) - 65536):
              A3= A3 - 65536:
          ELSE
              A1= PEEK(A3)
1060      A4= VARPTR(C$(Z8,C)) + SZ:
          IF A4 > 32767:
              A2= (PEEK(A4) - 65536):
              A4= A4 - 65536:
          ELSE
              A2= PEEK(A4)
1070      POKE A3, A2: POKE A4, A1
1080      NEXT SZ:
          NEXT C:
          RETURN
1090 PRINT:PRINT,"FILE NOT ON DISKETTE":PRINT:RESUME150
1100 END

```

Program Listing 3. Main Program

```

10 '-----
15 ' FLEXCAT MAIN PROGRAM
20 '
25 'WRITTEN BY:
30 '      LAWRENCE A. TERRE
35 '      1100 RANDVILLE DRIVE #205
40 '      PALATINE, ILLINOIS 60067
45 '
50 '-----
55 'REMARK STATEMENTS AND UNNECESSARY SPACES SHOULD BE
60 'REMOVED TO CONSERVE MEMORY. THERE ARE NO PROGRAM
65 'BRANCHES TO REMARK STATEMENTS. IF REMARKS AND SPACES
70 'ARE REMOVED, THE NUMBER IN THE CLEAR STATEMENT SHOULD
75 'BE INCREASED.
80 'NOTE: [ DENOTES UP ARROW
85 '-----
100 POKE16425,1: CLEAR20000: DEFINTA-Z: DIMD$(2100): DIMB$(14,3)

110 FS="INITDISK": NR=0: II=0: B$=STRING$(21, "."):
      Z$=STRING$(41,CHR$(136))+CHR$(32)
120 ON ERROR GOTO 210
125 '---READ DISK ROUTINE-----
130 CLS: A$="MAIN PROGRAM": GOSUB1310
140 PRINT: PRINT"DEFAULT FILE NAME IS <";F$;">"
150 INPUT"IF DESIRED, ENTER NEW FILE NAME ";F$
155 '---TEST FOR EXISTING FILE WITH SAME NAME
160 OPEN"1",1,F$+"/TXT"
165 '---NO EXISTING FILE, TURN OFF ERROR HANDLING ROUTINE
170 ON ERROR GOTO 0
175 '---NR= # OF RECORDS, F= # OF FIELDS, h= # OF HEADINGS
180 INPUT#1,NR,F,H: II=NR
185 '---B$( ,1)=HEADING, B$( ,2)="NUMERIC / ="ALPHANUMERIC
186 '---B$( ,3)= # OF FIELDS FOR HEADING B$( ,1)
190 FORCC=1TOH:
      INPUT#1,B$(CC,1),B$(CC,2),B$(CC,3):
      NEXT
195 '---ZZ=SUBSCRIPT FOR LAST FIELD OF LAST RECORD
196 '---D$( )=DATA STRING
200 ZZ=(NR*F):
      FORCC=1TOZZ:
          INPUT#1,D$(CC):
          NEXT:
          CLOSE: GOTO220
210 PRINT: A$="FILE DOES NOT EXIST": GOSUB1310 : RESUME140
215 '---MENU SELECTION ROUTINE-----
220 CLS: PRINT: BT=20:
      A$="FLEXCAT: FLEXIBLE TEXT-ORIENTED CATALOGING SYSTEM":
      GOSUB1310
230 PRINT: PRINTTAB(BT)"1 - ADD DATA"
240 PRINTTAB(BT)"2 - LIST DATA"
250 PRINTTAB(BT)"3 - SEARCH DATA"
260 PRINTTAB(BT)"4 - SAVE DATA ON DISKETTE"
270 PRINTTAB(BT)"5 - ENABLE AUTO PRINT FUNCTION"
280 PRINTTAB(BT)"6 - END PROGRAM"
290 PRINT: A$="MAKE SELECTION, THEN PRESS <ENTER>": GOSUB1310
300 ZZ$="2": INPUTZZ$: ZZ=VAL(ZZ$): IFZZ<0 OR ZZ>6THEN220
310 ON ZZ GOSUB330 ,500 ,750 ,630 ,1450 ,1120
320 GOTO220

```

Listing 3 continues

Listing 3 continued

```

325 '---ADD DATA ROUTINE-----
330 CLS:
    A$="*INPUT*   TYPE 'END' TO KILL PRESENT RECORD AND EXIT":
    GOSUB1310
335 '---PRINT HEADINGS & GRAPHIC BOXES FOR FIELDS
340 FORX=1TOH:
    PRINTB$(X,1);
    FORY=1TOVAL(B$(X,3)):
        PRINTTAB(22)Z$;
    NEXTY:
    NEXTX
360 PRINTSTRING$(63,"-");T=22;Z=(II*F)+1
365 '---REPRINT HEADING & INPUT FIELD DATA
370 FORX=1TOH:
    PRINT@T+42,B$(X,1);
    FORY=1TOVAL(B$(X,3)):
        T=T+64
390     PRINT@T,Z$;
        PRINT@T,"";
400     LINEINPUTBB$:
        BB$=LEFT$(BB$,41)
410     IFBB$="END"THEN490
420     IFINT((Z-1)/F)<>((Z-1)/F)THEN470
430     IFBB$<>" "THEN470
440     IFB$(1,3)="1" AND F>1
        PRINT@120,B$(2,1);:
        PRINT@T+64,Z$;
450     IFF>LPRINT@T+64,Z$;
460     GOTO390
470     D$(Z)=BB$:
        Z=Z+1;
    NEXTY:
    NEXTX
480 II=II+1: NR=NR+1: GOTO330
490 RETURN
495 '---LIST DATA ROUTINE-----
500 XX=0: Z=1: IF NR<1 RETURN
510 XX=XX+1: CLS:
    IFAT$<>"AUTO ON"
        A$="*LIST* <E>-ESCAPE, <[>-BACKSPACE, <SHIFT>: <L>-LAST,
    <S>-SKIP"
    ELSE
        A$="LIST ROUTINE - PRESS <E> TO EXIT"
520 GOSUB1310 : GOSUB1140
530 IFAT$="AUTO ON":
    Z=Z-F:
    GOSUB1370
535 '---NOTE: THE CHARACTER TESTED IN ZZ$ IN LINES
536 '---540, 550, 580, 590, AND 600 IS SHIFTED
537 '---(I.E. PRESS THE <SHIFT> KEY, THEN THE CHARACTER).
538 '---TEST TO SEE IF SPECIAL FUNCTION IS DESIRED
540 IFZZ$="d" AND LEFT$(D$(Z-F),1) <> CHR$(191):
    D$(Z-F)=CHR$(191)+LEFT$(D$(Z-F),40):
    NR=NR-1
550 IFZZ$="u":
    Z=Z-F:
    GOSUB1180
560 IFZZ$=CHR$(91) AND XX=1:
    Z=Z-F:
    XX=XX-1
570 IFZZ$=CHR$(91) AND XX>1:
        XX=XX-2:
        Z=Z-(2*F)
580 IFZZ$="s":
    XX=XX+9:
    Z=Z+(9*F)
590 IFZZ$="1":
    XX=II-1:
    Z=(XX*F)+1
600 IFZZ$="p":
    Z=Z-F:
    GOSUB1370
610 IFZZ$="E": RETURN
615 '---IF XX<II THERE ARE MORE RECORDS TO LIST
620 IFXX<II
    THEN510
    ELSE
        AT$="AUTO OFF":
        RETURN
625 '---SAVE DATA ROUTINE-----
630 IFNR<1: RETURN
640 CLS: A$="SAVE DATA ROUTINE": GOSUB1330
650 IFZZ$="E": RETURN
660 PRINT: PRINT"OLD FILE NAME IS <";F$;">": PRINT
670 INPUT"ENTER NEW FILE NAME ";F$
680 OPEN"O",1,F$+"/TXT"
690 PRINT#1,NR;F;H
700 FORCC=1TOH:
    PRINT#1,
        CHR$(34);B$(CC,1);CHR$(34);
        CHR$(34);B$(CC,2);CHR$(34);
        CHR$(34);B$(CC,3);CHR$(34);
    NEXT
705 '---ZZ=TOTAL NUMBER OF FIELDS (INCLUDING DELETE RECORDS)
710 ZZ=(II*F):
    FORCC=1TOZZ
715 '---TEST FOR DELETE RECORDS & DON'T WRITE THEM TO DISK
720     IFLEFT$(D$(CC),1)=CHR$(191)
        THENCC=CC+(F-1):
        GOTO740
730     PRINT#1,CHR$(34);D$(CC);CHR$(34)
740 NEXT: CLOSE: RETURN
745 '---SEARCH ROUTINE-----
750 IFNR<1: RETURN
760 CLS: A$="*SEARCH*   <E> TO ESCAPE, ANY KEY TO CONTINUE":
    GOSUB1310 : GOSUB1320
770 IFZZ$="E": RETURN
780 FF=1: JJ(1)=1: Q(1)=1: YB=1
785 '---PRINT HEADINGS
790 CLS:
    FORX=1TOHSTEP2:
        PRINTB$(X,1);:
        PRINTTAB(40)B$(X+1,1):
    NEXT
800 PRINTSTRING$(63,"."):
    A$="TO FIND RECORDS TO BE DELETED, PUSH <ENTER> FOR HEADING
# 1":
    GOSUB1310
810 PRINTSTRING$(63,".")
815 '---FOLLOWING LINE LIMITS # OF TEXT SEARCHES TO 5
820 IF FF>5:
    YB=FF:
    GOTO930

```

Listing 3 continues

If You Do A Lot Of Editing Of Your BASIC Programs, Then This Is The Editor For You!!!

The Full Screen Text Editor for BASIC, we were the first to give the TRS-80 this indispensable ability. What ability? The ability to edit your BASIC program with the ease of word processing. It is a type of word processor specifically designed to handle BASIC programs instead of letters and documents.

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Listing 3 continued

```

830 PRINT"SELECT SEARCH HEADING #";FF;: PRINTTAB(30);: LINEINPUT
SS$(FF)
835 '---TEST FOR BLANK ON HEADING #1
840 IFSS$(1)="":
      SS=B$(1,1):
      QQ$(1)=CHR$(191):
      GOTO920
845 '---TEST FOR BLANK ON ANY HEADING
850 IFSS$(FF)="":
      YB=FF:
      GOTO930
855 '---ADD TRAILING PERIODS TO HEADING ENTRY
860 SS=SS$(FF)+RIGHT$(B$(21-LEN(SS$(FF)))
870 Q(FF)=0:
      FORX=1TOH:
        Q(FF)=Q(FF)+VAL(B$(X,3))
880   IFB$(X,1)=SS:
        PRINT"ENTER ";SS$(FF);" SOUGHT ";:
        PRINTTAB(40);:
        LINEINPUTQQ$(FF):
        JJ(FF)=VAL(B$(X,3)):
        FF=FF+1:
        GOTO820
890 NEXT
900 A$="HEADING DOES NOT EXIST": GOSUB1330
910 IFZZ$="E"
      THENRETURN
      ELSE
        820
920 CLS: A$="SEARCHING FOR RECORDS TO BE DELETED": GOSUB1310 : G
OTO940
930 FF=1: CLS: A$="SEARCHING FOR A MATCH": GOSUB1310
940 FORX=1TO11*FSTEPF
945 '---Q(FF)=LAST RELATIVE FIELD POSITION OF HEADING FF
946 '---JJ(FF)= # OF FIELDS ATTACHED TO HEADING FF
947 '---G=FIRST FIELD OF HEADING IN CURRENT RECORD
948 '---E=LAST FIELD OF HEADING IN CURRENT RECORD
950 G=(X+Q(FF)-JJ(FF)): E=(G+JJ(FF)-1)
960 FORY=GTOE
970   L(FF)=INSTR(D$(Y),QQ$(FF))
980   IF L(FF)<>0:
        FF=FF+1:
        GOTO1030
990   NEXTY:
        PRINT@55,INT((X+F)/F):
        FF=1
1000 NEXTX: AT$="AUTO OFF"
1005 '---IF YOU GET HERE, THE RECORD SOUGHT DOESN'T EXIST
1010 CLS: PRINT: A$="NO MORE DATA TO SEARCH": GOSUB1330
1020 IFZZ$="E"
      THEN RETURN
      ELSE
        780
1025 '---IF FF<YB, THERE ARE MORE HEADINGS TO SEARCH IN RECORD
1030 IF FF<YB
      THEN950
      ELSE
        FF=1
1040 CLS: A$=" * FOUND RECORD *   PRESS <E> TO ESCAPE": GOSUB131
0
1050 Z=X: GOSUB1140

```

```

1060 IFAT$="AUTO ON":
      Z=Z-F:
      GOSUB1370
1065 '---NOTE: THE CHARACTER TESTED IN ZZ$ IN LINES
1066 '---1070, 1080, AND 1090 IS SHIFTED
1067 '---(I.E. PRESS THE <SHIFT> KEY, THEN THE CHARACTER).
1070 IFZZ$="d" AND LEFT$(D$(Z-F),1)<>CHR$(191):
      D$(Z-F)=CHR$(191)+D$(Z-F):
      Z=Z-F:
      NR=NR-1:
      GOTO1040
1080 IFZZ$="u":
      Z=Z-F:
      GOSUB1180 :
      Z=Z+F
1090 IFZZ$="p":
      Z=Z-F:
      GOSUB1370
1100 IFZZ$="E": RETURN
1105 '---IF YOU GET HERE, SEARCH FILE FOR ANOTHER MATCH
1110 CLS: A$="SEARCHING FOR A MATCH": GOSUB1310 : GOTO1000
1115 '---EXIT PROGRAM ROUTINE-----
1120 CLS: PRINT: PRINT"VALID RECORDS -> ",NR: PRINT:
A$="EXIT ROUTINE - DATA WILL BE LOST IF NOT SAVED BEFORE EX
IT": GOSUB1310
1130 PRINT:
A$="PRESS: <M>-MENU OR <E>-EXIT":
GOSUB1310 : GOSUB1320 :
IFZZ$<>"E"
  THENRETURN
  ELSE
    END
1135 '---DISPLAY DATA ROUTINE-----
1140 GOSUB1340
1150 IFAT$<>"AUTO ON"
      PRINT"ANY KEY TO CONTINUE, <SHIFT>: <U>-UPDATE, <P>-PRI
NT, <D>-DELETE";:
      ELSE
        PRINTTAB(21)"AUTO PRINT FUNCTION ON";
1160 IFAT$="AUTO ON": RETURN
1170 GOSUB1320 : RETURN
1175 '---UPDATE ROUTINE-----
1180 CLS:
A$="*UPDATE*   CHANGE, THEN <ENTER> ELSE <ENTER> TO ADVANCE
CURSOR": GOSUB1310
1185 '---DF=1 MEANS DELETE FLAG IS ON (RECORD MARKED TO DELETE)
1190 IFLEFT$(D$(Z),1)=CHR$(191)
      THENDF=1
      ELSE
        DF=0
1200 GOSUB1340
1210 PRINTSTRING$(63,"-");
1215 '---Z=Z-F MEANS BACK UP ONE RECORD
1220 Z=Z-F: T=22
1225 '---IF USER ENTERS DATA, PLACE IN D$(Z)
1230 FORW=1TOH:
      PRINT@T+42,B$(W,1);
      FORJ=1TOVAL(B$(W,3)):
        T=T+64
1250   PRINT@T+1,D$(Z);:PRINT@T,"";
1260   LINEINPUTBB$:

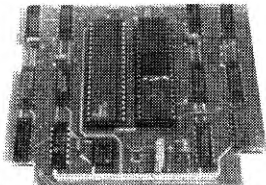
```

Listing 3 continues


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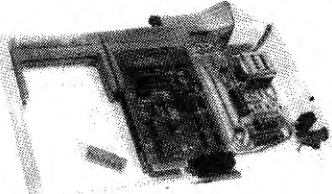
1270  BB$=LEFT$(BB$,41)
1280  IF BB$<>" " THEN$(Z)=BB$
1280  PRINT@+1,STRING$(41," ");
1280  PRINT@,D$(Z);
1280  Z=Z+1;
1280  NEXTU;
1285  '---IF RECORD WAS, BUT IS NOT NOW, MARKED TO DELETE
1286  '---ADD 1 TO NUMBER OF RECORDS (NR)
1290  IF D$=1 AND LEFT$(D$(Z-F),1)<>CHR$(191): NR=NR+1
1300  RETURN
1305  '---CENTER AND DISPLAY (A$) SUBROUTINE
1310  TB=.5 * LEN(A$): TB=32-TB: PRINTTAB(TB)A$: RETURN
1315  '---INKEY$ SUBROUTINE
1320  Z$=INKEY$:
1320  IF Z$=""
1320  THEN 1320
1325  RETURN
1330  '---DISPLAY, PROMPT, & INKEY$ SUBROUTINE
1330  GOSUB1310: PRINT: A$="PRESS <E> TO ESCAPE, ANY KEY TO CONT
1330  INUE":
1335  GOSUB1310: GOSUB1320: RETURN
1340  '---DISPLAY RECORD SUBROUTINE
1340  FORV=LTOH:
1340  PRINT$(V,1);
1340  FORU=LTOVAL(B$(V,3)):
1340  PRINTTAB(22)D$(Z):
1340  Z=Z+1;
1340  NEXTU;
1350  '---PRINT RECORD SUBROUTINE
1360  RETURN
1365  '---PRINT RECORD SUBROUTINE
1370  LN=66
1380  IF PEEK(14312)>127
1380  IF AT$="AUTO ON"
1380  GOTO 1380 <
1380  ELSE
1380  AT$="AUTO OFF":
1380  Z$="E":
1380  Z=Z+F:
1380  RETURN:
1380  ELSE
1380  Z=Z+F:
1380  RETURN
1390  IF PEEK(16425)+F>LN-1: LPRINTCHR$(12): POKE16425,1
1400  IF PEEK(16425)=1: LPRINT "
1405  '---PRINT RECORD
1410  FORV=LTOH:
1410  LPRINT$(V,1);
1410  FORU=LTOVAL(B$(V,3)):
1410  LPRINTTAB(22)D$(Z):
1410  Z=Z+1;
1410  NEXTU;
1420  '---ENABLE AUTO PRINT SUBROUTINE
1430  LPRINTSTRING$(63,"-")
1440  RETURN
1445  '---ENABLE AUTO PRINT SUBROUTINE
1450  CLS: PRINTCHR$(23): PRINTTAB(6)"AUTO PRINT ENABLED":
1450  FORH=LTO500: NEXT: AT$="AUTO ON": RETURN
1460  END
    
```

"Double Density Adapter"
\$129.50



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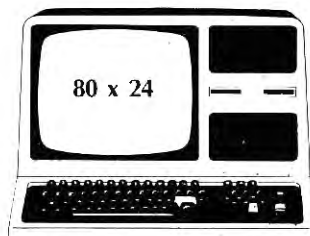


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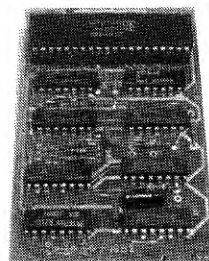
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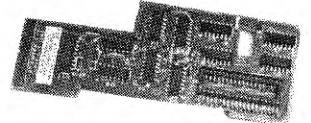


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Math Hangman

by Tim Knight

Help your children learn addition, subtraction, multiplication, and division with this fun game—and brush up your own math skills, too.

Extra Features

Just for fun, I put some extra features in this simple game. First, the playing instructions are in the game. Even though you might not need them, they are helpful to children and players who didn't type in the program.

Second, the computer repeats a problem if you get it wrong, providing a true test of your skills.

A third feature is found at the end of the game when the percentage of right answers is given. This lets a player know if his skills are improving—or getting worse!

In case you want to modify the pro-

Math Hangman is educational as well as entertaining. It helps people develop their skills in addition, subtraction, multiplication, and division, and it will probably be used mostly by young people. However, since many of us are becoming increasingly dependent upon calculators and computers, our mathematical skills are, no doubt, rusty. So, adults, too, may find this game challenging.

In Math Hangman, you answer questions about random math problems. For each wrong answer, a piece of the hangman appears. If the whole man is formed, you lose; if you get through all the problems, you win!

The Key Box

Models I & III
16K, 32K
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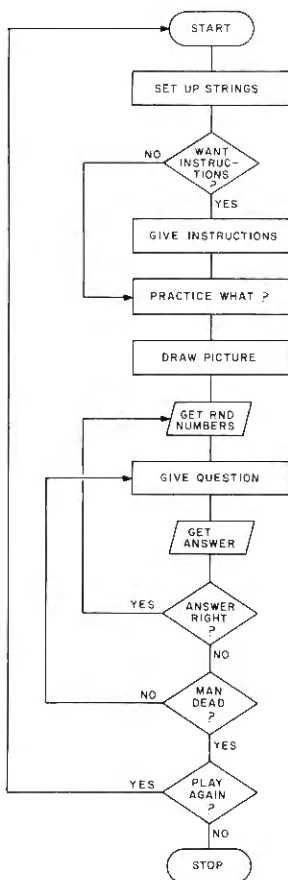


Fig. 1. Program Flowchart

IMPORTANT VARIABLE LIST

A	CHRS DATA
B\$(I)	PARTS OF MAN'S BODY
B (I)	PLACES ON SCREEN PIECES OF BODY GO
R1, R2	RANDOM NUMBERS
GU, GUS	PLAYER'S GUESS
AN, AN\$	TRUE ANSWER
RT	RIGHT ANSWERS
WR	WRONG ANSWERS
P	PERCENTAGE

Table 1. Variables

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Table treats ① and ③. Speed improvement ratios give minimum expected results!

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SPEED/SPACE Performance Table.

Speed Improvement (Ratio)				Operation	Space Degradation (Bytes)			
INT	SNG	DBL	STR		INT	SNG	DBL	STR
178	28	20	7.3	Assignment (LET)	-4	0	0	0
3.5	3.6	3.6	3.5	Array Reference (1-dim)	13	13	13	13
3.0	3.0	3.0	3.0	Array Reference (2-dim)	12	12	12	12
35	1.8	1.6		AND, OR	4	7	7	
23	2.0	1.6	6.6	Compare (=, >, <, etc.)	3	10	10	3
57	1.8	1.4	3.6	Add, Concatenate (+)	1	6	6	2
48	1.8	1.3		Subtract (-)	4	6	6	
1.5	1.5	1.1		Multiply (*)	6	6	6	
1.08	1.17	1.02		Divide (/)	6	6	6	
77	70	84	9.3	Constant Reference	0	6	6	4
7.1	1.9			FOR-NEXT	6	23		
111	6.8	4.8		POKE	-1	5	5	
10	4.5	3.6		SET, RESET	-1	5	5	
47	4.6	3.0	8.1	IF THEN ELSE	3	9	9	3
33	4.3	3.5		ON expression GOTO	-2	0	0	
50	6.8	5.1		ON expression GOSUB	0	3	3	
1.2	1.01	1.03	1.2	PRINT simple-variable	-1	-1	-1	-1
61	5.0	3.7		OUT	5	11	11	
				Flow of Control				
				GOTO				
				GOSUB/RETURN	-7			
				Functions	-10			
				VARPTR				
inf	inf	inf	inf	POINT	-3	-3	-3	-3
5.2	1.9	1.7		INP	3	9	9	
38	2.3	1.7		PEEK	5	8	8	
149	2.3	2.0		String Functions	0	3	3	
				ASC				
				LEN	5			
				LEFT\$	0			
				RIGHT\$	1			
				MID\$	1			
				CHR\$	2			
				CVI	0			
				MKI\$	0			
				CVS	0			
				MKS\$	0			
				CVD	0			
				MKD\$	0			

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gram, I've included a flowchart and a list of important variables. You might want to include easier problems, or ones that are more difficult. This program was not designed solely as an instruction course; it can also serve as a skeleton for

other programmers who want to write educational programs. ■

Tim Knight is a 16-year-old high school student. He can be reached at 10 Fieldbrook Place, Moraga, CA 94556.

Program Listing

```

10 ' Math Hangman program, by Tim Knight
20 ' 10 Fieldbrook Place
30 ' Moraga, CA 94556
40 ' for educational use on a TRS-80 Model I or III
50 CLEAR 500
60 CLS
70 DEF$NG A-Z
80 FOR I=1 TO 6
90 READ A
100 IF A=999 THEN NEXT ELSE IF A=333 THEN 190 ELSE IF A<128 AND
A<>26 AND A<>32 AND A<>24 THEN READ B: FOR J=1 TO A-1: B$(I)=B$(
I)+CHR$(B): NEXT: GOTO 90
110 B$(I)=B$(I)+CHR$(A)
120 GOTO 90
130 DATA 176, 186, 3, 176, 26, 7, 24, 188, 2, 191, 187, 143, 183
, 3, 191, 188, 26, 8, 24, 131, 143, 191, 2, 179, 191, 143, 131,
999
140 DATA 2, 188, 7, 191, 2, 188, 26, 9, 24, 9, 191, 26, 9, 24, 9
, 191, 999
150 DATA 3, 176, 2, 188, 7, 191, 2, 188, 26, 11, 24, 2, 191, 26,
2, 24, 2, 191, 999
160 DATA 2, 188, 7, 191, 2, 188, 3, 176, 26, 2, 24, 2, 191, 26,
2, 24, 2, 191, 999
170 DATA 2, 191, 26, 2, 24, 2, 191, 26, 4, 24, 3, 188, 2, 191, 9
99
180 DATA 2, 191, 26, 2, 24, 2, 191, 26, 2, 24, 2, 191, 3, 188, 3
33
190 ' PROGRAM BEGINS HERE
200 B(1)=210
210 B(2)=401
220 B(3)=399
230 B(4)=401
240 B(5)=595
250 B(6)=598
260 PRINT TAB(20)"= MATH HANGMAN ="
270 PRINT
280 INPUT"Would you like instructions ";RES$
290 IF LEFT$(RES$, 1)="Y" THEN CLS ELSE GOTO 470
300 PRINT TAB(15)"* MATH HANGMAN INSTRUCTIONS *"
310 PRINT
320 PRINT" This game is very simple to use. It will both teach
a person"
330 PRINT"and also serve as entertainment! Its main purpose, th
ough,"
340 PRINT"is to help a person with his or her math skills."
350 PRINT" The program will begin by asking if you would like t
o work"
360 PRINT"on addition, subtraction, multiplication, or division.
You"
370 PRINT"chose one of these that you want most. After that, ty
pe in "
380 PRINT"how many problems you would like to do, and the comput
er will"
390 PRINT"take it from there!"
400 PRINT" You will do problems from then on. For each one you
get wrong";
410 PRINT"though, another piece of the hangman will come up. If
the"
420 PRINT"whole hangman is formed, then you lose. However, if y
ou make"
430 PRINT"it through those problems without any trouble, you win
!"
440 PRINT
450 PRINT TAB(10)"Hit the space bar to begin game....";
460 IF PEEK(14400)=128 THEN CLS ELSE 460
470 CLS
480 PRINT
490 PRINT
500 PRINT"WOULD YOU LIKE TO PRACTICE ADDITION, SUBTRACTION, MULT
IPLICATION";
510 PRINT"OR DIVISION? (TYPE IN A,S,M, OR D) ";
520 INPUT CH$
530 CH$=LEFT$(CH$, 1)

```

Listing continues

Smartcat

by Irwin Rappaport

The Lynx modem and Emterm software make an impressive communications package; Smartcat makes this combination even more powerful.

The program Emterm, supplied with the Lynx modem (Emtrol Systems Inc., Lancaster, PA), creates a smarter TRS-80 terminal. Emterm and Lynx provide telephone dialing from the keyboard, storage and subsequent operator-commanded transmission of a message, alteration of certain operating parameters under software control, and simultaneous screen and line-printer (parallel) output. Emterm can also output control-key codes required by some data banks, and provides for up to 10 user-defined control keys.

These are powerful capabilities, but your TRS-80 terminal can do much more. You can discard Emterm and buy a more extensive program that supports the Lynx, or you can add the following features to Emterm:

- Uploading and downloading (trans-

mitting and receiving) of program files.

- Support for upper/lowercase modification.
- Screen dump to line printer.
- Delay routine for keyboard debounce or transmission rate adjustments.
- Telephone directory storage with instant phone-number retrieval.

Passing Control to Smartcat

Three program listings are presented here. The two Basic programs play supporting roles while Smartcat, the Assembly listing, is the addition to Emterm. When Emterm is loaded and executed, it disassociates itself from the TRS-80 operating system and runs its own keyboard scan routine, enabling output of control-key codes. The first of two jump-to-Smartcat patches is made at this scan routine, location 7BB8 hex in Emterm.

While Emterm is running, frequent calls are made to 7BB8H to determine keyboard status and to decode the matrix if a key is pressed. The ASCII value of the key is sent to the accumulator. By having control at that point, Smartcat can test the accumulator and take whatever action has been programmed for a particular key. For example, the program contains a routine to dump the screen contents to a line printer when you press the

“zero” key. Smartcat checks the accumulator and branches to the dump if it finds 30 hex.

In effect, the Lynx/TRS-80 gains the ability to learn whatever you teach it. A terminal must know whether its user wants a program routine or the actual character when a key is pressed. Emterm makes this distinction by incorporating the down arrow as a control key while Smartcat requires that shift, @ be used as the control-key sequence.

Since Emterm resides from 7537H-7E03H and uses all the area below it through 7100H for the stack and message storage, the Smartcat Assembly listing (see Program Listing 1) begins at 7F00H. The two programs are combined and saved in one package, from 7537H-880FH with the entrance at 7F00H. Upon execution, the Smartcat code creates two patches into Emterm: one for the keyboard-scan jump routine and the other to make provision for downloading. In addition, a patch is made into TRSDOS at 401EH for lowercase display support.

The lowercase driver routine supports the 2102 RAM chip piggyback modification, such as the kit marketed by Emanuel B. Garcia, Jr. and Associates, Chicago, IL. In Listing 1, the location labeled SWLC is specifically included for those not having the lowercase modification. If you do not have the lowercase modification, change the instruction from RET (C9) to NOP (00), which negates the lowercase routine. If you install the modification at some later date, change it back.

Emterm jumps to Smartcat at

The Key Box

**Disk Basic
Assembly Language
Model I or III
32K RAM
One disk drive
Editor/Assembler
Lynx modem**

UTENTR. The first three bytes there are the instructions originally contained in 7BB8,9,AH, and which were replaced with the jump-out patch. Then the remainder of the keyboard scan is called. Regaining control upon the return, Smartcat calls SWD, the delay routine.

SWD initially contains an RET (C9) instruction. When the delay routine is

activated by issuing the appropriate keyboard command, location SWD is changed to NOP (00), thereby allowing the call to the delay routine to proceed. The contents of the BC register pair determine the amount of delay. Three levels of delay are user selectable from the keyboard as determined in FUNC10, FUNC11, and FUNC12 at the LD instruction (02,10,80 hex re-

spectively). You may vary all three values.

The call to FUNC begins the routine that permits Smartcat to distinguish a program function command from an ordinary keyboard character when a key is pressed. If FUNC finds a shift, @ (60H) in the accumulator, switch SWF is changed from RET to NOP, similarly to the action at the SWD switch. When FUNC is called upon the next key press, the routine reaches SWF, and since it contains 00, passes through it. The switch is then closed by reloading it with C9, and the routine continues to search for the commanded function.

Program Listing 1. Smartcat

```

00010 ;*** SMARTCAT *** OMIT LOWER CASE PORTION FOR MODEL III
7F00 00020 ORG 7F00H
7BB8 00030 CMDEMT EQU 7BB8H ;JUMP OUT POINT FROM EMTERM KEY-SCAN

81FF 00040 TABLE EQU 81FFH ;START PHONE NUMBER TABLE
8500 00050 DIRECT EQU 8500H ;START DIRECTORY
88FE 00060 BUFFER EQU 88FEH ;BEGINNING OF UPLOAD BUFFER
7F00 3EC3 00070 LD A,0C3H
7F02 325779 00080 LD (7957H),A;EMTERM JUMP-OUT TO DNLOAD
7F05 21CF80 00090 LD HL,DNLOAD
7F08 225879 00100 LD (7958H),HL
7F0B 211D7F 00110 LD HL,LCENTR ;LOWER CASE DRIVER PATCH ...

7F0E 221E40 00120 LD (401EH),HL ;OMIT FOR MODEL III
7F11 32B87B 00130 LD (CMDEMT),A
7F14 21447F 00140 LD HL,UTENTR
7F17 22B97B 00150 LD (CMDEMT+1),HL
7F1A C33775 00160 JP 7537H ;ALSO TRY USING 755C ... SEE TEXT
7F1D CD3E7F 00170 LCENTR CALL SWLC ;LOWER CASE DRIVER BEGINS ...
7F20 DD6E03 00180 LD L,(IX+03);OMIT DRIVER ROUTINE FOR MOD III
7F23 DD6E04 00190 LD H,(IX+04)
7F26 DA9A04 00200 JP C,049AH
7F29 DD7E05 00210 LD A,(IX+05)
7F2C B7 00220 OR A
7F2D 2801 00230 JR Z,ENTR1
7F2F 77 00240 LD (HL),A
7F30 79 00250 ENTR1 LD A,C
7F31 FE20 00260 CP 20H
7F33 DA0605 00270 JP C,0506H
7F36 FE80 00280 CP 80H
7F38 D2A604 00290 JP NC,04A6H
7F3B C37D04 00300 JP 047DH
7F3E C9 00310 SWLC RET
7F3F 33 00320 INC SP
7F40 33 00330 INC SP
7F41 C35804 00340 LD 0458H ;END OF LOWER CASE DRIVER ROUTINE
7F44 D9 00350 UTENTR EXX ;ORIGINAL EMTERM CODE
7F45 3EFF 00360 LD A,0FFH ;ORIGINAL EMTERM CODE
7F47 CDB87B 00370 CALL CMDEMT+3
7F4A CD6F80 00380 CALL SWD
7F4D B7 00390 OR A
7F4E C4587F 00400 CALL NZ,FUNC
7F51 CD8680 00410 CALL SWK
7F54 CD5B80 00420 CALL SWU
7F57 C9 00430 RET
7F58 FE60 00440 FUNC CP 60H
7F5A 2006 00450 JR NZ,SWF
7F5C F1 00460 POP AF
7F5D AF 00470 XOR A
7F5E 32627F 00480 LD (SWF),A
7F61 C9 00490 RET
7F62 C9 00500 SWF RET
7F63 F5 00510 PUSH AF
7F64 3EC9 00520 LD A,0C9H
7F66 32627F 00530 LD (SWF),A
7F69 F1 00540 POP AF
7F6A FE3A 00550 FUNC1 CP 3AH ;KEY<.>=UPPER/LOWER REVERSE
7F6C 2006 00560 JR NZ,FUNC2
7F6E F1 00570 POP AF
7F6F AF 00580 XOR A
7F70 325B80 00590 LD (SWU),A
7F73 C9 00600 RET
7F74 FE2A 00610 FUNC2 CP 2AH ;KEY<*>=REVERSE OFF
7F76 2008 00620 JR NZ,FUNC3
7F78 F1 00630 POP AF
7F79 3EC9 00640 LD A,0C9H
7F7B 325B80 00650 LD (SWU),A
7F7E AF 00660 XOR A
7F7F C9 00670 RET
7F80 FE3B 00680 FUNC3 CP 3BH ;KEY<.>=DELAY
7F82 2006 00690 JR NZ,FUNC4
7F84 F1 00700 POP AF
7F85 AF 00710 XOR A
7F86 326F80 00720 LD (SWD),A
7F89 C9 00730 RET
7F8A FE2B 00740 FUNC4 CP 2BH ;KEY<+>=DELAY OFF
7F8C 2008 00750 JR NZ,FUNC5
7F8E F1 00760 POP AF
7F8F 3EC9 00770 LD A,0C9H
7F91 326F80 00780 LD (SWD),A
7F94 AF 00790 XOR A
7F95 C9 00800 RET
7F96 FE30 00810 FUNC5 CP 30H ;KEY<0>=PRINT SCREEN

```

Listing continues

“(Emterm has) powerful capabilities, but your TRS-80... can do much more.”

Switches SWK and SWU are called next. SWK opens when either a phone number or an upload transmission is wanted. For keyboard shift reversing (shift for capitals, no shift for lower-case), SWU is open. Both switches are toggled with one of the keyboard function command routines. After completing all the Smartcat calls, program action returns to the point in Emterm where the keyboard scan was originally called.

Upload, Download, and the Telephone Directory

For uploading, the file to be transmitted is placed into a RAM buffer area beginning with two control bytes at 88FEH and the actual file following at 8900H. The Basic program UP-DOWN/CAT (see Program Listing 2) loads the buffer. Then when in Emterm terminal mode, a keyboard command begins the upload transmission.

To download a file, the same buffer area is used. Upon keyboard command, Smartcat begins loading every byte received by the Lynx into the RAM area starting at 8900H. Downloading continues until you issue a stop command from the keyboard, or the designated end of the buffer is reached. If the downloaded file was an ASCII format Basic program, it would be subsequently taken from RAM and saved

Listing continued

```

7F98 2025      00820      JR      NZ,FUNC6
7F9A E5        00830      PUSH   HL
7F9B 21003C    00840      LD      HL,3C00H
7F9E CD2080    00850  AGAIN  CALL   READY
7FA1 7E        00860      LD      A,(HL)
7FA2 32E837    00870      LD      (37E8H),A
7FA5 23        00880      INC    HL
7FA6 7D        00890      LD      A,L
7FA7 CBBF      00900      RES    7,A
7FA9 CBB7      00910      RES    6,A
7FAB B7        00920      OR     A
7FAC 20F0      00930      JR      NZ,AGAIN
7FAE CD2080    00940      CALL   READY
7FB1 3E0D      00950      LD      A,0DH
7FB3 32E837    00960      LD      (37E8H),A
7FB6 7C        00970      LD      A,H
7FB7 FE40      00980      CP     40H
7FB9 20E3      00990      JR      NZ,AGAIN
7FBB E1        01000      POP    HL
7FBC F1        01010      POP    AF
7FBD AF        01020      XOR    A
7FBE C9        01030      RET
7FBF FE40      01040  FUNC6  CP     40H      ;KEY<@>=SHOW PHONE DIRECTORY
7FC1 2013      01050      JR      NZ,FUNC7
7FC3 E5        01060      PUSH   HL
7FC4 D5        01070      PUSH   DE
7FC5 C5        01080      PUSH   BC
7FC6 210085    01090      LD      HL,DIRECT
7FC9 11803C    01100      LD      DE,3C00H
7FCC 010003    01110      LD      BC,0300H
7FCF EDB0      01120      LDIR
7FD1 C1        01130      POP    BC
7FD2 D1        01140      POP    DE
7FD3 E1        01150      POP    HL
7FD4 AF        01160      XOR    A
7FD5 C9        01170      RET
7FD6 FE2F      01180  FUNC7  CP     2FH      ;KEY</>=DOWNLOAD ON
7FD8 2008      01190      JR      NZ,FUNC8
7FDA AF        01200      XOR    A
7FDB 32D180    01210      LD      (SWDN),A
7FDE CD2880    01220      CALL   ONMSG
7FE1 C9        01230      RET
7FE2 FE3F      01240  FUNC8  CP     3FH      ;KEY<?>=DOWNLOAD OFF
7FE4 200A      01250      JR      NZ,FUNC9
7FE6 3EC9      01260      LD      A,0C9H
7FE8 32D180    01270      LD      (SWDN),A
7FEB CD2E80    01280      CALL   OFFMSG
7FEE AF        01290      XOR    A
7FEF C9        01300      RET
7FF0 FE2E      01310  FUNC9  CP     2EH      ;KEY<.>=BEGIN UPLOAD TRANSMISSION
7FF2 200A      01320      JR      NZ,FUNC10
7FF4 E5        01330      PUSH   HL
7FF5 21FE88    01340      LD      HL,BUFFER;1ST BYTE FF, THEN KEY<.>,THEN PROG

7FF8 22EF80    01350      LD      (WDADR5),HL      ;CHANGE ADR TO PROG.
7FFB E1        01360      POP    HL
7FFC 181B      01370      JR      FUNC20 ;GO TO TRANSMIT
7FFE FE31      01380  FUNC10  CP     31H      ;KEY<1>=DELAY AMOUNT OF 02
8000 2004      01390      JR      NZ,FUNC11
8002 3E02      01400      LD      A,02
8004 180E      01410      JR      AMTLD
8006 FE32      01420  FUNC11  CP     32H      ;KEY<2>=DELAY AMOUNT OF 10H
8008 2004      01430      JR      NZ,FUNC12
800A 3E10      01440      LD      A,10H
800C 1806      01450      JR      AMTLD
800E FE33      01460  FUNC12  CP     33H      ;KEY<3>=DELAY AMOUNT OF 80H
8010 2007      01470      JR      NZ,FUNC20
8012 3E80      01480      LD      A,80H
8014 327480    01490  AMTLD  LD      (AMTDEL+1),A
8017 AF        01500      XOR    A
8018 C9        01510      RET
8019 F5        01520  FUNC20  PUSH   AF      ;WILL OUTPUT PHONE NUMBERS/DPLDOW
OR SWK WILL CLOSE IF NEITHER

801A AF        01530      XOR    A
801B 328680    01540      LD      (SWK),A
801E F1        01550      POP    AF
801F C9        01560      RET
8020 3AE837    01570  READY  LD      A,(37E8H)      ;CHECK PRINTER STATUS
8023 CB7F      01580      BIT    7,A
8025 C0        01590      RET    Z
8026 18F8      01600      JR      READY
8028 E5        01610  ONMSG  PUSH   HL      ;PRINT DOWNLOAD ON MESSAGE TO SCREEN

8029 214080    01620      LD      HL,DOWNON
802C 1804      01630      JR      PRMSG
802E E5        01640  OFFMSG  PUSH   HL      ;DOWNLOAD OFF MESSAGE
802F 214C80    01650      LD      HL,DOWNOF
8032 D5        01660  PRMSG  PUSH   DE      ;BLOCK TRANSFER TO SCREEN
8033 C5        01670      PUSH   BC
8034 11C03F    01680      LD      DE,3FC0H
8037 010C00    01690      LD      BC,000CH
803A EDB0      01700      LDIR
803C C1        01710      POP    BC
803D D1        01720      POP    DE
803E E1        01730      POP    HL
803F C9        01740      RET
8040 44        01750  DOWNON  DEFM    'DOWNLOAD ON '
804C 44        01760  DOWNOF  DEFM    'DOWNLOAD OFF '
8058 00        01770      NOP
8059 00        01780      NOP
805A 00        01790      NOP
805B C9        01800  SWU    RET
805C FE41      01810      CP     41H

```

Listing continues

on disk using UPDOWN/CAT from Basic.

Smartcat provides for storage of 55 telephone numbers, any of which may be called with a keyboard command. In addition, a directory is included so the user can easily determine which phone number belongs to whom, and what key brings it up. You use the directory and phone-number functions at the point in Emterm where you would ordinarily enter the number to be dialed from the keyboard. With the Basic program PHONEDIR/CAT (see Program Listing 3) you can establish, review, and revise the directory. Table, at the beginning of Listing 1, sets the start of the phone numbers at 81FFH. Similarly, Direct dictates that the informational portion begins at 8500H.

Creating the Programs

Assemble Smartcat with an assembler, or load the object code directly with Debug. You may omit all NOPs in the listing.

Using Debug, load location 81FFH with FFH. Again with Debug, load all locations from 8200H-880FH with 20H. Then load location 84FFH with 00H.

Load but do not execute Emterm. Be sure all the above, including Smartcat, is in memory. Save the entire package on disk using Dump or Tape-disk. Pick a suitable name for the combined program which starts at 7537H, ends at 880FH, and has its entrance at 7F00H. Then type in and save the two Basic programs, PHONEDIR/CAT and UPDOWN/CAT.

Putting the Programs to Work

To set up a telephone directory, load the combined Smartcat/Emterm program, but do not execute it. Enter Basic, enter 0 for files, reserve memory at 30006, and run PHONEDIR/CAT. Press enter at the prompt to add new listings. Input as prompted, first any key desired, then the name of the party (10-character limit), and finally the phone number. Ten digits are available for the number so you can use area codes where needed.

Enter telephone numbers just as you would for Emterm dialing using digits only, no punctuation. Continue with a few more entries, and end by pressing enter instead of a new key. The entries will be POKed into Smartcat and you will be reminded to save the Smartcat/Emterm combination, now containing your new directory.

Before doing that, run the Basic program again but this time enter D to see the directory. Page 1 scrolls onto the

screen. Wait for the page ending prompt. PHONEDIR/CAT displays three directory pages, each ending with the same prompt. Pressing enter produces the next page while pressing G gets back to the three choices at the beginning of the program. Input G and then try C to change a listing. Input any previously entered directory key, then the revised name and number at the appropriate prompts. Review the directory to be sure that the change has been made. Save Smartcat/Emterm each time after revising the directory.

Uploading preparation begins in Basic. Run UPDOWN/CAT and press 2 for uploading. Enter the file name (the file should be a Basic program in ASCII format) and unless you have made some program revisions, press enter at the starting-address prompt that appears after the disk drive stops. The file is printed to the screen and POKed into RAM, sector by sector. Enter CMD“S” and load and execute Smartcat/Emterm in the usual way. When you are ready to transmit the file, press shift, @ and then the period key. Uploading will proceed, returning to Emterm terminal mode upon completion. The receiving party must process your transmission according to his own system’s needs.

You may transmit anything contained in the RAM buffer with the upload routine. If you will be sending a non-Basic file, place it in the buffer in any way desired—load it, block transfer it, or type it in, beginning at 8900H. At 88FEH and 88FFH put the start codes FFH and 3EH respectively (UPDOWN/CAT puts them in when loading a Basic file). Then upload from Emterm as before.

To download any Basic file, or anything your Lynx receives, press shift, @ and then the slash key. “DOWNLOAD ON” will appear on your screen, and every byte received thereafter will be stored in RAM beginning at 8900H. Downloading continues until you press shift, @ followed by the question-mark key and “DOWNLOAD OFF” appears (or the end of the buffer is reached). If desired, you may download another file immediately using the same procedure. It will be stored in the buffer following the previous file.

You can save received files on disk when you terminate the phone connection. If the downloaded file is an ASCII-format Basic program that you will put on disk with UPDOWN/CAT, follow this procedure after hanging up the phone:

Listing continued

805E	F8	01820	RET	M	
805F	FE61	01830	CP	61H	
8061	3006	01840	JR	NC,UL1	
8063	FE5B	01850	CP	5BH	
8065	D0	01860	RET	NC	
8066	C620	01870	ADD	A,20H	
8068	C9	01880	RET		
8069	D620	01890	SUB	20H	
806B	C9	01900	RET		
806C	00	01910	NOP		
806D	00	01920	NOP		
806E	00	01930	NOP		
806F	C9	01940	RET		
8070	E5	01950	PUSH	HL	
8071	C5	01960	PUSH	BC	
8072	F5	01970	PUSH	AF	
8073	0602	01980	LD	B,02H	;AMOUNT OF DELAY
8075	0E01	01990	LD	C,01	
8077	AF	02000	XOR	A	
8078	0B	02010	MORDEL	DEC	BC
8079	B8	02020	CP	B	
807A	20FC	02030	JR	NZ,MORDEL	
807C	F1	02040	POP	AF	
807D	C1	02050	OUTDEL	POP	BC
807E	E1	02060	POP	HL	
807F	C9	02070	RET		
8080	00	02080	NOP		
8081	00	02090	NOP		
8082	00	02100	NOP		
8083	00	02110	NOP		
8084	00	02120	NOP		
8085	00	02130	NOP		
8086	C9	02140	SWK	RET	
8087	E5	02150	PUSH	HL	
8088	2AEF80	02160	LD	HL,(WDADRS)	
808B	F5	02170	PUSH	AF	
808C	3EFF	02180	LD	A,0FFH	
808E	BE	02190	CP	(HL)	
808F	2022	02200	JR	NZ,MIDDLE	
8091	F1	02210	POP	AF	
8092	B7	02220	OR	A	
8093	2002	02230	JR	NZ,GOON	
8095	E1	02240	POP	HL	
8096	C9	02250	RET		
8097	23	02260	GOON	INC	HL
8098	BE	02270	KEY1	CP	(HL)
8099	2810	02280	JR	Z,KEY3	
809B	F5	02290	PUSH	AF	
809C	23	02300	KEY2	INC	HL
809D	3EBF	02310	LD	A,0BFH	
809F	BE	02320	CP	(HL)	
80A0	20FA	02330	JR	NZ,KEY2	
80A2	23	02340	INC	HL	
80A3	3EFF	02350	LD	A,0FFH	
80A5	BE	02360	CP	(HL)	
80A6	2818	02370	JR	Z,KEY4	
80A8	F1	02380	POP	AF	
80A9	10ED	02390	JR	KEY1	
80AB	23	02400	KEY3	INC	HL
80AC	7E	02410	LD	A,(HL)	
80AD	23	02420	INC	HL	
80AE	22EF80	02430	LD	(WDADRS),HL	
80B1	E1	02440	POP	HL	
80B2	C9	02450	RET		
80B3	F1	02460	MIDDLE	POP	AF
80B4	3EBF	02470	LD	A,0BFH	
80B6	BE	02480	CP	(HL)	
80B7	2808	02490	JR	Z,KEY5	
80B9	7E	02500	LD	A,(HL)	
80BA	23	02510	INC	HL	
80BB	22EF80	02520	LD	(WDADRS),HL	
80BE	E1	02530	POP	HL	
80BF	C9	02540	RET		
80C0	F1	02550	KEY4	POP	AF
80C1	21FF81	02560	KEY5	LD	HL,TABLE
80C4	22EF80	02570	LD	(WDADRS),HL	
80C7	E1	02580	POP	HL	
80C8	3EC9	02590	LD	A,0C9H	
80CA	328680	02600	LD	(SWK),A	
80CD	AF	02610	XOR	A	
80CE	C9	02620	RET		
80CF	E67F	02630	DNLOAD	AND	7FH ;BEGINNING OF DOWN-LOAD ROUTINE
80D1	C9	02640	SWDN	RET	
80D2	E5	02650	PUSH	HL	
80D3	F5	02660	PUSH	AF	
80D4	2AED80	02670	LD	HL,(BUFADR)	
80D7	77	02680	LD	(HL),A	
80D8	23	02690	INC	HL	
80D9	22ED80	02700	LD	(BUFADR),HL	
80DC	3EE0	02710	LD	A,0E0H ;ESTABLISH END OF BUFFER AT E000H	
80DE	BC	02720	CP	H	
80DF	2803	02730	JR	Z,BUFEND	
80E1	F1	02740	POP	AF	
80E2	E1	02750	POP	HL	
80E3	C9	02760	RET		
80E4	F1	02770	BUFEND	POP	AF
80E5	E1	02780	POP	HL	
80E6	3E3F	02790	LD	A,3FH	
80E8	C3E27F	02800	JP	FUNC8	
80EB	E1	02810	POP	HL	
80EC	C9	02820	RET		
80ED	0089	02830	BUFADR	DEFW	BUFFER+2;INITIALIZE BUFFER ADR
80EF	FF81	02840	WDADRS	DEFW	TABLE ;INITIALIZE TABLE FOR PHONE.
0000		02850	END		

- Enter Debug and examine the area at 8900H.
- Determine the beginning address of the file and make a note of it for later use.
- Locate the last byte of the file and load 00 into the location immediately after it.
- Go into Basic and run UPDOWN/CAT. Enter 1 for the download save.

- Enter a file name for the program as desired.
- Enter the program starting address noted before (decimal required). The easiest way to obtain the decimal value is to press break, use &H to get the hex to decimal conversion, type and enter CONT, and input the decimal.
- The lines will be printed on screen as saving proceeds.

```

10 CLEAR 1000:CLS:PRINT:PRINT"GET FILES TO AND FROM DISK":PRINT:
PRINT"1 - SAVE DOWNLOADED FILE FROM MEMORY TO DISK":PRINT"2 - GE
T FILE FROM DISK TO MEMORY FOR UPLOAD TRANSMISSION":PRINT:PRINT"
ENTER LINE NUMBER FOR ROUTINE DESIRED"
20 RS=INKEY$:IF RS="" OR VAL(R$)>2 OR VAL(R$)=0 THEN 20 ELSE ON
VAL(R$) GOSUB 100,200:GOTO 10
100 REM *** START OF TO-DISK SEGMENT ***
110 CLS:PRINT"MEMORY TO DISK ROUTINE":LINEINPUT"FILE NAME: ";F$:
OPEN"O",1,F$
120 INPUT"START OF FILE IN MEMORY";P
130 PRINT#1,CHR$(PEEK(P));:PRINTCHR$(PEEK(P));:P=P+1:IFPEEK(P)=0
THEN140 :ELSE130
140 RETURN
200 REM *** START OF FROM-DISK SEGMENT ***
210 CLS:PRINT"DISK TO MEMORY ROUTINE":LINEINPUT"FILE NAME: ";F$:
OPEN"I",1,F$
220 A=&H88FE:INPUT"PROGRAM WILL START AT 88FE. <ENTER> IF OK OR
ENTER DESIRED STARTING ADDRESS";A:POKEA,&HFF:A=A+1:POKEA,&H
2E:A=A+1
230 LINEINPUT#1,A$:PRINTA$:FORX=1TOLEN(A$):POKEA,ASC(MID$(A$,X,1
)):A=A+1:IFA>&HE800THENPRINT"BUFFER FULL":GOTO240 :ELSENEXTX:PO
KEA,&H0D:A=A+1:IFEOF(1)THEN240 :ELSEGOTO230
240 POKEA,&HBF:A=A+1:POKEA,&HFF
250 RETURN

```

Program Listing 2. UPDOWN/CAT

If you are going to return to modem operation, start fresh by reloading and executing Smartcat/Emterm.

Using Smartcat's other features is a matter of pressing the right keys. To obtain the telephone directory, press shift, @ followed by the unshifted @ key. The entire directory, showing each party's name and the key that will bring up his phone number, will be block transferred to the screen. To have the phone number come up when in the Emterm dialing mode, press shift, @ and then the key wanted. Press enter as usual and the Emterm function dials the number just as if you had typed it in.

The screen-dump-to-line-printer feature is useful when you do not select the Emterm function for simultaneous video and printer output, but then decide you want a printout of the current screen contents. To print the screen, press shift, @ and then the zero key. Reversing the keyboard shift for upper/lowercase is accomplished with shift, @ once again, followed by the colon key. Shift, @ and the asterisk key returns the normal keyboard. Shift, @ and the semicolon key turns on the delay feature, while shift, @ and the plus-sign key turns it off. To select the desired amount of delay, press shift, @ and then either the one, two, or three key.

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Model III Notes

For the Model III, eliminate the lines in Smartcat for lowercase display as indicated in the remarks. Uploading, downloading, the directory, and the delay feature work equally well with either the Model I or III.

If you wish to expand Smartcat, simply continue the series following FUNC12 so that a branch to your subroutine is produced at the press of shift, @ and a designated key. The accumulator is normally zeroed prior to the return from a FUNC. That action avoids printing or transmitting the character. In effect, Emterm will never know that a key was pressed.

You can also write routines to be activated upon receiving a specific character. As Emterm jumps to Smartcat at DNLOAD, the first three bytes found are the instructions originally contained in Emterm. The return at SWDN serves as an original instruction and the download switch. At that point the control is in Smartcat and the accumulator contains the last received byte, thereby providing the opportunity to devise your routine.



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When executing Emterm, with or without Smartcat, try using an entrance address of 755CH instead of 7537H so the beginning of the program is bypassed. Do that by loading but not executing Emterm, then load and execute Debug, and finally enter the program with G 755CH. You can then leave Emterm and enter Debug with the break key, and return to Emterm by entering G from Debug. This will not terminate a phone connection if there was one prior to the break. To incorporate this into Smartcat, change the jump address in Listing 1 line 160 from 7537H to 755CH.

The final note involves somewhat of

a mystery. The assembler listing for Smartcat places the end of the available download buffer considerably below the actual end of memory. It seems that Lynx causes some bit resets at certain locations in very high memory. If that problem doesn't appear in your system, then the buffer can end at the top of RAM. In any case, use only the most significant byte to designate the buffer end, as in assembler line 2710. ■

Irwin Rappaport can be reached at 24 Hemlock Hill Road, Upper Saddle River, NJ 07458.

```

5 REM *** PHONEDIR/CAT *** NOTE THAT CLEAR STRING SPACE LIMITS
NUMBER OF NEW ENTRIES THAT MAY BE MADE AT ONE TIME
10 CLEAR1000:DIM K$(55),N$(55),P$(55):CLS
20 X=0:CS="":INPUT<ENTER> TO ADD NEW LISTINGS ... OR ...
ENTER 'C' TO CHANGE A LISTING ... OR ...
ENTER 'D' TO SEE DIRECTORY";CS:IFCS="C"THEN110:ELSEIFCS="D"THEN
GOSUB500:GOTO20:ELSEIFCS<>" "THEN20
50 P=&H8540
60 IFPEEK(P)=128THEN70:ELSEP=P+1:GOTO60
70 A=55-PEEK(&H84FF):PRINT"SPACE AVAILABLE FOR";A;"ADDITIONAL PH
ONE NUMBERS":S=PEEK(&H84FF)+1
100 FORX=STO55
110 INPUT"KEY";K$(X):IFK$(X)="ANDCS<>"C"THEN150:ELSEIFLEN(K$(X)
)<>1THEN110:ELSELINEINPUT"NAME: ";N$(X):INPUT"PHONE NUMBER";P$(X
)
120 IFLEN(N$(X))=10THEN125:ELSEIFLEN(N$(X))>10THENPRINT"NAME TOO
LONG ... REDO":GOTO110:ELSEFORY=1TO10-LEN(N$(X)):N$(X)=N$(X)+"
":NEXTY
125 N$(X)=K$(X)+"-"+N$(X):P$(X)=K$(X)+P$(X):LP=LEN(P$(X)):P$(X)=
P$(X)+STRING$(11-LP,0)
127 P$(X)=P$(X)+CHR$(&HBF):IFCS="C"THENGOSUB300:GOTO20
130 NEXTX
150 FORY=STOX-1:IFK$(S)=" "THENS=0:GOTO20
155 N=Y/5
160 FORZ=1TO12:C=ASC(MID$(N$(Y),Z,1))
170 POKEP,C:P=P+1:NEXTZ:IFN<>INT(N)THENPOKEP,32:P=P+1
175 NEXTY:POKE&H84FF,X-1:POKEP,128
200 P=&H8200
210 IFPEEK(P)=255THEN220:ELSEP=P+1:GOTO210
220 FORY=STOX-1
230 FORZ=1TO12:C=ASC(MID$(P$(Y),Z,1))
240 POKEP,C:P=P+1:NEXTZ:NEXTY:POKEP,255
250 PRINT"NEW ENTRIES COMPLETE":PRINT"SAVE THE NEW SMARTCAT/EMTE
RM WITH TAPEDISK":END
300 P=&H8540:N=0:IFK$(X)=" "THENRETURN
310 IFPEEK(P)=128THEN400:ELSEIFPEEK(P)<>ASC(K$(X))THENN=N+1:IFN<
>5THENP=P+13:GOTO310:ELSEN=0:P=P+12:GOTO310
320 FORZ=1TO12:C=ASC(MID$(N$(X),Z,1))
330 POKEP,C:P=P+1:NEXTZ
340 P=&H8200
350 IFPEEK(P)<>ASC(K$(X))THENP=P+12:GOTO350
360 FORZ=1TO12:C=ASC(MID$(P$(X),Z,1))
370 POKEP,C:P=P+1:NEXTZ:RETURN
400 PRINT"KEY ";K$(X);" NOT IN DIRECTORY":RETURN
500 P1=&H8540:P2=&H8200:N=0
505 CLS:PRINT"TELEPHONE DIRECTORY PAGE";N/20+1:PRINT:PRINT:F
ORW=1TO10
510 FORY=1TO2:N=N+1
520 FORZ=1TO12
530 PRINTCHR$(PEEK(P1));:P1=P1+1:NEXTZ
540 IFN/5<>INT(N/5)THENP1=P1+1
550 PRINT" ";:P2=P2+1
560 FORZ=1TO10:PRINTCHR$(PEEK(P2));:P2=P2+1:NEXTZ:P2=P2+1:IFY=1T
HENPRINTTAB(32)" ";
570 IFN=55THENPRINT" ":GOTO580:ELSENEXTY:PRINT" ":NEXTW
580 G$="":INPUT<ENTER> FOR OTHERS ... OR ENTER 'G' TO GO ON";G
$:IFG$="G"THENPRINT@832,STRING$(60,32);:PRINT@831," ";:RETURN:EL
SEIFG$<>" "THENS=0
590 IFN<41THEN505:ELSE500

```

Program Listing 3. PHONEDIR/CAT

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by David Cecil

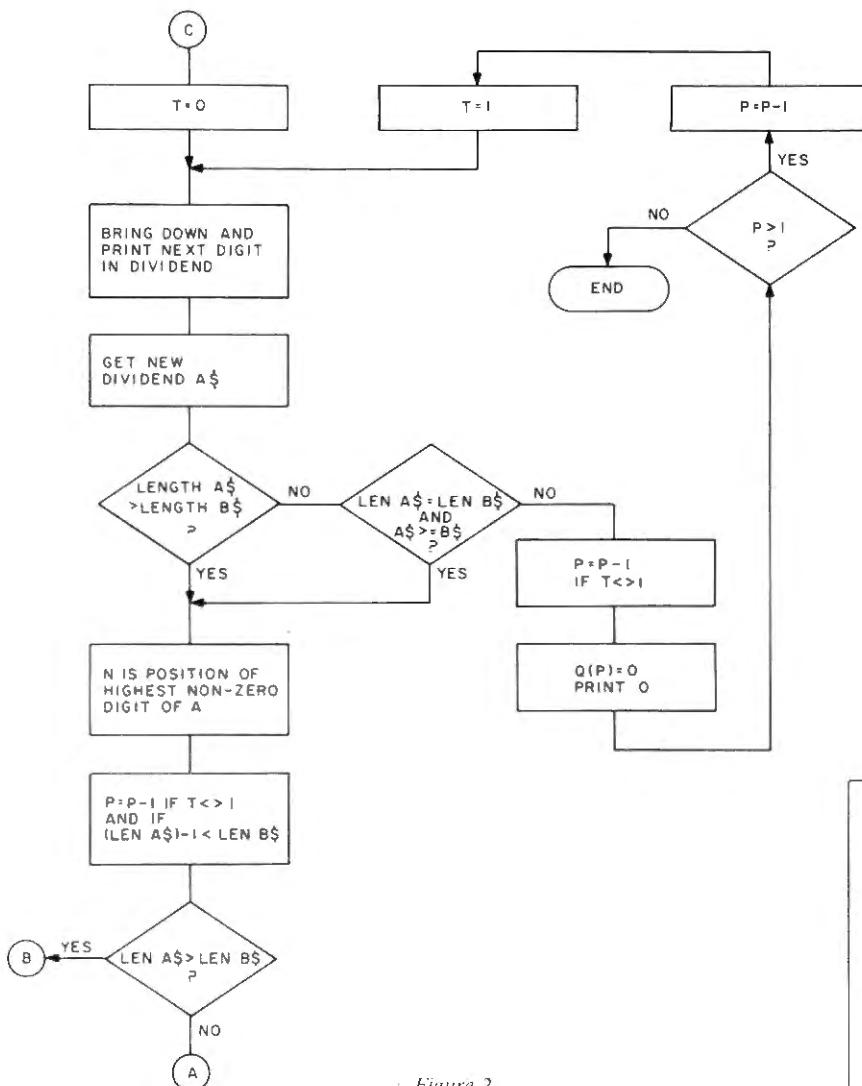


Figure 2

Teach your kids (or yourself) long division. Your Model I makes a good, patient tutor.

Remember the first elementary school teacher to torture you with long, long division problems? With this program you can have a total of 254 digits in the divisor and dividend, but for easy readability of the intermediate steps, restrict yourself to 64 digits.

The division is displayed on the screen just as on paper. The quotient appears at the top and the remainder on the last line. I chose not to draw lines after each two rows of figures. Instead, rows that would be under lines on paper begin with a zero. Figure 1 is

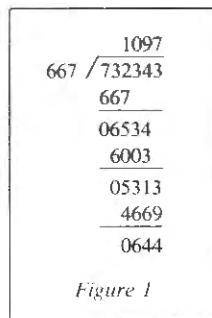


Figure 1

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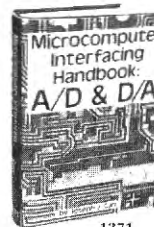
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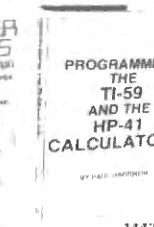
1070
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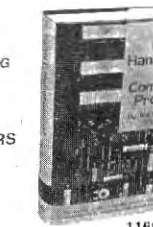
1055
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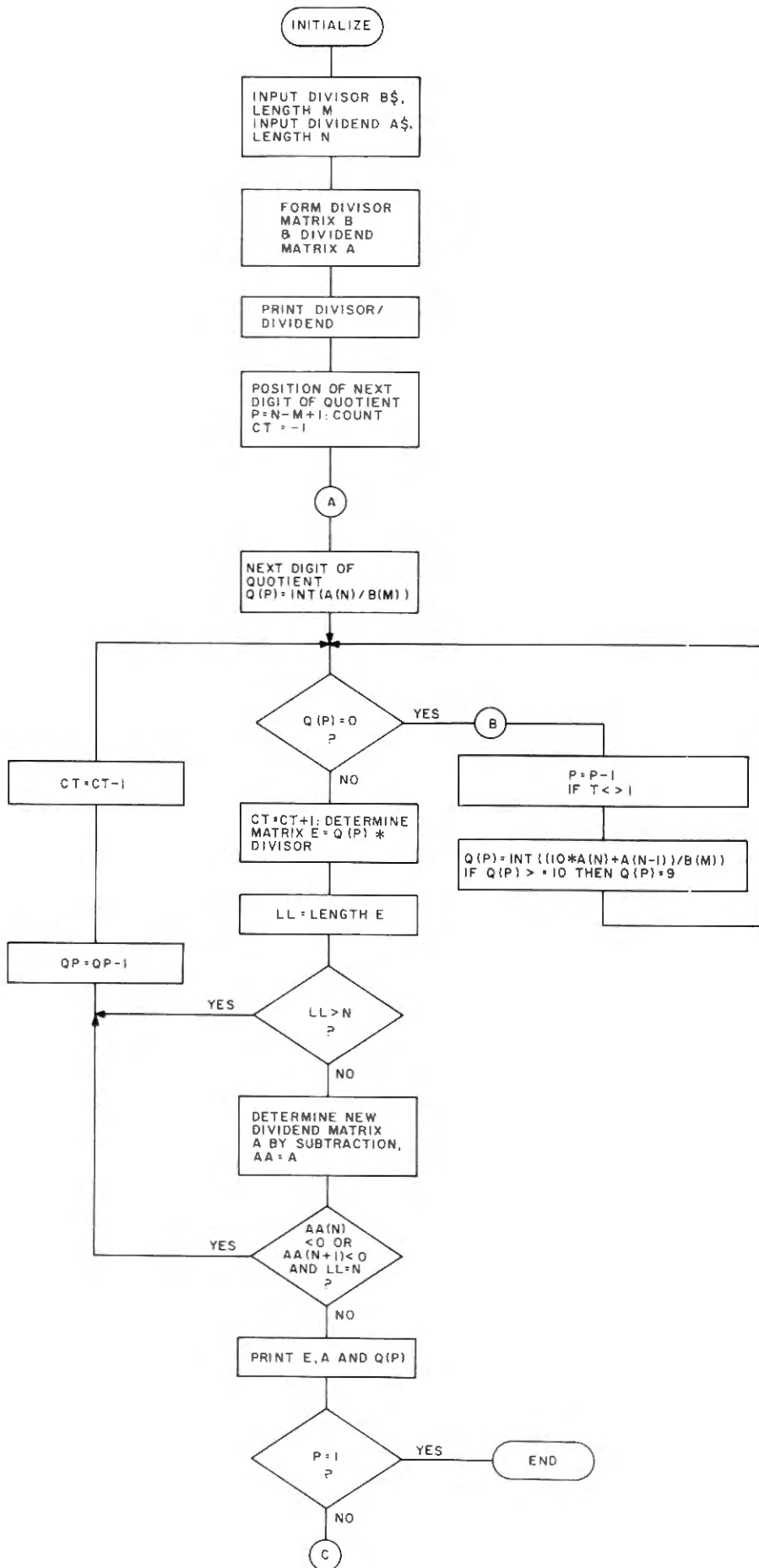


Figure 3

an example of long division.

PRINT@ statements are used to add digits to the quotient during division without scrolling the screen. If the division uses more than 14 lines of intermediate steps, the screen will scroll. We cannot scroll backward to see the quotient so the entire quotient is printed at the end whenever scrolling occurs.

The Program

After typing Run, the screen clears and prompts "Input divisor as a string, highest digit to lowest digit." After entering the divisor, a second prompt asks for the dividend.

If you enter a smaller dividend than divisor you get the error message "Illegal function call." To divide 17 into 13 use 17 for the divisor and 1300000000000 for the dividend. A word of caution: This program is not set up to handle decimals. The program will interpret a decimal as a zero; to the program 31.4 appears as 3104.

The line numbers in the Program Listing are in increments of 10. All the remark line numbers end in five; skip those lines when typing in the program. The lines have been printed for clarity but you need not indent when entering. The remark statements are keyed to the flowchart (Figs. 2 and 3) for your ease in following the program.

The divisor and dividend are entered as strings (lines 20 and 30). For arithmetic manipulations they are changed to single indexed matrices in lines 50 and 60. During solving, the dividend appears as the string A\$ (lines 330-370 and 450-480) and at other times as the matrix A (lines 100-150 and 230-280, 340).

Subtraction is performed in lines 230-280. The dividend A is put in the temporary matrix AA and line 250 does the subtraction. Borrowing is handled by line 260. If the trial quotient digit Q(P) is too large, it is reduced by one in line 270 and the multiplication-subtraction sequence (lines 110-280) is redone.

Lines 590-640 and the variable DD are only needed for scrolling.

Since most intermediate dividends begin with one or more zeros, line 460 obtains the correct length of the dividend as a string with leftmost entry nonzero.

May long division no longer haunt you in your dreams. ■

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```

5 'INITIALIZE
10 CLEAR 5000:CLS:DEFINT A-Z
20 INPUT"INPUT DIVISOR AS A STRING,HIGHEST DIGIT TO LOWES
T DIGIT";B$
30 INPUT"INPUT DIVIDEND AS A STRING,HIGHEST DIGIT TO LOWE
ST DIGIT";A$
40 NZ=LEN(A$):N=NZ:M=LEN(B$):DIM A(N+1),AA(N+1),E(N+1),B(M)
Q(N-M+1)
45 'PUT THE DIVISOR INTO MATRIX B
50 FOR I=1 TO M:B(M-I+1)=VAL(MID$(B$,I,1)):NEXT I
55 'PUT THE DIVIDEND INTO MATRIX A
60 FOR I=1 TO N:A(N-I+1)=VAL(MID$(A$,I,1)):NEXT I
70 CLS
80 PRINT@65,BS+" / "+AS;
85 'P IS THE POSITION OF THE NEXT DIGIT OF THE QUOTIENT
90 P=N-M+1:CT=1
95 'Q(P) IS THE NEXT DIGIT OF THE QUOTIENT
100 Q(P)=A(N)/B(M)
110 IF Q(P)<>0 THEN 160
120 IF T<>1 THEN P=P-1
130 Q(P)=(10*A(N)+A(N-1))/B(M)
140 IF Q(P)>=10 THEN Q(P)=9
150 GOTO 110
155 'OBTAIN THE PRODUCT OF QUOTIENT Q(P) & DIVISOR B, PUT RESULT
IN MATRIX E
160 CT=CT+1:C=0:FOR I=P TO P+M-1
170 E(I)=Q(P)*B(I-P+1)+C
180 C=E(I)/10
190 E(I)=E(I)-10*C
200 NEXT I
205 'LL IS THE LENGTH OF B
210 IF C<>0 THEN E(P+M)=C:LL=P+M:ELSE LL=P+M-1
220 IF LL>N THEN Q(P)=Q(P)-1:CT=CT-1:GOTO 110
225 'GET THE NEW DIVIDEND A BY SUBTRACTION
230 FOR J=P TO N:AA(J)=A(J):NEXT J
240 AA(N+1)=0
250 FOR J=P TO LL:AA(J)=AA(J)-E(J):K=J
260 IF K<LL AND AA(K)<0 THEN AA(K)=AA(K)+10:AA(K+1)=AA(K)
+1)-1:K=K+1:
GOTO 260
270 IF AA(N)<0 OR {AA(N+1)<0 AND LL=N} THEN Q(P)=Q(P)-1:C
T=CT-1:GOTO 110
280 NEXT J
285 'PRINT THE MATRIX E
290 AL=132+M*NZ-I+128*CT:IF AL>1023 THEN PRINT
300 FOR I=LL TO P STEP -1
310 AL=132+M*NZ-I+128*CT:GOSUB 590

```

```

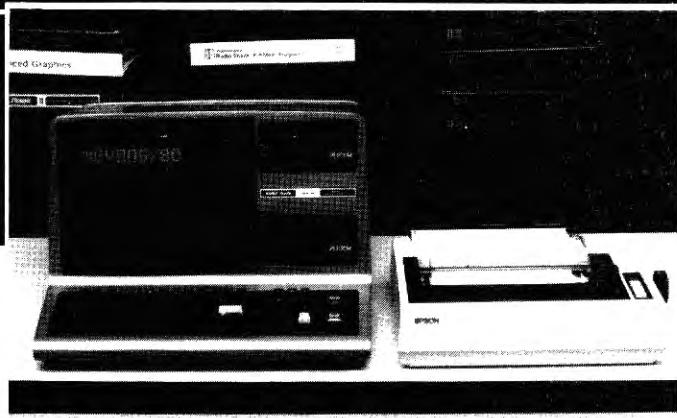
320 PRINT@AL,RIGHT$(STR$(E(I)),1);:NEXT I
325 'PRINT THE NEW DIVIDEND A
330 A$=""
340 FOR K=N TO P STEP -1:A(K)=AA(K):A$=A$+RIGHT$(STR$(A(K)
),1):NEXT K
350 A2=A1+64-LEN(A$)+1
360 GOSUB 610
370 PRINT@A2,A$;
375 'PRINT THE NEXT DIGIT OF THE QUOTIENT
380 A3=4+M*NZ-P
390 IF DD=1 THEN 410
400 PRINT@A3,RIGHT$(STR$(Q(P)),1)-
405 'BAS UNIT'S PLACE DIGIT OF QUOTIENT BEEN PRINTED?
410 IF P=1 THEN 550 ELSE T=T+1
415 'PRINT THE NEXT DIGIT IN THE DIVIDEND
420 NN=0:W=P-1
430 A4=A2+LEN(A$)+NN:GOSUB 630
440 PRINT@A4,RIGHT$(STR$(A(W)),1);
445 'COMPARE SIZE OF NEW DIVIDEND WITH DIVISOR
450 A$=A$+RIGHT$(STR$(A(W)),1)
460 Z$=LEFT$(A$,1):IF LEN(A$)=1 THEN 470 ELSE IF Z$="0"
THEN
AS=MID$(A$,2,LEN(A$)-1):NN=NN+1:GOTO
TO 460
470 IF LEN(A$)>LEN(B$) THEN 530
480 IF LEN(A$)=LEN(B$) AND A$>B$ THEN 530
485 'LOOP IF A LESS THAN B
490 IF T<>1 THEN P=P-1
500 Q(P)=0:IF DD=1 THEN 510 ELSE PRINT@4+M*NZ-P,"0";
510 IF P>1 THEN P=P-1 ELSE 550
520 T=1:W=P:GOTO 430
525 'GET POSITION OF HIGHEST NON-ZERO DIGIT OF A
530 N=N-NN:IF T<>1 AND (LEN(A$)-1)<LEN(B$) THEN P=P-1
540 IF LEN(A$)>LEN(B$) THEN 120 ELSE 100
545 'FINAL PRINTING
550 IF DD=1 THEN 560 ELSE PRINT@890,""
560 IF DD<>1 THEN END
570 PRINT:PRINT"QUOTIENT=";:FOR J=N2-M+1 TO 1 STEP -1:PRIN
T
RIGHT$(STR$(Q(J)),1);:NEXT J
580 END
585 'THE FOLLOWING LINES SCROLL THE SCREEN
590 IF AL>1023 THEN DD=1:A1=A1-64:GOTO 590
600 RETURN
610 IF A2>1023 THEN DD=1:A2=A2-64:GOTO 610
620 IF DD=1 THEN PRINT:RETURN ELSE RETURN
630 IF A4>1023 THEN DD=1:A4=A4-64:GOTO 630
640 RETURN

```

Program Listing 1

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Almazar I

by Winston Llamas

As you visit the 72 rooms of Almazar I, you'll find treasures and run into danger, and if you're lucky, you'll reach the next dimension.

Almazar Part I is the first part of a multi-part adventure known simply as Alamazar. In Part I, the adventurer's goal is to be transported into the next dimension. The game might lack the refinement of programs such as Zork, but it is more advanced than typical adventure games written in Basic. Almazar starts similarly to the original Adventure program, and it provides ample puzzles for the adventurer to solve.

The game has seventy-two rooms; some rooms are filled with treasures, while others are replete with danger. A familiarity with various books and movies will be helpful in achieving success, yet there are numerous occasions in which common sense alone can lead the adventurer out of trouble.

Almazar is divided into seven separate programs. One is the Almazar main program, which is loaded when the user wishes to play the game. The other programs create the data base necessary for the program to run. This version of Almazar was designed for a one-drive 32K Model III. The modifications needed to make the program run on a one-

drive Model I are outlined below.

Modifications

One-drive Model I owners must use two disks to hold the program (unless

the drives are either 80 tracks or the system is running double density, or both, allowing everything to fit in one disk). You must also add the line:

```
60 INPUT"REPLACE DISK AND
HIT ENTER WHEN READY";G$
```

The first disk should contain the Almazar main program as well as the SFZVOC, SFAMOVE, SFAOBDES data bases while the second disk should contain SFALDES, SFASDES, and

MO	possible moves
VC\$	command file verbs
TC\$	command file objects
VC	command verb identifier
TC	command object identifier
OP	designates location of object
LO\$	long object descriptions
SO\$	short object descriptions
LC	length of command line
V1	length of first word
C1	location of space in command
OW	indicates one word command
IV	index to verb
IO	index to object
S2	initial positions of objects
PR	points subtracted for hints
LI	turns remaining before lamp goes out
TU	number of turns remaining in the game
FT	indicates if room has been visited
SR	indicates special rooms
KG	indicates if gnome is dead
SC	flag gnome chase
W1	flag dimming lamp
W2	flag limited turns
EN	indicates if there is something to enter
LE	indicates possibility of leaving
DI	indicates how many times player has died
IN	number of items carried
PT	points adventurer scored
NF\$	name of file for long or short room descriptions
SP	special situations array

Table 1. Variable Listings and Explanations

The Key Box

Model I or III
32K RAM
Disk Basic
1 Disk Drive

“The game has 72 rooms; some rooms are filled with treasures, while others are replete with danger”

Program Listing 1. The Search for Almazar, Part 1—The Proving Ground

```
10 CLS:PRINTTAB(18)"The Search for Almazar: Part 1":PRINTTAB(24)
"The Proving Ground":PRINT
20 PRINT" This program is the first of a projected series of p
rograms
whose central theme is the continuing search for the super being
Almazar. This game, however, will play to a satisfactory ending
if the player does not wish to continue";
30 PRINT" the series.":PRINT:PRINT" The game begins at one end
of a road, by an old abandoned shack. (Just like the origin
```

Listing 1 continues

SFARESP. The Model III uses the up-
percase @ as a closing single quote, and
this must be modified for Model I use.

Almazar's design lets you change it
easily. If you want to expand the vocabu-
lary, the changes in SFAVOC and in
the main program are simple. Likewise,
all the other data bases can be altered by
changing the data-base-generating pro-
grams. A word of caution: Since the
data bases SFALDES, SFASDES, and
SFARESP are random-access files, you
must be careful to limit the text to 256
characters.

Running Almazar

The game isn't easy, since you must
gather various treasures before you
move to the next dimension. In addi-
tion, numerous traps and puzzles catch
the unwary. ■

*Winston Llamas is a student at
Rensselaer Polytechnic Institute where
he's majoring in computer science. His
address is 121 North Gordon St., Alex-
andria, VA 22304.*

Command

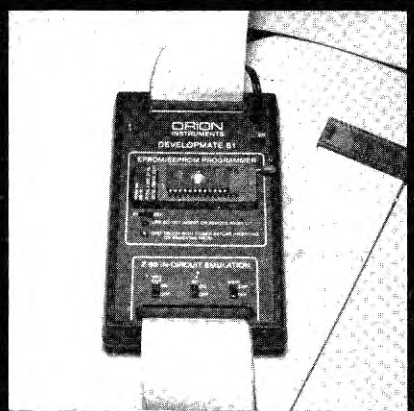
- N
- Light Lamp
- Off Lamp
- Enter
- Inventory
- Hint or Help
- Look
- Throw Knife
- Take object
- Drop object

Action

- adventurer moves northward
- lamp is lit
- lamp is turned off
- adventurer enters something
- prints objects adventurer is carrying
- asks for hints
- ask for new room description
- throws knife
- adventurer takes object
- adventurer drops object

Table 2

**CONVERT YOUR TRS-80 MODEL-I OR III INTO A
DEVELOPMENT
SYSTEM**



Now you can develop Z-80 based, stand-alone devices such as games, robots, instruments and peripheral controllers, by using your TRS-80 as a development system. The DEVELOPMATE plugs into the expansion connector of your TRS-80 and adds **PROM PROGRAMMING** and **IN-CIRCUIT-EMULATION** capabilities to your system (with or without expansion interface).

Complete instructions and sample schematics are included to help you design your own simple stand-alone microcomputer systems. THESE SYSTEMS CAN BE AS SIMPLE AS FOUR ICs: one TTL circuit for clock and reset, a Z-80, an EPROM, and one peripheral interface chip.

When the In-Circuit-Emulation cable is plugged into the Z-80 socket of your stand-alone system, the system becomes a part of your TRS-80: You can use the full power of your editor/assembler's debug and trace program to check out both the hardware and the software. Simple test loops can be used to check out the hardware, then the system program can be run to debug the logic of your stand-alone device.

Since the program is kept in TRS-80 RAM, changes can be made quickly and easily. When your stand-alone device works as desired, you use the Developmate's PROM PROGRAMMER to copy the program into a PROM. With this PROM, and a Z-80 in place of the emulation cable, your stand-alone device will work by itself.

The DEVELOPMATE is extremely compact: Both the PROM programmer and the In-Circuit-Emulator are in one small plastic box only 3.2" x 5.4". A line-plug mounted power supply is included. The PROM programmer has a "personality module" which defines the voltages and connections of the PROM so that future devices can be accommodated. However, the system comes with a "universal" personality module which handles 2758, 2508 (8K), 2716, 2516 (16K), 2532 (32K), as well as the new electrically alterable 2816 and 48016 (16K EEPROMs).

- The COMPLETE DEVELOPMATE 81, for Model I, with software, power supply, emulation cable, TRS-80 cable, and "universal" personality module \$329
- DEVELOPMATE 83, Model III version, same as above \$329
- PM2 PERSONALITY MODULE for 2732A EPROM \$15
- PM3 PERSONALITY MODULE for 2764 EPROM \$15

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Listing 1 continued

```

a1 ADVENTURE program.) The player will then explore the many di
fferent scenarios in the game. Butbe careful. There are many";
40 PRINT" traps to catch the careless and unthinking adventu
rer."
45 I$=INKEY$:IFI$<>"THEN50ELSE45
50 CLS:PRINT"The program accepts one or two word commands. Some
examples:
To take an object, type TAKE OBJECT or T OBJECT for short.
To go north, type NORTH or N for short.
To see what you're carrying, type INVE(NTORY)."
```

```

60 PRINT" Type SCORE and the program will give you your curren
t score. Type SAVE and the program will save the game for lat
er play.
Type QUIT and the game will be terminated.
To light or turn off a lamp, type LIGHT LAMP or OFF LAMP."
70 PRINT" To get a description of the room, type LOOK.":PRINT:
PRINT"Other commands include SMASH, TOSS, SHOW, CROSS, etc.":PRI
NT"In addition, one may type ENTER to enter a shack or type LEAV
E
to leave a snack. Of course, if there is no";
80 PRINT" way out you cannot leave. A hint - caves are dark and
often dangerous."
85 I$=INKEY$:I$<>"THEN90ELSE85
90 CLS:PRINT" You have a limited number of turns in which to a
ccomplish your task. If you don't finish on time, you will..
. From time to time you may need a hint, so just type HINT or H
ELP. But remember, nothing is free in ";
100 PRINT"the world today.":PRINT:PRINT" Good luck and may Alm
azar guide you to a safe journey."
105 I$=INKEY$:IFI$="THEN105ELSECLS:RUN"SFAMAIN:0"
```

Program Listing 2. Main Program

```

10 CLS:PRINT@320,CHR$(23);" The Search for Almazar":PRINTTAB
(13)"Part 1":PRINT:PRINT" Written by Winston M. Llamas":PRINT:P
RINT"c. Aug 1981 All Rights Reserved"
20 CLEAR2000:DIMFT(72),MO(72,5),VC$(53),VC(53),TC$(42),TC(42),OP
(29),LO$(29),SO$(29),SP(14)
30 OPEN"I",1,"SFAMOVE:0":FORX=1TO72:INPUT#1,RI,MO(X,0),MO(X,1),M
O(X,2),MO(X,3),MO(X,4),MO(X,5):NEXT:CLOSE1
40 OPEN"I",1,"SFAVOC:0":FORX=0TO53:INPUT#1,VC$(X),VC(X):NEXTX:FO
RY=0TO42:INPUT#1,TC$(Y),TC(Y):NEXTY:CLOSE1
50 OPEN"I",1,"SFAOBDES:0":FORX=0TO29:INPUT#1,DU,LO$(X):NEXTX:FOR
Y=0TO19:INPUT#1,DU,SO$(Y):NEXTY:FORZ=0TO29:INPUT#1,OP(Z):NEXTZ:C
LOSE1
70 CLS:N=1:GOSUB7000
100 IFRN>10ANDRN<30GOSUB7400
114 TU=TU+1:IFTU>400THENRE=74:PRINT:GOSUB7100:DI=3:GOTO7300
115 IFS$(8)=1THENSP(14)=SP(14)+1:ELSEIFSP(8)=0THENSP(14)=0
116 IFSP(2)=1THENSP(1)=SP(1)-1:IFSP(1)<1THENSP(2)=0
117 IFSP(1)<20ANDSP(2)=1ANDOP(8)=-1ANDW1<1THENRE=17:PRINT:GOSUB
7100:W1=1
118 IFS$(13)>0THENSP(13)=SP(13)+1:IFSP(13)>5THENRE=70:PRINT:GOSU
B7100:GOSUB7200:GOTO100
119 IFTU>360ANDW2<>1THENRE=16:PRINT:GOSUB7100:W2=1
```

```

121 IFRN=15THENSC=1:ELSEIFOP(23)=RNTHENSP(6)=SP(6)+1:IFSP(6)>5TH
ENIO=22:PRINT:GOSUB1800
122 IFSP(14)>7THENRE=65:PRINT:GOSUB7100:SP(14)=0:SP(8)=0:GOSUB72
00:GOTO100
123 C1=0:OW=0:PRINT:INPUTCO$:PRINT:LC=LEN(CO$):FORX=1TOLC:IFMID$(
CO$,X,1)=" THENC1=X:GOTO125:ELSENEXT
124 IFCO$=" THENRE=2:GOSUB7100:GOTO100
125 V1=C1-1:IFC1=0ORV1>4THENV1=4:ELSEOW=1
130 C1$=LEFT$(CO$,V1):FORX=0TO53:IFC1$=VC$(X)THENIV=VC(X):GOTO14
0:ELSENEXT:RE=2:GOSUB7100:GOTO100
140 IFIV>16THEN970:ELSEIFIV>6THEN190
144 IFIV=1ANDSP(7)<>2ANDRN=62THENRE=91:GOSUB7100:GOTO100
145 IFIV=1ANDRN=59ANDOP(29)<>59THENRE=1:GOSUB7100:GOTO100
150 N=MO(RN,(IV-1)):IFN=0THENRE=1:GOSUB7100:GOTO100:ELSEGOSUB700
0:GOTO100
190 ONIV-6GOSUB200,300,400,500,600,700,800,900,3300,3400:GOTO100
```

```

200 N=RN:FT(N)=0:GOSUB7000:RETURN
300 IFRN=47ORRN=43ORRN=52ORRN=63ORRN=54ORRN=61ORRN=70ORRN=69THEN
305:ELSERE=102:GOTO390
305 INPUT"THE HINT WILL COST YOU 3 POINTS. DO YOU STILL WANT IT"
;HQ$:IFLEFT$(HQ$,1)="N"THENRETURNELSEPRINT
310 IFRN=47THENRE=94
315 IFRN=63THENRE=95
320 IFRN=54THENRE=96
325 IFRN=61THENRE=97
330 IFRN=70THENRE=98
335 IFRN=69THENRE=99
340 IFRN=52THENRE=100
345 IFRN=43THENRE=101
385 PR=PR+3
390 GOSUB7100:RETURN
400 CA=0:PRINT"YOU ARE CARRYING:":FORX=0TO29:IFOP(X)=-1THENPRINT
SO$(X):CA=1
410 NEXTX:IFCA=0THENPRINT"NOTHING"
420 RETURN
500 RE=6:IFRN=27ORRN=28THENRE=43
505 IFRN=41THENRE=48
510 IFRN=43ORRN=44ORRN=49THENRE=30
520 GOSUB7100:IFRE=30THENRE=31:GOSUB7100
530 IFRE<>6THEN7200ELSERETURN
600 PT=0:FORX=0TO7:IFOP(X)=-1THENPT=PT+7
610 IFOP(X)=72THENPT=PT+10
620 NEXTX:PT=PT-(DI*10)-PR:IFRE=8THENPT=PT+10
630 PRINT"YOU HAVE SCORED ";PT;"POINTS.":RETURN
700 INPUT"ARE YOU SURE YOU WANT TO QUIT";QU$:IFLEFT$(QU$,1)<>"N"
THEN7300ELSERETURN
800 OPEN"O",1,"SFA/SAV:0":FORX=0TO29:PRINT#1,OP(X),"":NEXTX:FOR
Y=1TO72:PRINT#1,FT(Y),"":NEXTY:FORZ=0TO14:PRINT#1,SP(Z),"":NEX
TZ:PRINT#1,RN,"TU","SC","IN","PR:CLOSE1
810 PRINT"THE GAME IS NOW SAVED FOR LATER USE. TO CONTINUE THE S
AME GAME,
TYPE 'RESTORE' ON YOUR FIRST TURN AFTER YOU RESUME PLAY.":PRINT:
GOSUB600:PRINT:END
900 IFTU>1THENPRINT"IT'S TOO LATE TO RESTORE AN OLD GAME.":RETUR
N
910 OPEN"I",1,"SFA/SAV:0":FORX=0TO29:INPUT#1,OP(X):NEXTX:FORY=1T
O72:INPUT#1,FT(Y):NEXTY:FORZ=0TO14:INPUT#1,SP(Z):NEXTZ:INPUT#1,R
```

Listing 2 continues

```

N,TU,SC,IN,PR:CLOSE1:N=RN:GOSUB7000:RETURN
970 S2=C1+1:C2$=MID$(C0$,S2,4)
980 FORX=0TO42:IFC2$=TC$(X) THENIO=TC(X):GOTO990:ELSENEXTX:RE=2:G
OSUB7100:GOTO100
990 ONIV-16GOSUB1000,1100,1200,1200,1400,1500,1600,1700,1800,190
0,2000,2100,2200,2300,2400,2500,2600,2700,2800,2900,3000,3100,32
00:GOTO100
1000 IFIO>18THENRE=2:GOTO1030
1005 IFIN+1>7THENRE=83:GOTO1099
1010 IFIO=18THENIFOP(5)=RNTHENRE=3:OP(5)=-1:GOTO1098:ELSEIFOP(19
)=RNTHENRE=3:OP(19)=-1:GOTO1098
1015 IFIO<>5ANDIO<>16THEN1018:ELSEIFIO=5THENIFOP(5)=-1THENRE=7:G
OTO1099:ELSEIFOP(19)=-1THENRE=62:GOTO1099
1016 IFIO=5THENIFOP(22)=RNTHENIFOP(18)=-1THENRE=3:OP(22)=0:OP(18
)=0:OP(5)=-1:GOTO1099:ELSERE=60:GOTO1099
1017 IFIO=16THENIFOP(16)=RNTHENIFSP(3)=1THENRE=3:OP(16)=-1:GOTO1
098:ELSERE=18:GOTO1099
1018 IFIO=1ANDOP(20)=RNTHENRE=23:GOSUB7100:GOTO7200
1020 IFOP(10)=RNTHENRE=3:OP(10)=-1:ELSEIFOP(10)=-1THENRE=7ELSERE
=4
1030 IFIO=28THENIFOP(8)<>-1THENRE=63:ELSEIFRN<>8THENRE=71:ELSERE
=3:SP(1)=100
1040 IFIO=5THENIFOP(5)=-1OROP(19)=-1THENRE=62:ELSEIFOP(18)<>-1T
HENRE=60:ELSEIFRN<>43ANDRN<>44ANDRN<>49THENRE=4:ELSERE=3:OP(18)=
0:OP(19)=-1
1045 IFIV=22THENIFRE=60THENRE=77:ELSEIFRE=4THENRE=78
1046 IFIV=22ANDRE=71THENRE=78
1050 IFIO=7ANDOP(26)=RNTHENOP(7)=-1:OP(26)=0:RE=3
1060 IFIO=27THENIFRN=32THENRE=9ELSERE=4
1070 IFIO=25THENIFRN=65THENRE=9ELSERE=4
1080 IFIO=2ANDOP(23)=RNTHENRE=93
1085 IFIO=31THENIFRN=69THENRE=9ELSERE=4
1086 IFIO=19THENIFRN=52THENRE=9ELSERE=4
1090 IFIO=3ANDOP(24)=RNTHENRE=61
1098 IFRE=3ANDIO<19THENIN=IN+1
1099 GOSUB7100:RETURN
1100 IFIO<19ORIO=29THEN1105:ELSERE=2:GOTO1199
1105 IFOP(10)=-1ANDIO<>7THENOP(10)=RN:RE=3:ELSERE=5
1106 IFIO=16ANDRE=3THENRE=66:SP(3)=0
1110 IFIO=18ANDOP(5)=-1THENOP(5)=RN:RE=3:GOTO1140
1120 IF(10=18ORIO=29)ANDOP(19)=-1THENOP(19)=RN:RE=3
1130 IFIO=7ANDOP(10)=-1THENIFOP(14)=RNTHENRE=3:OP(7)=RN:ELSERE=7
5:OP(7)=0:IN=IN-1
1140 IFRE=3THENIN=IN-1
1199 GOSUB7100:RETURN
1200 IFIO>18THENRE=2:GOTO1299
1210 IFOP(10)=-1THENRE=6:ELSERE=5:GOTO1299
1220 IFIV=19AND(RN=43ORRN=44)ANDIO=12THENSP(8)=ABS(SP(8)-1):IFSP
(8)=1THENRE=28ELSERE=29
1230 IFIV=19AND(RN=27ORRN=28)ANDIO=11THENSP(9)=ABS(SP(9)-1):IFSP
(9)=1THENRE=35ELSERE=36
1240 IFIV=20ANDIO=10THENGOSUB1300
1299 GOSUB7100:RETURN
1300 IFRN=61ANDSP(5)=0THENSP(5)=1:RE=22:GOSUB7100:RE=25:PRINT:OP
(2)=RN:OP(23)=0:RETURN
1400 RE=4:IFRN=25ANDIO=26THENRE=34
1410 IFRN=32ANDIO=26THENRE=37
1420 IFRN=43ANDIO=35THENRE=32
1430 IFRN=44ANDIO=26THENRE=67

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1440 IFRN=65ANDIO=25THENIFSP(10)=1THENRE=38ELSERE=44
1450 IFRN=70ANDIO=26THENRE=33
1454 IFIO<>26ANDIO<>25ANDIO<>35THENRE=2
1455 IFRN<>70ORIO<>26THEN1460
1456 FORX=0TO7:IFOP(X)<>72THEN1460
1457 NEXTX:IFOP(10)=-1THENRE=8:GOSUB7100:GOTO7300
1460 GOSUB7100:IFRE=44THEN7200
1470 RETURN
1500 IFIO=8THENIO=28:GOTO1000
1510 IFIO=18THENIO=29:GOTO1000
1520 RE=2:GOSUB7100:RETURN
1600 RE=2:IFIO<>8ANDIO<>13THEN1690
1605 IFSP(2)=1ANDIO=8THENRE=82:GOTO1690
1610 IFOP(10)<>-1THENRE=5:GOTO1690
1620 RE=2:IFIO=8ANDSP(1)<1THENRE=13:GOTO1690
1630 IFOP(17)<>-1THENRE=12:GOTO1690
1640 IFIO=8THENRE=3:SP(2)=1:SP(13)=0:ELSEOP(13)=0:IN=IN-1:IFRN=5
2THENOP(20)=0:OP(1)=RN:RE=24:ELSERE=3
1690 GOSUB7100:RETURN
1700 RE=6:IFIO=20ORIO=22ORIO=36ORIO=27THEN1705:ELSERE=2:GOTO1690

1705 IFIO=36THENIFOP(21)<>RNTHENRE=4
1706 IFIO=20ANDOP(24)<>RNTHENRE=4
1707 IFIO=22ANDOP(23)<>RNTHENRE=4
1708 IFRE=4THEN1690
1710 INPUT"WITH WHAT, YOUR BARE HANDS";QU$:IFLEFT$(QU$,1)="#N"THE
N1750
1720 IFIO=20THENRE=21
1730 IFIO=22THENRE=45
1740 IFIO=36THENRE=81
1745 IFIO=27THENRE=11
1750 PRINT:GOSUB7100:IFRE<>21ANDRE<>45THENRETURNELSE7200
1800 RE=2:IFIO=27THENIFOP(25)=RNTHENRE=10ELSERE=4
1810 IFIO=22ANDOP(23)=RNTHENSP(6)=0:RE=45:GOSUB7100:GOTO7200
1811 IFIO>19THEN1820
1815 IFOP(10)<>-1THENRE=5:ELSEIFOP(10)<>RNTHENRE=4
1816 IFOP(10)=-1THENOP(10)=RN:RE=3:IN=IN-1
1820 GOSUB7100:RETURN
1900 RE=6:IFIO>18ANDIO<>27THENRE=2:GOTO1960
1910 IFIO=27THENIFOP(25)=RNTHEN1710ELSERE=4:GOTO1960
1920 IFIO=7ANDOP(7)=-1THENRE=75:OP(7)=0
1930 IF(10=18ORIO=5)ANDOP(5)=-1THENRE=84:GOSUB7100:PRINT:RE=73:O
P(5)=0:IN=IN-1:GOTO1960
1940 IFIO=18ANDOP(19)=-1THENOP(19)=0:IN=IN-1:RE=84
1950 IFOP(10)<>-1THENRE=5
1955 IFIO=18ANDOP(18)=-1THENIN=IN-1:OP(18)=0:RE=84
1960 GOSUB7100:RETURN
2000 RE=2:IFIO>18THEN2099
2010 IFIO=18ORIO=5THEN1900
2020 IFOP(10)<>-1THENRE=5:GOTO2099:ELSERE=3:IN=IN-1:OP(10)=RN:IF
(10=6ANDOP(21)=RN)THEN2030:ELSE2099
2030 KG=RND(0)-(IN*.01):IFKG>.4THENPRINT"YOU KILLED A NASTY, KNI
FE THROWING GNOME!":OP(21)=0:ELSEPRINT"YOU MISSED! YOU OUGHT TO
GET YOU EYES EXAMINED."
2040 RETURN
2099 GOSUB7100:RETURN
2100 RE=19:IFIO<>5THEN2110:ELSEIFOP(5)=-1OROP(5)=RNTHENRE=40:OP(
5)=0:OP(18)=-1:GOTO2199
2101 IFOP(5)=RNTHENRE=40:OP(5)=0:OP(18)=RN
2105 IFOP(22)=RNTHENOP(22)=0:RE=40:GOTO2199

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Listing 2 continued

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2110 IFIO=15THENIFOP(15)=-1THENOP(15)=0:IN=IN-1:RE=80:ELSEIFOP(1
5)=RNTHENOP(15)=0:RE=80
2120 IFIO=16THENIFOP(16)=-1THENRE=41:IN=IN-1:OP(16)=0:GOSUB7100:
GOTO7200:ELSEIFOP(16)=RNTHENRE=66
2199 GOSUB7100:RETURN
2200 RE=5:IFIO<>29THENRE=2:GOTO2199
2210 IFOP(19)=-1THENRE=56:OP(19)=0:OP(18)=-1
2215 IFOP(19)=RNTHENRE=56:OP(19)=0:OP(18)=RN
2220 IFRN=43ORRN=44ORRN=49THENRE=56
2230 GOTO2199
2300 IFIO<>16ANDIO<>20THENRE=2:GOTO2199
2310 IFIO=16THENIFOP(16)<>RNTHENRE=4:GOTO2199:ELSEIFOP(15)=-1THE
NSP(3)=1:RE=3:GOTO2199:ELSERE=19:GOTO2199
2320 IFOP(24)<>RNTHENRE=4:GOTO2199:ELSEIFOP(16)<>-1THENRE=19:GOT
O2199
2330 IN=IN-1:OP(24)=0:RE=20:GOSUB7100:OP(16)=0:RE=26:PRINT:OP(3)
=RN:GOTO2199
2400 RE=6:IFIO>18ANDIO<>24THENRE=2:GOTO2199
2410 IFIO<>24THEN2199:ELSEIFRN<>59THENRE=4:GOTO2199
2415 IFOP(29)=59THENRE=85:OP(29)=0:GOTO2199
2420 RE=72:OP(29)=59:GOTO2199
2500 IFIO<>30ANDIO<>31ANDIO<>32THENRE=2:GOTO2199
2501 IFIO=30ANDRN=62THEN2530
2505 RE=4:IFIO=32ANDRN=66THENIFOP(9)=-1THENSP(11)=1:RE=3:ELSERE=
14
2510 IFIO=31ANDRN=69THENIFOP(9)=-1THENRE=3:SP(12)=1:ELSERE=14
2520 GOTO2199
2530 INPUT"LEFT";N1$:INPUT"RIGHT";N2$:INPUT"LEFT";N3$:PRINT
2540 IFVAL(N1$)=3ANDVAL(N2$)=7ANDVAL(N3$)=21THENRE=87:SP(7)=1:EL
SERE=89
2550 GOTO2199
2600 RE=2:IFIO<>21ANDIO<>23THEN2199
2610 RE=4:IFIO=21THENIF(RN<>27ANDRN<>28)THEN2199:ELSEIFSP(9)=0TH
ENRE=42:GOTO2199
2620 IFIO=23THENIF(RN<>43ANDRN<>44)THEN2199:ELSEIFSP(8)=0THENRE=
27:GOTO2199
2630 IFRN=43THENN=44:ELSEIFRN=44THENN=43
2640 IFRN=27THENN=28:ELSEIFRN=28THENN=27
2650 GOTO7000
2700 RE=2:IFIO<>23ANDIO<>29THEN2720
2710 IFRN=43ORRN=44ORRN=49THENRE=31:ELSERE=57
2720 GOSUB7100:IFRE=31THEN7200:ELSE:RETURN
2800 IFIO<>30ANDIO<>31ANDIO<>32ANDIO<>33THENRE=2:GOTO2899
2810 RE=4:IFIO<>30THEN2820:ELSEIFRN<>62THEN2899:ELSEIFSP(7)<1THE
NRE=88:GOTO2899:ELSEIFSP(7)=2THENRE=68:GOTO2899:ELSERE=3:SP(7)=2
:GOTO2899
2820 IFIO=31ANDRN=69THENIFSP(12)<1THENRE=86:ELSEIFSP(12)=2THENRE
=68:ELSERE=39:SP(12)=2
2830 IFIO=32ANDRN=66THENIFSP(11)<1THENRE=86:ELSEIFSP(11)=2THENRE
=68:ELSESP(11)=2:IFOP(4)=0THENOP(4)=RN:RE=76:ELSERE=3
2840 IFIO=33THENIFRN<>65THEN2899:ELSEIFSP(10)=1THENRE=3:SP(10)=0
:OP(27)=RN:OP(28)=0:ELSERE=68
2899 GOSUB7100:RETURN
2900 IFIO<>30ANDIO<>31ANDIO<>32ANDIO<>33THENRE=2:GOTO2899
2910 RE=4:IFIO=30ANDRN=62THENIFSP(7)=0THENRE=69:ELSERE=3:SP(7)=0

2920 IFIO=31ANDRN=69THENIFSP(12)=0THENRE=69:ELSERE=3:SP(12)=0
2930 IFIO=32ANDRN=66THENIFSP(11)=0THENRE=69:ELSERE=3:SP(11)=0
2940 IFIO=33ANDRN=65THENIFSP(10)=1THENRE=69:ELSERE=3:SP(10)=1:OP

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(27)=0:OP(28)=RN
2950 GOTO2899
3000 IFIO<>8THENRE=2:GOTO2899
3010 IFOP(10)<>-1THENRE=5ELSEIFSP(2)<>0THENSP(2)=0:RE=3:ELSERE=9
2
3020 GOTO2899
3100 RE=6:IFIO>18ANDIO<>34THENRE=2:GOTO3199
3110 IFIO<>34THEN3199
3120 IFRN<>60THENRE=4:GOTO3199:ELSERE=79:N=61
3199 GOSUB7100:IFRE<>79THENRETURN:ELSEPRINT:GOTO7000
3200 IFIO<>18THENRE=2:GOTO2899
3205 RE=5:IFOP(18)=-1THENRE=90
3210 IFOP(5)=-1THENOP(5)=0:OP(18)=-1:RE=73
3220 IFOP(19)=-1THENRE=3:OP(19)=0:OP(18)=-1
3230 GOTO2899
3300 EN=0:IFRN=10ORRN=10ORRN=55THENN=RN+1:EN=1
3305 IFRN=62THENIFSP(7)=2THENN=72:EN=1:ELSERE=91:GOTO2199
3310 IFRN=31THENN=33:EN=1
3320 IFRN=51THENN=70:EN=1
3330 IFEN=0THENRE=58:GOSUB7100:ELSEGOSUB7000
3340 RETURN
3400 LE=0:IFRN=20ORRN=11ORRN=56THENN=RN-1:LE=1
3410 IFRN=33THENN=31:LE=1
3420 IFRN=70THENN=51:LE=1
3425 IFRN=72THENN=62:LE=1
3430 IFLE=0THENRE=59:GOSUB7100:ELSEGOSUB7000
3440 RETURN
7000 IF((RN=43ANDN=44)OR(RN=44ANDN=43))ANDSP(8)=0THENRE=27:GOSUB
7100:N=RN:RETURN
7001 IF((RN=27ANDN=28)OR(RN=28ANDN=27))ANDSP(9)=0THENRE=42:GOSUB
7100:N=RN:RETURN
7002 IFRN=61ANDN<>61ANDIV=1ANDSP(5)=0THENRE=64:GOSUB7100:N=RN:RE
TURN
7003 IFRN=67ANDN=71ANDSP(5)=0THENRE=1:GOSUB7100:N=RN:RETURN
7004 SR=0:IF((N>11ANDN<>15ANDN<30)OR(N>32ANDN<39))THENSR=1
7005 IFSR=0THEN7009
7006 IFSR(2)=LAND(OP(8)=-1OROP(8)=N)THEN7009:ELSERE=15:GOSUB7100
:IFSR(13)=0THENSP(13)=1
7007 RN=N:N=0:RETURN
7009 IFPT(N)=0THENNF$="SFALDES:0"ELSENF$="SFASDES:0"
7010 OPEN"R",1,NF$:FIELD1,255ASDES:GET1,N:CLOSE1:SP(13)=0
7015 FORX=1TO255:IFMID$(DES,X,1)=" "THEN7040
7030 PRINTMID$(DES,X,1);NEXTX
7040 PRINT:RN=N:PT(N)=1:N=0:IFRN=41ANDVO=0THENRE=55:PRINT:GOSUB7
100:VO=1
7050 FORX=0TO29:IFOP(X)=RNANDX<>21THENPRINT:PRINTLO$(X)
7060 NEXTX:RETURN
7100 OPEN"R",1,"SFARESP:0":FIELD1,255ASRES:GET1,RE:CLOSE1:FORX=1
TO255:IFMID$(RES,X,12)=" "THEN7110:ELSEPRINTMID$(RES,
X,1);NEXTX
7110 PRINT:RETURN
7200 DI=DI+1:IFDI=3THENRE=49:PRINT:GOSUB7100:GOTO7300
7205 PRINT:INPUT"DO YOU WANT ANOTHER CHANCE";QU$:IFLEFT$(QU$,1)<
>"Y"THEN7300
7210 IN=0:PRINT:RE=DI+45:GOSUB7100:FORX=0TO18:IFOP(X)=-1THENOP(X
)=INT(RND(15))
7220 NEXTX:OP(8)=4:OP(17)=6:OP(12)=42:N=1:SP(2)=0:SP(8)=0:SP(14)
=0:SC=0:PRINT:GOSUB7000:RETURN
7300 PRINT:GOSUB600:RE=50:IFPT>7THENRE=51

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Listing 2 continues

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7320 IFPT>35THENRE=52
7330 IFPT>79THENRE=53
7340 IFPT=90THENRE=54
7350 PRINT:GOSUB7100:PRINT:END
7400 IFSC=0THENRETURN
7410 IFOP(21)=0THENOP(21)=INT(RND(35))
7420 IFOP(21)>RNTHENOP(21)=OP(21)-1
7425 IFOP(21)<RNTHENOP(21)=OP(21)+1
7430 IFOP(21)<>RNTHENRETURN
7440 PRINT:PRINTLOS(21):RA=RND(0)+(IN*.01):IFRA>.7THENPRINT:PRIN
T"HE THROWS A SMALL KNIFE AT YOU!":PRINT:IFRA>.9THENPRINT"IT GET
S YOU!":GOTO7200:ELSEPRINT"IT MISSES YOU!"
7450 RETURN

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Program Listing 3

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10 OPEN"O",1,"SFAMOVE:0"
20 FORX=1TO72:READN1,N2,N3,N4,N5,N6
30 PRINT#1,X,"N1","N2","N3","N4","N5","N6:NEXTX:CLOSE1
40 DATA7,2,0,3,0,0,0,0,1,0,0,6,1,0,4,0,0,5,3,0,0,0,0,0,6,4,0,0
,0,0,0,3,5,0,0,9,8,1,0,0,0,32,0,0,7,0,0,30,0,7,10,0,0,0,9,0,11,0
,0,0,10,12,29,0,0,11,0,13,0,0,0
50 DATA12,0,0,14,0,0,0,13,0,15,0,0,0,14,16,17,0,0,15,0,0,0,28,0
,0,15,0,18,0,0,18,18,19,23,18,18,18,19,19,20,19,17,21,19,20,22,20
,20,0,0,20,0,0,0,23,20,22,22,22,22,23,18,22,23,24,23,0,25,23,0,0
,0
60 DATA0,26,0,24,0,0,27,29,0,25,0,0,28,0,26,0,0,0,0,27,0,0,16
,0,11,0,26,0,0,39,31,9,0,0,0,0,33,32,30,0,0,31,0,8,0,0,0,38,36,34
,31,33,33,33,35,34,34,34,34,34,36,35,35,34,35,35,37,36,35,33,36,36
70 DATA37,37,36,38,37,37,38,37,33,38,38,38,40,0,0,30,0,0,0,43,41,3
9,0,0,0,42,0,40,0,0,0,0,41,0,0,44,0,40,0,0,45,0,43,0,0,0,5
,0,46,44,48,0,0,0,47,0,45,0,0,54,0,0,46,0,0,51,45,49,0,0,0
80 DATA48,0,0,0,0,55,53,45,51,0,0,70,50,48,52,0,0,0,51,0,0,0,0
,0,54,0,50,0,0,0,47,53,0,0,56,0,50,0,0,0,63,59,55,57,0,0,58,56
,0,0,0,0,0,0,51,0,0,0,60,0,0,56,0,0,0,0,59,0,0,0
90 DATA62,0,0,0,0,72,71,61,0,0,0,0,56,0,64,0,0,65,0,66,68,63
,0,0,0,64,0,0,0,64,67,0,0,0,66,0,0,0,71,0,0,0,69,0,64,0,68,0,0
,0,0,0,0,51,0,0,0,0,62,67,0,0,0,62,0,0,0

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Program Listing 4

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10 OPEN"R",1,"SFALDES:0"
20 FORX=1TO72:READDE$:FIELD1,255ASD$:LSETD$=DE$:PUT1:NEXTX
30 CLOSE1
100 DATAYOU ARE STANDING AT AN ENTRANCE TO AN OLD ABANDONED SHAC
K. TO THE WEST IS A ROCKY PATH. A ROAD GOES NORTH.
110 DATAYOU ARE INSIDE AN OLD SHACK. THERE IS A DOOR TO THE WEST
.
120 DATAYOU ARE STANDING AT THE EDGE OF A ROCK STREWN PATH. THE
PATH CONTINUES EAST. SMALL WALKS LEAD TO THE NORTH AND WEST.

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130 DATAYOU ARE IN A FOREST.
140 DATAYOU ARE IN A FOREST.
150 DATAYOU ARE IN A FOREST.
160 DATAYOU ARE IN THE MIDDLE OF A ROAD. THE ROAD CONTINUES TO T
HE NORTHAND SOUTH. A SMALL PATH LEADS EASTWARD.
170 DATAYOU ARE ON THE EDGE OF A MURKY POOL. A DARK LIQUID IS FL
OATING ON TOP OF THE POOL. THERE IS A SMALL PATH FROM THE NORTH
. A SMALL WALK LEADS WEST.
180 DATAYOU ARE IN A THREE WAY JUNCTION. A ROAD GOES NORTH AND S
OUTH. THERE IS A PASSAGE LEADING WEST.
190 DATAYOU ARE AT AN ENTRANCE TO A SMALL CAVE. A SMALL NARROW H
OLE IS WEST. A PASSAGE LEADS EAST. ON TOP OF THE HOLE A SIGN RE
ADS 'BEWARE BRAVE ADVENTURER. FOR IT IS THE SMALL THINGS IN
LIFE THAT SO OFTEN DESTROYS IT.'
200 DATAYOU ARE INSIDE A CAVE. LIGHT FILTERS THROUGH FROM THE EA
ST. A SMALL PATH LEADS WEST. A SMALLER PATH LEADS SOUTH.
210 DATATHE PATH IS FULL OF BROKEN ROCKS. THE PATH CONTINUES TO
THE NORTH AND SOUTH.
220 DATAYOU ARE INSIDE A SMALL CAVERN. SCATTERED THROUGHOUT THE
ROOM ARETHE REMAINS OF LESS FORTUNATE ADVENTURERS. A PATH LEADS
NORTH. A PASSAGE LEADS WEST.
230 DATAYOU ARE IN A LONG HALL EXTENDING EAST AND WEST.
240 DATAYOU ARE IN A ROOM LIGHTED BY A SIGN THAT SAYS 'GNOMES NE
ED FEW TOOLS TO DO THEIR DIRTY DEEDS.' PASSAGES LEAD EAST AND W
EST. A SMALL PATH LEADS SOUTH.
250 DATATHIS IS THE TOOL ROOM. STREWN ALL OVER THE FLOOR ARE SMA
LL KNIVES WHICH DISAPPEAR TO THE TOUCH. A PASSAGE IS NORTH.
A WALK LEADS UP.
260 DATAYOU ARE IN A LONG CORRIDOR LEADING EAST AND WEST.
270 DATAYOU ARE IN A TWISTY LITTLE MAZE OF PASSAGES.
280 DATAYOU ARE IN A MAZE OF TWISTY LITTLE PASSAGES.
290 DATAYOU ARE IN A MAZE OF TWISTY LITTLE PASSAGES.
300 DATAYOU ARE AT A DEAD END.
310 DATAYOU ARE IN A MAZE OF TWISTY LITTLE PASSAGES.
320 DATAYOU ARE IN A LITTLE MAZE OF TWISTY PASSAGES.
330 DATAA TALL WALL RISES ABOVE YOU. YOU ARE NEARLY ENCIRCLED BY
LARGE UNCLIMBABLE CANYONS. THE ONLY EXITS LEAD SOUTH AND EAST.
340 DATAYOU ARE IN A LONG HALL. ENGRAVED ON THE ROCKS IS A MESSA
GE. EXITS LEAD EAST AND WEST.
350 DATAYOU HAVE COME TO A PLACE WHERE THREE PATHS MEET. A SMALL
PATH LEADS NORTH. LARGER PATHS LEAD EAST AND WEST.
360 DATAA BROAD CHASM SEPARATES YOU FROM A LEDGE IN THE NORTH. A
SMALL PATH LEADS SOUTH.
370 DATAYOU ARE IN A SMALL NARROW LEDGE. THERE IS A CAVERN ACROS
S THE CHASM IN THE SOUTH. A WALK LEADS DOWN.
380 DATAYOU ARE IN AN EXTREMELY NARROW PART OF THE CAVE. EXITS L
EAD EASTAND WEST.
390 DATAYOU ARE IN A 'T.' A LARGE PATH LEADS EAST. A ROAD CONTIN
UES TO THE NORTH AND TO THE SOUTH.
400 DATAYOU ARE AT AN ENTRANCE TO AN OLD ABANDONED MINE. A SMALL
PATH LEADS SOUTH. A LARGE PATH LEADS WEST.
410 DATAYOU ARE STANDING BY A LARGE OAK TREE. ENGRAVED ON THE BA
RK IS A MESSAGE. PATHS LEAD NORTH AND SOUTH.
420 DATAYOU ARE INSIDE A MINE. THERE ARE PASSAGES IN EVERY DIREC
TION.
430 DATAYOU ARE INSIDE A MINE. PATHS LEAD TO ALL DIRECTIONS.
440 DATAYOU ARE INSIDE A MINE. PATHS LEAD TO ALL DIRECTIONS.
450 DATAYOU ARE INSIDE A MINE. PATHS LEAD TO ALL DIRECTIONS.

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Listing 4 continued

460 DATAYOU ARE INSIDE A MINE. PATHS LEAD TO ALL DIRECTIONS.
 470 DATAYOU ARE INSIDE A MINE. PASSAGES LEAD TO ALL DIRECTIONS.
 480 DATAYOU'RE IN A ROAD. A COLD WIND BLOWS INTO YOUR FACE. IT SEEMS TO SAY 'LUCK DOESN'T RUN FOREVER.' THE ROAD CONTINUES TO THE NORTH AND TO THE SOUTH.
 490 DATATHE ROAD GROWS SMALLER. TO THE EAST IS A SELDOM USED GRAVEL PATH. THE ROAD CONTINUES NORTHWARD AND SOUTHWARD.
 500 DATAYOU HAVE CLIMBED UP A HILL. THE VIEW IS SPECTACULAR (AS ONE WOULD EXPECT). SHARP ROCKS PROTRUDE FROM THE BASE OF THE HILL. BEYOND A RIVER A STRANGE HOUSE CAN BE SEEN. THE SILENCE HERE IS UNCANNY. PATHS LEAD EAST AND WEST.
 510 DATATHE GRAVEL PATH ENDS. A LARGE ROCK MARKS THIS SPOT.
 520 DATAYOU ARE AT THE RIVERS' SOUTHERN EDGE. THERE IS A SMALL SIGN ON THE SHORE. A ROAD GOES SOUTH.
 530 DATAYOU ARE AT THE RIVERS' NORTHERN EDGE. A LARGE SIGN SAYS 'WELCOME TO YOUR DEATH.' BELOW THE SIGN (SCRIBBLED IN RED) IS A MESSAGE. A ROAD GOES NORTH.
 540 DATAYOU ARE AT A CROSSROADS. A ROAD GOES NORTH AND SOUTH. EXITS LEAD EAST AND WEST.
 550 DATATHE GROUND HERE IS LITTERED BY LARGE HOLES. THERE ARE PATHS LEADING EAST AND WEST.
 560 DATAYOU ARE STANDING NEAR AN OLD STABLE. A SIGN READS 'OLD ODDORS NEVER DIE...THEY JUST ACCUMULATE.' PATHS LEAD NORTH AND WEST.
 570 DATATHE ROAD ENDS HERE. SMALL PATHS LEAD NORTH AND SOUTH. A ROAD GOES TO THE EAST.
 580 DATAYOU ARE AT THE RIVERFRONT. UPON THE SHORE YOU SEE THE BONES OF UNSUCCESSFUL RIVER CROSSERS. A PATH LEADS NORTH.
 590 DATAYOU ARE STANDING BY A LARGE GARGOYLE STATUE. IT SEEMS TO BE STARING AT YOU. INSCRIBED AT ITS BASE IS THE NUMBER 13. A ROAD GOES SOUTH. EXITS LEAD EAST AND WEST. A HOUSE IS NORTH.
 600 DATAYOU ARE OUTSIDE AN outhouse. A PATH LEADS SOUTH. OTHER PATHS LEAD EAST AND WEST.
 610 DATAA LARGE STONE IDOL STANDS IN FRONT OF YOU. THERE IS A SMALL CHARRED PIT IN FRONT OF THE IDOL. A PATH LEADS EAST.
 620 DATAYOU ARE IN A GARDEN. HALF A DOZEN FRESHLY PICKED CARROTS ARE LYING ON THE GROUND. AN ORCHARD IS EAST. A PATH LEADS WEST.
 630 DATAYOU ARE IN AN ORCHARD. SURROUNDED BY A FLOOD OF ORANGES IS ONE SOLITARY APPLE TREE. A PATH LEADS WEST. ANOTHER PATH GOES SOUTH.
 640 DATAYOU ARE AT AN ENTRANCE TO AN ODD LOOKING HOUSE. IN THE MAILBOX IS A LETTER MARKED 'C/O WIZARD OF OZ.' A WALK LEADS SOUTH.
 650 DATAYOU ARE INSIDE THE HOUSE. A LARGE DOOR IS TO THE SOUTH. A LARGE HALLWAY CONTINUES NORTH. THERE IS AN ARCHED DOOR TO THE EAST. A SMALL DOORWAY IS WEST.
 660 DATATHIS IS THE DINING ROOM. IT LOOKS LIKE SOMEBODY IS EXPECTING GUESTS. THERE ARE SEVEN PLATES ON THE TABLE. A DOOR IS NORTH. A DOORWAY IS EAST.
 670 DATATHIS IS THE KITCHEN. A BIG POT OF BOILING WATER IS OVER A WOOD STOVE. A DOOR IS SOUTH.
 680 DATAYOU ARE IN THE LIVING ROOM. A SMALL STATUE WITH A ROUND HEAD IS SITTING ON A TABLE. A LARGE DOORWAY IS WEST.
 690 DATAYOU ARE IN A SMALL HIDDEN ROOM. A ROPE HANGS FROM THE CEILING. THERE IS AN OPEN PANEL TO THE SOUTH.
 700 DATAYOU ARE IN THE BASEMENT. A CORRIDOR LEADS NORTH.
 710 DATAA LARGE COMBINATION VAULT IS STANDING IN FRONT OF YOU. A SIGN ON TOP OF THE VAULT SAYS 'DEPOSIT TREASURES INSIDE THE VAULT FOR FULL CREDIT.' A CORRIDOR LEADS SOUTH. A DOOR IS EAST.

720 DATAYOU ARE IN THE RECEPTION HALL. A LARGE TABLE IS ON ONE SIDE OF THE ROOM. AS YOU GAZE UPON THE TABLE YOU SEE SOMEONE STARE BACK AT YOU. A CAN OF PLEDGE SITS IN THE FAR SIDE OF THE ROOM. STAIRS LEAD UP. THE HALL EXTENDS SOUTH.
 730 DATAYOU ARE IN THE MIDDLE FLOOR. STAIRS LEAD UP AND DOWN. DOORWAYS ARE TO THE EAST AND WEST.
 740 DATAYOU ARE IN THE LIBRARY. A LARGE HEAVY BOOK LIES OPEN ON TOP OF A DESK BY A WINDOW. A DOOR IS WEST.
 750 DATAYOU ARE IN THE BEDROOM. A LARGE WALK IN CLOSET IS SOUTH. THERE IS A LARGE DRESSER WITH A CENTRAL DRAWER NEAR THE BED. A DOOR IS TO THE EAST.
 760 DATAYOU ARE IN A LARGE WALK IN CLOSET WITH A DOOR TO THE NORTH.
 770 DATAYOU ARE ON THE UPPER FLOOR. A DOOR IS WEST. STAIRS LEAD DOWN.
 780 DATAYOU ARE IN A MUSTY ATTIC. AN OLD CHEST IS SITTING IN ONE CORNER OF THE ROOM. A DOOR IS EAST.
 790 DATAYOU ARE INSIDE THE outhouse. A STRANGE MESSAGE IS PASTED ON THE WALL. A DOORWAY IS SOUTH.
 800 DATAYOU ARE INSIDE A SMALL CUBICLE. INSCRIBED ON TOP OF THE DOOR ARE THE LETTERS I F AND T. ONE OTHER LETTER APPEARS TO BE MISSING. THE DOOR IS WEST.
 810 DATAYOU ARE INSIDE A VAULT.

Program Listing 5

```
10 OPEN"R",1,"SFASDES:0":FIELD1,255ASDES$
20 FORX=1TO72:READD$:LSETDES=D$:PUT1:NEXT:CLOSE1
25 DATAYOU ARE OUTSIDE AN OLD SHACK.,YOU ARE INSIDE A SHACK.,YOU
  ARE ON THE EDGE OF A LARGE PATH.
30 DATAYOU ARE IN A FOREST.,YOU ARE IN A FOREST.,YOU ARE IN A FO
  REST.,YOU'RE IN THE MIDDLE OF A ROAD.,YOU ARE BY A MURKY POOL.,Y
  OU'RE IN A THREE WAY JUNCTION.,YOU'RE AT THE ENTRANCE TO A CAVE.
40 DATAYOU'RE INSIDE PLACE WHERE LIGHT FILTERS FROM THE EAST.,YO
  U ARE IN A PASSAGE OF BROKEN ROCKS.,YOU'RE INSIDE A SMALL CAVERN
  .,YOU ARE IN A LONG HALL.,THIS IS A ROOM LIGHTED BY A SIGN.,YOU'
  RE IN THE TOOL ROOM.,YOU ARE IN A LONG CORRIDOR.
50 DATAYOU ARE IN A TWISTY LITTLE MAZE OF PASSAGES.,YOU ARE IN A
  MAZE OF TWISTY LITTLE PASSAGES.,YOU ARE IN A MAZE OF TWISTY LIT
  TLE PASSAGES.,YOU ARE AT A DEAD END.,YOU ARE IN A MAZE OF TWISTY
  LITTLE PASSAGES.
60 DATAYOU ARE IN A LITTLE MAZE OF TWISTY PASSAGES.,YOU'RE IN TH
  E TALL WALL CANYON.,YOU'RE IN A LONG HALL.,YOU ARE IN A PLACE WH
  ERE THREE PATHS MEET.,YOU'RE AT THE CHASM.,YOU ARE IN A NARROW L
  EDGE.,YOU'RE IN NARROW PART OF CAVE.
70 DATAYOU ARE IN THE 'T.',YOU ARE AT THE MINE ENTRANCE.,YOU ARE
  NEAR AN OAK TREE.,YOU ARE INSIDE THE MINE. PASSAGES LEAD TO ALL
  DIRECTIONS.,YOU ARE INSIDE A MINE. PATHS LEAD TO ALL DIRECTIONS
  .
80 DATAYOU ARE INSIDE A MINE. PATHS LEAD TO ALL DIRECTIONS.,YOU
  ARE INSIDE A MINE. PATHS LEAD TO ALL DIRECTIONS.,YOU ARE INSIDE
  A MINE. PATHS LEAD TO ALL DIRECTIONS.,YOU ARE INSIDE A MINE. THE
  RE ARE PASSAGES IN ALL DIRECTIONS.
90 DATAYOU ARE IN A PLACE WHERE COLD WINDS BLOW.,THE ROAD NARROW
  S HERE.,YOU'RE ON TOP OF A HILL.,YOU ARE BY A LARGE ROCK.,YOU AR
```

Listing 5 continues

RUN BASIC PROGRAMS AT SUPER SPEED

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- BUILT-IN and much improved MUSIC and SOUND EFFECTS commands.
- Improved CHAINING for disk users.
- TIME\$ now available on DISK version.
- ZBASIC 2.2 now has an INPUT @ command (similar to PRINT @).
- The TAB function will now tab 255 columns on a printer. (BASIC cannot tab past column 64.)
- NEWDOS 80 2.0 USERS can use the CMD "dos command" function!
- NEW and EASIER to use USER COMMANDS.
- New math functions to calculate XOR and INTEGER REMAINDERS.
- Logical STRING COMPARISONS are now supported.
- The disk commands INSTR, MID\$, ASSIGNMENT are now supported on both DISK AND TAPE ZBASIC.
- DEFSTR is now supported.
- Eight disk files may be opened simultaneously; random, sequential or mixed.
- LINE INPUT#, is now supported.
- Invoke the compiler by simply hitting these two keys: ":-"
- NEW 100+ PAGE MANUAL WITH DESCRIPTIONS AND EXAMPLE
- ZBASIC 2.2 Comes with CMDFILE/CMD program from MISOSYS, to allow appending or merging compiled programs and machine language programs from tape or disk.

ZBASIC 2.2 DOES NOT SUPPORT THESE BASIC COMMANDS:

- ATN, EXP, COS, SIN, LOG, TAN, and exponentiation (However, subroutines are included in the manual for these functions.)
- ERROR, ON ERROR GOTO, ERL, ERR RESUME.
- No direct commands like AUTO, EDIT, LIST, LLIST ETC., although these commands may be used when writing programs.
- Others NOT supported: CDLBL, CINT, CSNG, DEFFN, FIX, FRE.
- Normal CASSETTE I/O. (ZBASIC supports it's own SPECIAL CASSETTE I/O statements.)
- SOME BASIC COMMANDS MAY DIFFER IN ZBASIC. For instance, END jumps to DOS READY, STOP jumps to BASIC READY etc.
- MEMORY REQUIREMENTS: to approximate the largest BASIC program that can be compiled in your machine (at one time), enter BASIC and type: PRINT (MEM-6500)/2. Remember, you can merge compiled programs together to fill memory.

ZBASIC 2.2 SPEED COMPARISON DEMO

To help give you an idea how fast compiled programs are, we have included this demo program:

ZBASIC 2.2 DEMO PROGRAM

Time to compile and run complete program	: 0 MIN. 2 SEC.
BASIC Execution speed MOD 1, LEVEL II	: 7 MIN. 34 SEC.
ZBASIC Execution speed MOD 1, LEVEL II	: 0 MIN. 18 SEC.
BASIC Program size (WITHOUT VARIABLES)	: 895 BYTES
ZBASIC Program size (WITHOUT VARIABLES)	: 2733 BYTES

(Remember that the ZBASIC program includes an 1879 byte sub-routine package.) Program shown exactly as compiled and run in BASIC and ZBASIC.

```

10 '===== ZBASIC 2.2 EXAMPLE PROGRAM AND TIME TEST=====
20 CLS: CLEAR 100: DEFINT A-X: DEFSTR Z: DIM AA(64,24), Z(50): RANDOM
30 AA=100: BB=-1000: CC=3: DD=-3: EE=-9999: ST$="START TIME "+TIME$
40 FOR I=1 TO 127 STEP 2: FOR J=47 TO 1 STEP -3: XX=POINT(I,J): SET(I,J)
50 XX=(I-J)/CC*(7+I+J): XX=ABS(INT(RND(I*J)-AA)+7): RESET(I,J)
60 XX=PEEK(I+J): POKE 15360+I+J, J: OUT255, J AND (3*J): XX=INP(I)
70 AB$=STR$(I+J): BA$=LEFT$(AB$,2): AA(I/2,J/2)=VAL(BA$)+AA*3
80 BA$=BA$+RIGHT$(BA$,RND(3)): XX=INSTR(1,BA$, "9"): XX=SQR(I*J)
90 BA$=MID$(BA$,2,2): MID$(BA$,1,1)=2: IF XX THEN 100 ELSE CLS
100 IF LEN(BA$) > 3 OR SGN(XX)=1 AND ASC(BA$)=32 THEN PRINT "+++"
110 IF POS(0) < 60 THEN TRON: TROFF: PRINT ELSE XX=NOT(RND(99))+100
120 AS$=INKEY$: IF AS$="Y" OR AS$="y" AND I < 120 THEN PRINT "TRUE.."
130 RESTORE: READ A,C,Z(J),D: GOSUB 170: GOSUB 170: GOSUB 170: GOTO 210
140 NEXT: PRINT "*" : NEXT I: CLS: PRINT @512, ST$: "STOP TIME "+TIME$
150 STOP'===== END OF MAIN TEST LOOP =====
160 DATA 12345,-1,"TEST",-9999
170 ON RND(6) GOTO 180,190,200,180,190,200
180 RETURN
190 RETURN
200 RETURN
210 ON RND(9) GOSUB 180,190,200,180,190,200,180,190,200
220 GOTO 140
    
```

NOTICE ZBASIC 2.0 OWNERS: you can upgrade your ZBASIC 2.0 for no charge. Just send us your original diskette/cassette and a S.A.S.E with your registered serial number and copy of your invoice. We will send you ZBASIC 2.2 and updates to your manual.

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Listing 5 continued

E AT THE RIVER'S SOUTHERN EDGE.,YOU ARE AT THE RIVER'S NORTHERN
EDGE.,YOU'RE AT A CROSSROADS.
100 DATAYOU ARE IN 'HOLEY' GROUND.,YOU'RE NEAR THE STABLE.,THE R
OAD ENDS HERE.,YOU ARE AT THE RIVERFRONT.,YOU ARE BY A GARGOYLE
STATUE.,YOU'RE OUTSIDE AN outhouse.,A LARGE STONE IDOL STANDS IN
FRONT OF YOU.,YOU'RE IN A GARDEN.
110 DATAYOU'RE IN AN ORCHARD.,YOU ARE STANDING AT AN ENTRANCE TO
A HOUSE.,YOU'RE NEAR THREE DOORWAYS.,THIS IS THE DINING ROOM.,Y
OU'RE IN THE KITCHEN.,YOU ARE IN A LIVING ROOM.,YOU ARE INSIDE A
SMALL ROOM.,YOU ARE IN THE BASEMENT.
120 DATAYOU'RE OUTSIDE A VAULT.,THIS IS THE RECEPTION HALL.,YOU
ARE IN THE MIDDLE FLOOR.,YOU ARE IN THE LIBRARY.,YOU ARE IN THE
BEDROOM.,YOU ARE INSIDE A WALK-IN CLOSET.,THIS IS THE TOP FLOOR
.
130 DATAYOU ARE IN THE ATTIC.,YOU'RE INSIDE AN outhouse.,YOU ARE
INSIDE A SMALL CUBICLE.,YOU ARE INSIDE A VAULT.

ACKAGE OF INCENSE LYING HERE.,THERE'S A BALE OF HAY HERE.,A PACK
AGE OF KRAFT CHEESE IS LYING HERE.,THERE IS A NOISY LITTLE MOUSE
HERE.,THERE'S A BOX OF MATCHES LYING HERE.
130 DATATHERE'S AN EMPTY BOTTLE HERE.,THERE'S A BROWNISH BOTTLE
OF WATER HERE.,AN EMERALD EYE SITS ON TOP OF THE IDOL.,THERE IS
A KNIFE WIELDING GNOME IN THE ROOM WITH YOU.,THERE ARE RARE SPIC
ES SITTING ON THE GROUND.
140 DATAAN ANGRY WIZARD WITH A PLATINUM CHAIN IS IN THE ROOM WIT
H YOU.,A GIANT SNAKE IS JEALOUSLY GUARDING A GOLDEN APPLE.,THERE
IS A LARGE CRYSTAL BALL ON THE GROUND.,A PRICELESS FIGURINE STA
NDS ON TOP OF THE TABLE.
145 DATATHE WINDOW IS OPEN.,THE WINDOW IS CLOSED.,THERE IS AN OP
EN PANEL NORTH.
150 DATALARGE DIAMOND,EMERALD EYE,PLATINUM CHAIN,GOLDEN APPLE,ST
RING OF PEARLS,BOTTLE OF SPICES,JEWELLED DAGGER,PRICELESS FIGURIN
E,OIL LAMP,BRASS KEY,RING,BLACK ROD,WOODEN STAFF,INCENSE,HAY,KRA
FT CHEESE,NOISY MOUSE
160 DATAMATCHES,EMPTY BOTTLE,BOTTLE OF WATER
170 DATA38,0,0,0,0,0,15,0,2,2,49,21,42,58,47,57,69,6,24,0,52,0,2
8,61,54,32,63,65,0

Program Listing 6

```
10 OPEN"O",1,"SFAVOC:0"
20 FORX=0TO96:READV$,V:PRINT#1,V$,"V:NEXT:CLOSE1:END
100 DATANORT,1,N,1,EAST,2,E,2,SOUT,3,S,3,WEST,4,W,4,UP,5,U,5,DOW
N,6,D,6,LOOK,7,HINT,8,HELP,8,INVE,9,JUMP,10,SCOR,11,QUIT,12,SAVE
,13,REST,14,ENTE,15,LEAV,16,TAKE,17,GET,17,T,17,OBTA,17,DROP,18,
DR,18,WAVE,19,SHOW,20,READ,21,FILL,22
110 DATALIGH,23,BURN,23,KILL,24,ATTA,24,KICK,25,SMAS,26,BREA,26,
THRO,27,TOSS,27,EAT,28,DRIN,29,FEED,30,TURN,31,UNLO,32,CROS,33,S
WIM,34,OPEN,35,CLOS,36,OFF,37,PULL,38,EMPT,39
120 DATADIAM,0,EMER,1,CHAI,2,PLAT,2,APPL,3,GOLD,3,PEAR,4,SPIC,5,
DAGG,6,KNIF,6,FIGU,7,LAMP,8,KEY,9,RING,10,ROD,11,STAF,12,INCE,13
,HAY,14,STRA,14,CHEE,15,MOUS,16,MATC,17,BOTT,18,IDOL,19,SNAK,20,
ABYS,21,CHAS,21,WIZA,22,RIVE,23,HEAD,24,BOOK,25
130 DATAMESS,26,BALL,27,CRYS,27,OIL,28,WATE,29,VAUL,30,CHES,31,D
RAW,32,WIND,33,ROPE,34,SIGN,35,GNOM,36
```

Program Listing 7

```
5 OPEN"O",1,"SFAOBDES:0"
10 FORX=0TO29:READOB$:PRINT#1,X$,"OB$:NEXT
30 FORX=0TO19:READOB$:PRINT#1,X$,"OB$:NEXT
40 FORX=0TO28:READOP:PRINT#1,OP$,"":NEXTX:PRINT#1,0:CLOSE1:END
100 DATAA LARGE DIAMOND IS LYING HERE.,THERE'S AN EMERALD EYE HE  
RE.,A PLATINUM CHAIN IS LYING HERE.,THERE IS A GOLDEN APPLE HERE  
.,A STRING OF PEARLS IS LYING HERE.,THERE IS A BOTTLE OF RARE SP  
ICES LYING HERE.  
110 DATATHERE IS A JEWEL ENCRUSTED DAGGER IN HERE.,A PRICELESS F  
IGURINE IS SITTING ON SOME HAY.,THERE IS AN OLD OIL LAMP HERE.,A  
N OLD BRASS KEY IS SITTING HERE.,THERE IS A WORTHLESS LOOKING RI  
NG HERE.,AN OLD BLACK ROD IS SITTING HERE.  
120 DATATHERE'S AN ANCIENT LOOKING STAFF LYING HERE.,THERE'S A P
```

Listing 7 continues

Program Listing 8

```
5 OPEN"R",1,"SFARESP:0"
10 FIELD1,255ASR$
15 FORX=1TO102:READR$:LSETR$=R$:PUT1:NEXT:CLOSE1
100 DATATHERE IS NO WAY TO GO IN THAT DIRECTION.,I DON'T UNDERST  
AND.,OK.,I DON'T SEE IT HERE.,YOU'RE NOT CARRYING IT.,NOTHING HA  
PPENS.,YOU'RE ALREADY CARRYING IT!,IN A BLAZE OF GLORY YOU FIND  
YOURSELF IN A LAND FAR AWAY.,IT'S TOO HEAVY FOR YOU TO TAKE.  
110 DATAOUCH! EVERY BONE IN YOUR FOOT JUST BROKE.,EECH! YOUR HAN  
DS JUST TURNED INTO A BLOODY MESS.,YOU DON'T HAVE ANY MATCHES.,Y  
OU CANNOT LIGHT AN EMPTY OIL LAMP.,YOU HAVE NO KEYS.  
120 DATATHERE IS NOT ENOUGH LIGHT TO SEE AROUND YOU.,YOU HAD BET  
TER HURRY. TIME IS RUNNING OUT.,YOU'RE LAMP IS GETTING DIM.,THE  
MOUSE IS FRIGHTENED BY YOU.,THE ONLY THING EDIBLE HERE IS YOU!,T  
HE MOUSE WAS USED FOR CARCINOGENIC TESTING. THE SNAKE IS DEAD.  
130 DATATHE SNAKE SEVERS YOUR HAND. YOU HAVE BEEN POISONED.,THE  
RING GLOWS BRIGHTLY. A LIGHTNING BOLT STRIKES THE WIZARD.,THE GO  
D IS INCENSED BY YOUR AUDACITY. WITH A BLINK OF AN EYE YOU FA  
LL DEAD TO THE GROUND.,AN EMERALD EYE FALLS TO THE GROUND.  
140 DATAA PLATINUM CHAIN LIES BEFORE YOU.,A GOLDEN APPLE HANGS B  
Y AN APPLE TREE.,YOU CAN'T CROSS THE RIVER.,HOLY MOSES! THE RIVE  
R JUST SPLIT IN TWO! A DRY PATH LEADS TO THE OTHER SIDE.,A LO  
UD NOISE SURROUNDS YOU AS THE RIVER CLOSSES.  
150 DATAYOU DID NOT JUMP LONG ENOUGH. YOU FELL INTO THE RIVER.,A  
SCHOOL OF PHYRANIAS DEVOURS YOU.,FISH FROM THE AMAZON.,FRODO LI  
VES.,MERLIN WAS HERE.,A CRYSTAL BRIDGE NOW SPANS THE CHASM!,THE  
BRIDGE HAS JUST AS SUDDENLY DISAPPERARED!  
160 DATATHE GREAT ALMAZAR BID'S YOU WELL. THOUGH YOU WILL ENCOUN  
TER MANYTRIALS HE SHALL PROVIDE FOR YOU. HE THAT IS BOTH WATER A  
ND FLAMESHALL SEND YOU A GIFT TO AID YOU IN YOUR QUEST. THUS SAY  
ETH ALMAZAR `LIVE AND YOU SHALL LIVE.'  
170 DATA`AND SO IT CAME TO PAST THAT IN THE THIRD DAY OF THE SEV  
ENTH MONTH OF THE TWENTY-FIRST YEAR A GREAT EVENT HAPPENED. T
```

Listing 8 continues

Random Access

by Karl L. Townsend

Joe Mulligan's tennis score is somewhere on the HighNet Tennis Club's disk. Can you find the score without reading the entire disk?

So you have just installed disks! Your cassette player is tucked away in the top of the closet, and with it those 15-minute waits for loads or saves. Even better, with the disk's random access ability you can read any single record—just jump into the middle of the file and get it.

Get to Work!

The HighNet Tennis Club scores now reside on a new disk. Joe Mulligan's score record needs to be updated. That's easy—just pull it from the file into memory, add the new score and write it back out. But where is it? How do you get the record when you don't know where it is?

When the file was transferred from cassette to disk, entries were in alpha-

betical order by name. They should still be in the same order. This means Joe's data is somewhere near the middle of the file. This isn't much help—the program is looking for a record number to find the data.

Well, you could just set up a loop, read each record in alphabetical order until Joe's record is found, change it and rewrite it.

Except for faster access from the disk, this sounds suspiciously like sequential operation used with a cassette. The question remains: How do we find a specific record in a random access file?

Strategies

Since the tennis file is sorted by names in alphabetical order, several

possibilities exist. As in the sample, a simple sequential read and compare will work. It is the same procedure used in any sequential file, but loses much of the advantage of random access. (You can still write the record randomly if you know where you want to write.)

Also, it's time consuming. Using a 100-record file, a desired record might be found anywhere from record 1 to record 100. Therefore, our best case (quickest find) is read one record. This procedure is good for Andy Aaron, but what about Sam Zwick? It looks like the whole file will have to be read to look at Sam's record. This is a worst case (slowest find) of about 100 read/compares. If we assume a random distribution, we will have an average of 50 read/compares. Imagine if this file had 10,000 records—that means 5,000 read/compares on the average!

A second approach is simply to list the file with record numbers. Then we just check the list for Joe Mulligan, note the record number and get it. But suppose the file is changed—a new listing is required each time. This might not be too bad with a small file, but remember that 10,000-record file.

I use a manual filing system for file folders. When I pull a file from the file

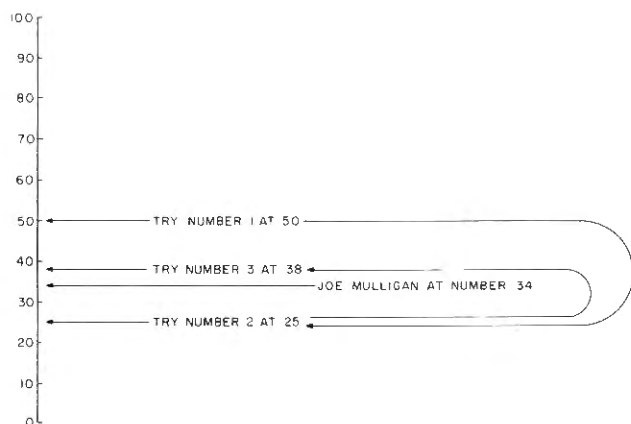


Fig. 1. Search Steps in the Halving Method

The Key Box

Model I or III
16K RAM
Cassette Basic

cabinet I always replace it in the very front of the drawer. After a time, the front of the drawer contains the folders I use most often and the least used move to the back. Every once in a while I remove those in the back and place them in dead storage.

You can adapt this for the computer. Each time a record is accessed, instead of replacing it where it was found, add it at the end of the file. (It's easier to add at the end than at the front.) When you are looking for a specific record, start reading from the end of the file. You should find it sooner this way if there is any difference in how often you access records. (The most often accessed will migrate toward the end of the file.)

Your worst case remains the maximum

number of records in the file. Average accesses required to find your selected record is difficult to determine. If there is a difference in how often an individual record is accessed, it should be less than 50 in a 100-record file. However, if there is no difference in frequency of record use, the average can approach the worst-case condition as those requiring next access gravitate to the front of the file (last to be read). If file size grows with each read/write and the file eventually requires purging, it looks like this approach is loaded with too many problems to be practical.

Let's take another look at the sequential read/compare previously discussed. The major problem is the number of reads required to find an entry. If we could reduce these numbers, a read/compare still might be the way to go.

Instead of reading from the start of the file, why not start in the middle? Since the file is arranged alphabetically, we can simply read backward or forward from the center depending on whether the compare is greater or less than the record being sought. Our worst case will now be one-half the file, or 50 read/comparisons for our 100-record file. The average will decrease from 50 to 25, a 2-1 gain. This is better, but maybe we can carry the idea further.

Suppose, instead of starting to read sequentially when we make our compare on the middle record, we go to the middle of that half the record is in. A read/compare here tells which quarter of the file the record is in. We are now down to a maximum of 25 records to

read. Actually, we can continue halving each remainder until we find the record. Confused? Take a look at the illustration in Fig. 1.

In this alphabetically sorted file of 100 records, we are looking for Joe Mulligan, whose data is in record number 34. Of course, we don't know this number or we could simply call the record by number.

Reading record number 50 and comparing the name found there with Mulligan, we find we are too far into the file; Joe's record must be in the first half. We now read record 25 and compare. This time we find we are too early in the file and that Mulligan must be in the second quarter (record 26 to 49). Again, we go to the center of the section (in this case, record number 38). We are now too far into the file and must move back. Keep halving the area and looking at the center record of each half and eventually we will find the record sought.

What do we save? I made tests on a file of 10,000 records. One million iterations were run of random selections from this file with rather interesting results. In every case the desired record was found by the fourteenth read—and this on a 10,000-record file! Compare this worst case of 14 with the 50 average reads required on a 100-record file using straight sequential methods.

Typically a find was made by 12 or 13 reads. Smaller files require fewer reads (100 records use up to seven reads) but as you can see, you will not save much nor will large files require many more reads.

For the statisticians in the group, Fig. 2 shows the results of the one million test runs. Note the number of finds made in each read and compare it to the finds preceding and following. Each time a read is made, the file remaining is cut in half and the number of finds appears to double.

Like to make this test yourself? The program listing demonstrates this search method. R defines the file size (in this case, 1,000 records). The program will loop through 100 successive finds of randomly selected records. A count of the tries in each test is saved in array G, printed at the conclusion of the run. You can change the file size by setting R to different values and the number of iterations by changing the loop value for K in line 100. Don't try a million unless you have a lot of time. Of course, change the LPRINTs to PRINTs if you have no printer. Type it in and give it a try. ■

Tries	Finds	Binary
1	102	1
2	199	2
3	392	4
4	820	8
5	1526	16
6	3210	32
7	6427	64
8	12633	128
9	25484	256
10	51017	512
11	103092	1024
12	198617	2048
13	202975	----
14	393506	----

Fig. 2. The number of read/comparisons to find a random record in a 10,000-record file. Notice the similarity to a binary progression.

```

5 ' FILE SEARCH TEST PROGRAM - KARL L. TOWNSEND - 30 JUNE 1981
10 DEFINT A-Z: DIM G(15): RANDOM 'HOUSEKEEPING
20 R = 1000 'SET FILE SIZE
30 FOR K = 1 TO 100 'SET ITERATION LOOP
40 S = RND(1000) 'GIVES RANDOM RECORD TO FIND
60 T = INT((R/2)+.5) 'FIND MIDDLE OF FILE TO START
70 T2 = T 'SAVE HALVING RESULT
80 FOR I = 1 TO 15 'LOOP CHECKING SELECTION TO FILE
85 Q = I 'SAVES LOOP CNT FOR NUMBER OF TRYS
90 T = INT((T/2)+.5) 'RE-HALVES FILE
100 LPRINT USING "*****";T2; 'PRINT RECORD NUMBERS TRIED
110 IF T2 = S THEN GOTO 151 'FIND IS MADE
120 IF T2 > S THEN T2 = T2 - T ELSE T2 = T2 + T 'FIND PROPER FILE HALF
140 NEXT I
151 LPRINT
160 G(Q) = G(Q) + 1 'ACCUMULATE COUNT OF FINDS
170 NEXT K 'GO BACK AND MAKE ANOTHER TEST
175 PRINT
180 FOR J = 1 TO 15
190 LPRINT G(J); 'PRINT SUMMARY OF FINDS
200 NEXT J
210 LPRINT
220 END

```

Program Listing

Auto-Dial/Auto-Answer

by Alan Moyer

Do you ever wish that your computer could automatically dial and answer your phone? With this addition to your modem, it can.

When I bought my modem, I wanted it to have an auto-dial/auto-answer feature. But since I couldn't justify the extra expense, I settled for a basic modem—a Novation D-Cat (direct-connect). After working with the D-Cat for a while, I decided to build an interface that would add the auto-dial/auto-answer feature. I wanted my interface to be:

- easy to design and build,
- independent from the telephone line's power so it wouldn't interfere with normal phone operation,
- designed to be plugged into the expansion bus of my computer, and
- inexpensive.

Figure 1 shows the interface I designed. It consists of six integrated circuits, two 12-volt relays, two diodes, two resistors, and one magnetic reed switch, all available from Radio Shack.

The integrated circuits IC1, IC2, and IC3 operate Z80 I/O port number 254 (FE hex) to allow the computer to read and write to that port. When this port is read from, the gates in IC4 are opened so the ring-detect signal and the hook-sense signal can pass through. IC5 is a flip-flop that sets the phone either on-hook or off-hook, and operates the dialing circuit. Being a flip-flop, once it is set on or off, it stays there until the state is deliberately altered. All the signals from the computer are standard from the expansion bus.

This is not a fancy circuit, and it is similar to one shown in the *TRS-80 Technical Reference Manual*, page 89, which I used as a guide.

This interface circuit hooks to the internal circuit block of the phone as shown in Fig. 2. Except where noted, all

connections are made directly to the terminals. Lines C and J require that the existing wires from the terminal block be removed and hooked directly to these lines. In effect, relay 1 parallels the internal switches inside the phone. Relay 2 is connected in series with the internal dialing circuit. It is currently hooked up to a touch-tone phone, but uses normal pulse dialing. Because of this arrangement, this method of dialing and hook control does not require power from the phone.

To make the modem detect a ringing phone, I taped a magnetic reed switch to the side of the phone's ringer coil. When the ringer coil rings the bell, the switch closes with it. Although it does cycle on and off with the coil's magnetic field, the first closing of the switch is all

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LDOS

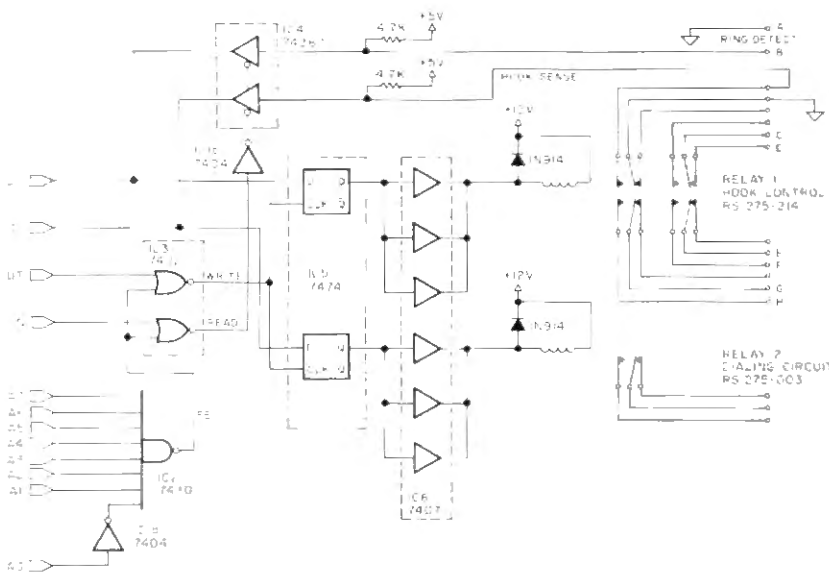


Figure 1

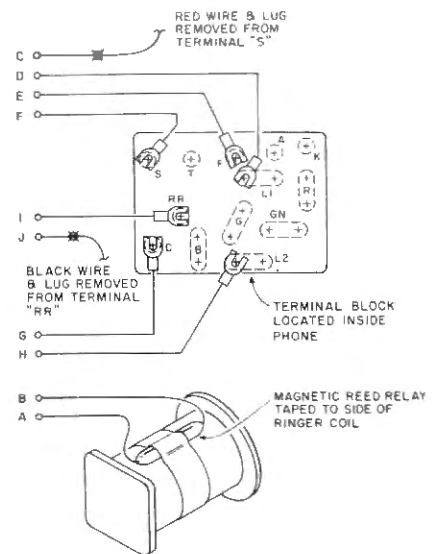


Figure 2

we need to use, so it need not be altered. In addition, this idea met all my goals for an interface.

Software

With the circuit using Z80 port FE hex (254 decimal) to access the device, Basic's command A=INP(254) will return A with the following bit information:

```
0000 0000
! !
! !—Bit zero, ring detect.
! 1=no ring (power-up
condition).
! 0=ring.
!
! — Bit one, hook sense.
! 1=on hook (power-up
condition).
! 0=off hook.
```

And accordingly, Basic's command OUT 254,A using the following bit pattern operates the phone.

```
0000 0000
! !
! !—Bit zero, hook control.
! 1=on hook (power-up
condition).
! 0=off hook.
!
! — Bit one, dialer.
! 1=no pulse (power-up
condition).
! 0=pulse line.
```

Listing 1 is the program I use to dial the phone. The program can be modified to add and display phone numbers. It operates the circuit by looping through a series of opening and closing the dialing relay to pulse the phone line.

Listing 2 is a modification of the first program. It dials a phone number at a predetermined time.

Program Listing 3 detects a ringing phone and answers it. When your computer answers the phone to communicate with another computer or terminal, it acts as a host, and you must have software that allows it to be used by another computer. Radio Shack has an RS-232 Communications Software package that performs adequately. I use LDOS as my main operating system and use the LDOS recommended host arrangement.

Program Listing 4 shows an LDOS JCL file that sets up the RS-232 driver and allows the computer to act as a host.

When running Program Listing 3, the computer answers the phone on the first ring. Several program lines check the time between responses and reset the phone after a period of no activity.

Listing 5 is a variation of Listing 3. I call it the ring-back method of answer-

ing the phone. As in most residences where only one phone line is present, this program will answer the phone according to a predetermined ringing sequence. If the phone rings only once and then rings again within 30 seconds, the computer answers the phone. The computer ignores the phone when it detects two rings in a row, as in typical phone calls.

This circuit works equally well with acoustic modems. If you have an acoustic modem, you can simply keep the handset in the modem, tape the hook buttons to the phone, and control the phone from the computer. My D-Cat hooks between the phone and handset, so I can leave the modem in the data mode, leave the handset in the cradle,

and the phone still rings and operates normally. With other direct-connect modems, like the RS Modem 1, you'll have to decide how to arrange the phone and the modem. The phone must be able to ring with the modem active, and the phone must be physically on hook, if only by the tape method.

To avoid legal problems, do not make connections directly to the telephone company's property when building this interface—make connections to your own phone. The altered phone should then be used through a phone coupler, available from your phone company. ■

Alan Moyer lives at 933 San Angelo Drive, Hamilton, OH 45013.

```
10 *****
20 ***          D I A L E R / B A S          **
30 ***          **
40 *** This program dials the phone after obtaining the **
50 *** desired phone number from a menu.          **
60 *****
70 DEFINT A-Z: DIM NUM(20): XY = 7
80 FOR XX = 1 TO XY: READ PN$(XX): READ HN$(XX): NEXT XX
90 DATA "7718851","HBBS","8637681","XBBS","6712753","APPLE (PMS)
","1234567","TSO ","5790908","MICRONET","7918208","CINTUG","5314
588","Bam-Bam"
100 CLS: P0=254
110 OUT P0,3 'Put the phone on the hook
120 IF INP(P0) AND 2 <> 2 THEN PRINT "Phone not put ON HOOK...r
etrying": LPRINT "Phone ON HOOK error at "TIMES$: GOTO 110
130 PRINT "Phone placed ON HOOK at " TIMES$
140 PRINT: FOR XX = 1 TO XY: PRINT XX " ) " HN$(XX): NEXT XX
150 PRINT " $ ) TO EXIT"
160 PRINT "*** YOUR CHOICE..."
170 A$ = INKEY$: IF A$ = "" THEN 170
180 IF A$ = "$" THEN CMD"$"
190 XX = INSTR("1234567",A$): IF XX = 0 THEN 170
200 A$ = PN$(XX): PRINT: PRINT "CALLING: " HN$(XX) " @ " RIGHT$(
TIMES$,8)
210 OUT P0,2 'Phone OFF HOOK
220 A = INP(P0) AND 2: IF A <> 0 THEN PRINT "Phone NOT OFF HOOK.
..retrying": LPRINT "Phone NOT OFF HOOK...ERROR @ " TIMES$ "...re
trying": GOTO 210
230 FOR Z = 1 TO 100: NEXT Z 'Wait for dial tone
240 FOR X = 1 TO LEN(A$)
250 NUM(X) = ASC(MID$(A$,X,1)) - 48
260 IF NUM(X) = 0 THEN NUM(X) = 10
270 NEXT X
280 FOR X = 1 TO LEN(A$)
290 IF NUM(X) = 10 THEN PRINT 0: ;ELSE PRINT NUM(X):
300 FOR Y = 1 TO NUM(X)
310 OUT P0,0 'Toggle line open
320 FOR Z = 1 TO 10: NEXT Z
330 OUT P0,2 'Toggle line on
340 FOR Z = 1 TO 10: NEXT Z
350 NEXT Y
360 FOR Z = 1 TO 100: NEXT Z 'Wait between numbers
370 NEXT X
380 PRINT: PRINT "Waiting for answer"
390 A = VAL(RIGHT$(TIMES$,2)): IF A > 29 THEN A = A - 30 ELSE A =
A + 30
400 IF INKEY$="" THEN 430 'Abort if a key is pressed
410 C = INP($HE8) AND 32: IF C = 0 THEN PRINT: PRINT "ON LINE...
Connection established..": END
420 B = VAL(RIGHT$(TIMES$,2)): PRINT@896, A; B;: IF B <> A THEN 4
00 ELSE PRINT
430 OUT P0,3 'Put phone back onto hook
440 IF INP(P0) AND 2 <> 2 THEN PRINT "NOT able to put phone ON H
OOK...retrying": LPRINT "NOT able to put phone ON HOOK at " TIME
$ "...retrying": GOTO 430
450 PRINT: PRINT "Connection NOT ESTABLISHED...Press <ENTER> to
continue...": INPUT A$: RUN
```

Program Listing 1

Program Listing 2

```

10 *****
20 ***           C A L L A L A N / B A S           **
30 ***                                           **
40 *** This program dials a number at a predetermined time. **
50 *** After thirty seconds, it puts the phone back on hook **
60 *****
70 DIM NUM(20)
80 CLS
90 P0 = 254
100 XX = 0: OUT P0,3 'Put the phone on the hook
110 IF INP(P0) AND 2 <> 2 THEN XX = XX + 1: PRINT "Phone not put
    ON HOOK...retrying": LPRINT "Phone ON HOOK error at " TIMES: I
F XX < 10 THEN GOTO 100 ELSE END
120 PRINT "Phone placed ON HOOK at " TIMES$
130 IF RIGHT$(TIMES$,8) = "07:30:00" THEN GOTO 140 ELSE 130
140 A$ = "xxxxxxx" 'Phone number goes here
150 PRINT "Calling ALAN at work at " TIMES$
160 XX = 0: OUT P0,2 'Phone OFF HOOK
170 A = INP(P0) AND 2: IF A <> 0 THEN XX = XX + 1: PRINT "Phone
    NOT OFF HOOK...retrying": LPRINT "Phone NOT OFF HOOK...ERROR @ "
    TIMES "...retrying": IF XX < 10 THEN GOTO 170 ELSE END
180 FOR Z = 1 TO 100: NEXT Z 'Wait for dial tone

```

```

190 FOR X = 1 TO LEN(A$)
200 NUM(X) = ASC(MID$(A$,X,1)) - 48
210 IF NUM(X) = 0 THEN NUM(X) = 10
220 NEXT X
230 FOR X = 1 TO LEN(A$)
240 PRINT NUM(X);
250 FOR Y = 1 TO NUM(X)
260 OUT P0,0 'Toggle line open
270 FOR Z = 1 TO 10: NEXT Z
280 OUT P0,2 'Toggle line closed
290 FOR Z = 1 TO 10: NEXT Z
300 NEXT Y
310 FOR Z = 1 TO 100: NEXT Z 'Wait between numbers
320 NEXT X
330 PRINT: PRINT "Waiting for answer"
340 A = VAL(RIGHT$(TIMES$,2)): IF A > 29 THEN A = A - 30 ELSE A =
    A + 30
350 B = VAL(RIGHT$(TIMES$,2)): PRINT@256, A; B;: IF B <> A THEN 3
50 ELSE PRINT
360 XX = 0: OUT P0,3 'Put phone back onto hook
370 IF INP(P0) AND 2 <> 2 THEN XX = XX + 1: PRINT "NOT able to p
    ut phone ON HOOK...retrying": LPRINT "NOT able to put phone ON H
    OOK at " TIMES$ "...retrying": IF XX < 10 THEN GOTO 360 ELSE END
380 RUN "RINGBACK/BAS

```

Program Listing 3

```

10 *****
20 ***           A N S W E R / B A S           **
30 ***                                           **
40 *** This supervisory routine will monitor the phone **
50 *** line for a ringing phone. **
60 *****
70 CMD"B","OFF" 'Disable the BREAK key in LDOS
80 DEFINT A-Z
90 TRUE = -1
100 FALSE = 0
110 P0 = 254
120 DEF FN XC$(A$) = CHR$((223) AND ASC(A$)) 'Lower to upper co
    nv.
130 CLS: PRINT "*** Phone silent ***"
140 C = INP(P0) AND 1
150 IF (VAL(MID$(TIMES$,10,2)) < 8) AND (C = 1) THEN 140
160 IF (VAL(MID$(TIMES$,10,2)) = 8) THEN PRINT "***** TIMED OUT
    @ " TIMES$ " *****: CMD"B","ON": CMD"S" 'Abort at 8 o'clock
170 XX = 0: OUT P0,2 'Take phone off the hook
180 D = INP(P0) AND 2: IF D <> 0 THEN XX = XX + 1: LPRINT "Phone
    NOT OFF HOOK...@ " TIMES$ "...retrying": IF XX < 10 THEN GOTO 18
    0 ELSE END
190 'Wait for a key to verify hook up
200 PRINT "Press any key...."
210 A = VAL(RIGHT$(TIMES$,2)): IF A <= 29 THEN A = A + 30 ELSE A
    = A - 30
220 A$ = INKEY$: IF A$ <> "" THEN 240
230 B = VAL(RIGHT$(TIMES$,2)): IF B = A THEN RUN ELSE 220
240 PRINT "Connection established...": PRINT
250 PRINT "Welcome..."

```

```

260 PRINT " Logged on at " RIGHT$(TIMES$,8) " on " LEFT$(TIMES$,8
    )
270 T=0
280 PRINT: PRINT "ENTER your password"
290 INPUT A$: IF LEN(A$) = 0 THEN 330
300 FOR X = 1 TO LEN(A$)
310 MID$(A$,X,1) = FN XC$(MID$(A$,X,1))
320 NEXT X
330 T = T + 1: IF T = 5 THEN 380
340 IF A$ <> "HOWDY" THEN PRINT CHR$(7) "*** Password NOT matched
    ***": GOTO 340
350 PRINT "****>>> PASSWORD MATCHED <<<****"
360 PRINT "Welcome on board, the system is yours"
370 CMD"B","ON": CMD"S"
380 PRINT "***SORRY** but you blew the password entry 5 times in
    a row"
390 PRINT "bye-bye": OUT P0,3: RUN
400 A = VAL(RIGHT$(TIMES$,2)): IF A <= 29 THEN A = A + 30 ELSE A
    = A - 30
410 CLS: PRINT "*** Waiting 30 seconds to purge this call ***"
420 B = VAL(RIGHT$(TIMES$,2)): IF B <> A THEN 420 ELSE 130

```

```

***** HOST/JCL *****
.Install the RS-232-C driver
SET *CL RS232R
.Set up the I/O links for remote operation
LINK *KI *CL
LINK *DO *CL

```

Program Listing 4

Program Listing 5

```

10 *****
20 **                               ***
30 **                               ***
40 ** This supervisory routine will monitor the phone ***
50 ** line for a ringing phone. If a second ring is ***
60 ** detected, the system is reset. If there is no ***
70 ** second ring, the computer will answer the phone ***
80 ** if the bell rings again within thirty seconds. ***
90 ** Otherwise the system is again reset. ***
100 ** Version 1.0 by Alan R. Moyer 09/10/81 ***
110 *****
120 CMD"B", "OFF"
'Disable BREAK in LDOS
130 DEFINT A-Z
140 TRUE = -1
    
```

```

150 FALSE = 0
160 P0 = 254
170 DEF FN XC$(A$) = CHR$( (223) AND ASC(A$)) 'Lower to Upper co
nv
180 CLS: PRINT "*** Phone silent ***"
190 C = INP(P0) AND 1: IF C = 1 THEN 190
200 PRINT "1st ring detected"
210 A = VAL(RIGHT$(TIME$,2)) 'Start countdown
220 PRINT "Waiting between the rings"
230 IF A <= 55 THEN A = A + 4 ELSE A = A - 56 'We'll wait 4 sec
onds between the rings
240 B = VAL(RIGHT$(TIME$,2)): PRINT B: PRINT CHR$(27);: IF B <>
A THEN 240
250 A = VAL(RIGHT$(TIME$,2)): IF A <= 55 THEN A = A + 4 ELSE A =
A - 56 'We'll wait 4 seconds for the second ring
260 PRINT "Waiting to see if there is a second ring"
270 B = VAL(RIGHT$(TIME$,2)): PRINT B: PRINT CHR$(27);
280 C = INP(P0) AND 1: IF C = 0 THEN PRINT "2nd ring detected, i
gnoring this call": GOTO 570 'Go wait, this is not our call
290 IF B = A THEN PRINT "No second ring, next call will be answe
red" ELSE 270
300 A = VAL(RIGHT$(TIME$,2)):FOR Z=0 TO 720: NEXT 'We'll wait 60
seconds for the second call
310 C = INP(P0) AND 1: IF C = 0 THEN PRINT "2nd call recieved...
answering...": GOTO 340
320 B = VAL(RIGHT$(TIME$,2)): PRINT B: PRINT CHR$(27);: IF B <>
A THEN 310
330 PRINT "Timed out, no 2nd call recieved....resetting...": GOT
O 180
340 XX = 0
350 OUT P0,2
360 PRINT "Press any key..."
370 A = VAL(RIGHT$(TIME$,2)): IF A <= 29 THEN A = A + 30 ELSE A
= A - 30
380 A$ = INKEY$: IF A$ <> "" THEN 400
390 B = VAL(RIGHT$(TIME$,2)): IF B = A THEN RUN ELSE 380
400 PRINT "Connection established...": PRINT
410 PRINT "Welcome ..."
420 PRINT " Logged on at " RIGHT$(TIME$,8) " on " LEFT$(TIME$,8
)
430 T = 0
440 PRINT: PRINT "ENTER your password"
450 INPUT A$: IF LEN(A$) = 0 THEN 490
460 FOR X = 1 TO LEN(A$)
470 MIDS(A$,X,1) = FN XC$(MIDS(A$,X,1))
480 NEXT X
490 T = T + 1: IF T = 5 THEN 550
500 IF A$ <> "HOWDY" THEN PRINT CHR$(7)"** Password NOT matched
**": GOTO 440
510 PRINT "*****>>> PASSWORD MATCHED <<<****"
520 CMD"B", "ON" 'Turn BREAK back on
530 PRINT "Welcome on board, the system is yours"
540 END
550 PRINT "***SORRY** but you blew the password entry 5 times in
a row"
560 PRINT "bye-bye": OUT P0,3: RUN
570 A = VAL(RIGHT$(TIME$,2)): IF A <= 29 THEN A = A + 30 ELSE A
= A - 30
580 PRINT "*** Waiting 30 seconds to purge this call ***"
590 B = VAL(RIGHT$(TIME$,2)): IF B <> A THEN 590 ELSE 180
    
```

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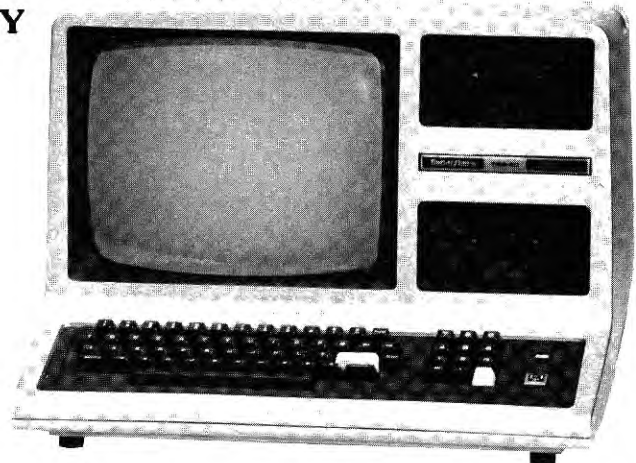
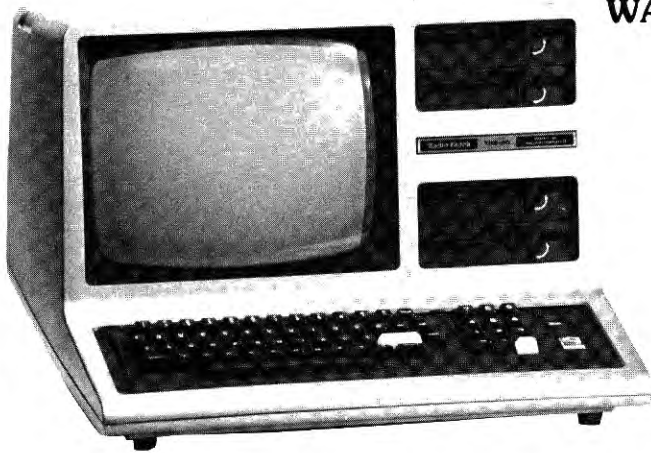
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by Ian Cohn

Use this simulation of a sailplane race on your Model I to learn the basics of the sport. It'll show you the thrill of being in the air.

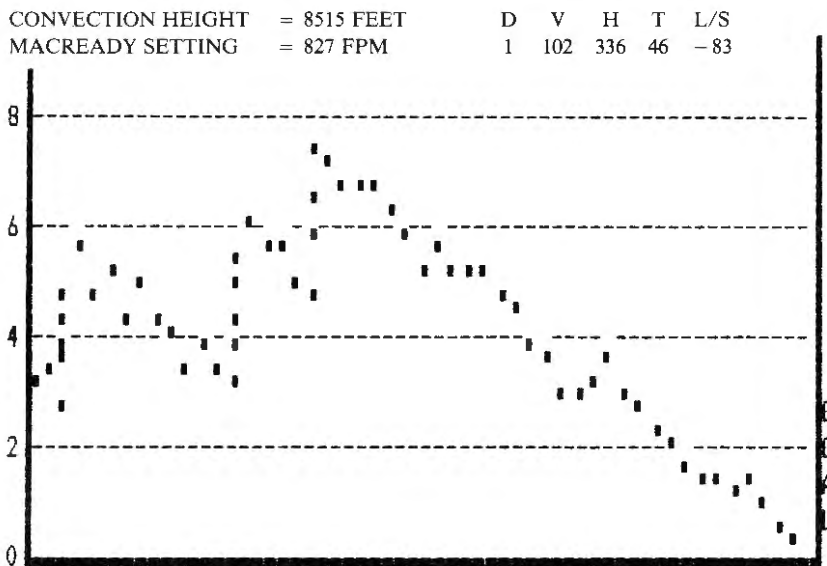
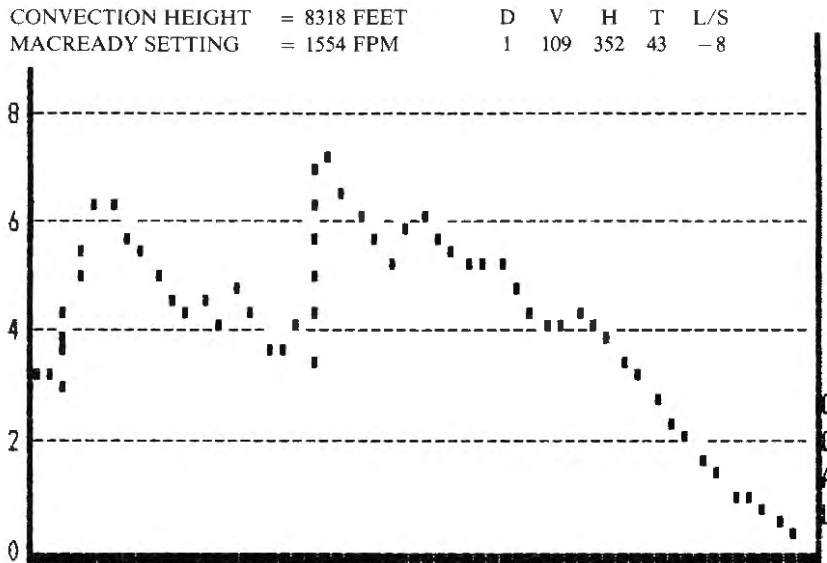


Figure 1

This program is a simulation of a sailplane race, but nevertheless includes most of the elements of the real thing.

Sailplanes are fixed wing, motorless aircraft propelled by the earth's gravitational attraction. They are distinguished from gliders by their ability to use upcurrents in the atmosphere to maintain height and travel long distances. Modern sailplanes are used in many countries for races over 200 km and 500 km distances. Often, speeds of 140 km per hour or higher are achieved.

Sailplane races start with the sailplane flying through a start gate. The pilot flies toward the goal looking for an upcurrent. A normal type of upcurrent is a column of rising air called a thermal. Thermals rise from ground heated by the sun at a different rate than the ground nearby.

When the pilot finds a sufficiently strong thermal, he circles to gain altitude. Eventually the climb rate reduces and the pilot straightens out and flies on. This cycle repeats until the pilot gets close enough to the goal to glide to the finish line without further circling.

A sailplane pilot relies to a great extent on his flight instruments (shown in Table 1). In addition to these, an instrument called an audio variometer can be used. The audio variometer gives a series of beeps, with the frequency indicating the lift's strength.

In the simulator program, lines 890-1330 contain the sailplane flight

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manual. Lines 1340-1500 contain a preflight check; this check establishes the sailplane configuration, the race task, and the start-gate speed and height. The pilot aims to go through the start gate close to the maximum allowed height (3,280 feet) and the sailplane's maximum speed (130 knots).

Finally, a random number establishes the atmosphere for the day and the computer notes the pilot's name. If A is the name, the autopilot (George), flies the task.

After completing the preflight check, the computer draws the sky and the instrument panel (lines 1510-1570). The sky is a graph of height versus distance with height reference lines at 2,000-foot intervals up to 8,000 feet.

The computer launches the sailplane and establishes the strength of the up or down current for the next mile in the weather-generator routine (lines 160-200). The weather generator reduces the strength of the air lift/sink near the ground and near the convection height. The weather generator also ensures that the air lift and sink are balanced. The average air lift is twice as strong as the air sink, but sink occurs twice as often as lift. If the lift is above the threshold value, the audio variometer gives a beep.

The sailplane position is set on the screen, and the instrument panel updates itself (lines 210-240). Now you find out if you've crossed the finish line ($D=0$) or landed before reaching the goal ($H<0$), and whether George is flying (lines 250-280).

The pilot now inputs his commands for the next segment of the flight. His options include:

- Fly straight at his selected speed. You can achieve this by entering a speed as a three-item number between the stall speed (45 knots with water ballast or 40 knots dry) and the maximum permitted speed (130 knots)—for example, 067 for a speed of 67 knots.

- Circle for one minute. Select this by entering O or C. The sailplane speed reduces to 5 knots above the stall speed when circling.

- Dump water ballast and circle, selected by entering D. The sailplane circling sink rate is 140 feet per minute when dry or 187 feet per minute with ballast. Water ballast is dumped only if the pilot is low and circling in weak lift.

- Select a pseudo-optimum (MacReady) speed to fly straight for one mile by entering a negative three-item number—for example, -05. This represents the pilot's estimate of his actual climb rate in the next thermal (climb

rate in feet per minute divided by 100. In this case, -05 means an estimate of 500 feet per minute for the next climb).

- The keyboard data-entry routine (lines 290-430) uses the INKEY\$ func-

tion within For...Next loops. This allows the audio variometer to continue beeping while the computer waits for keyboard input. While the computer beeps, hold the appropriate key down

Altimeter—	Gives height in feet (above ground in this case).
Air Speed—	Shows current speed in knots.
Indicator	
Clock—	Shows time in minutes since start.
Air lift—	Shows air vertical speed in feet per minute.
Distance—	Gives distance to goal in nautical miles.
Indicator	
MacReady—	Shows current setting of optimum speed-to-fly indicator.
Setting	
Convection—	Gives height at which thermal strength reduces to zero.

Table 1. Flight Instruments

Program Listing. Sailplane Simulator

```

100 GOTO 840 '
                                SAILPLANE SIMULATOR
                                by
                                IAN COHN
110 '
    **** keyboard entry routine ****

120 PRINT@Z,C$;:FOR X1=0 TO X2:Z$=INKEY$:IF Z$<>" THEN X1=X2
    :NEXT ELSE NEXT:IF C$=A$ THEN C$=F$ ELSE C$=A$
130 RETURN
140 '
    **** sound generator ****

150 Z=VARPTR(V$):Y=PEEK(Z+1)+PEEK(Z+2)*X:Z=INT(Y/X):POKE16527,Z
    :POKE16526,Y-Z*X:F=9+4*L:FC=INT(4E4/F):DC=F/29:POKEY+6,FC/X
    :POKEY+5,FC-INT(FC/X)*X:POKEY+3,DC/X:POKEY+2,DC-INT(DC/X)*X
    :Z=USR(0):RETURN
160 '
    **** weather generator ****

170 N=(N+PI+.2/(D+1))[4:N=N-INT(N):LB=(K+I/4)*(N-2/3)
    :IF LB<0 THEN LB=LB/4
180 L=LB:IF H<K2 THEN L=H*L/K2
190 IF H>I-K2 THEN L=L*(I-H)/K2
200 IF L>LT GOSUB 150
210 '
    **** locate sailplane on screen ****

220 IF H>0 THEN SET(4+120*(1-D/DS),10+36*(1-H/8000))
230 '
    **** update instrument panel ****

240 PRINT@99,USING B$;D;V;H;T;L;
250 '
    **** have we crashed or finished? ****

260 IF H<=0 GOTO 560 ELSE IF D=0 GOTO 570
270 '
    **** is "GEORGE" flying? ****

280 IF M$="A" GOTO 760
290 '
    **** look for and display keyboard data entry ****

300 X2=9:PRINT@122,"? ";:C$=A$:IF L<LT THEN X2=44
310 Z=123:GOSUB 120:J$=Z$:IF I$<>" GOTO 330
320 IF L<LT GOTO 310 ELSE GOSUB 150:GOTO 310
330 PRINT@Z,I$;:IF I$="D" OR I$="d" GOTO 620
340 IF I$="O" OR I$="o" OR I$="C" OR I$="c" THEN E=0:GOTO 640
360 IF I$="E" THEN V=E:GOTO 450
370 Z=124:GOSUB 120:J$=Z$:IF J$<>" GOTO 390
380 IF L<LT GOTO 370 ELSE GOSUB 150:GOTO 370
390 IF J$="E" OR J$="e" THEN 300 ELSE PRINT@Z,J$;
400 Z=125:GOSUB 120:K$=Z$:IF K$<>" GOTO 420
410 IF L<LT GOTO 400 ELSE GOSUB 150:GOTO 400
420 IF K$="E" OR K$="e" PRINT@Z," ";:GOTO 370
430 PRINT@Z,K$;:V=VAL(I$+J$+K$)

```

Listing continues

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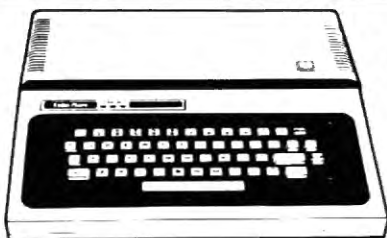
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```

440 '
    **** circling option ****
450 E=V:IF V=0 GOTO 640
460 '
    **** Beep if in lift ****

470 IFL>LTGOSUB150
480 '
    **** McReady optimum speed ****

490 IF V<0 GOTO 670 ELSE PRINT@84," ";
500 '
    **** speed limiter ****

510 IF V<VS THEN V=VS ELSE IF V>130 THEN V=130
520 '
    **** increment flight parameters and BEEP if in lift ****

530 T=T+60/V:S=A1*V*V+V/V:IF L>LT GOSUB 150
540 H=H+60*(L-S)/V+(U*U-V*V)/23:U=V:D=D-1:GOTO 170
550 '
    **** flight completion data ****

560 PRINT@32,"LANDED AT";D;" MILES TO GO.":V(NA)=NA/9999:GOTO
590
570 Z$="ELAPSED TIME =####.# MIN.          AVERAGE SPEED ="
580 V(NA)=111.2*DS/T+NA/999:PRINT@0,USINGZ$+"####.# KPH.          ";T
;V(NA)
:PRINTUSING"FINISH HEIGHT =####.# FT.          ";H;
590 D(NA)=DS-D:T(NA)=T:H(NA)=H:GOSUB 1900:PRINT"COMMAND?";
600 CC$=INKEY$:IF CC$="" THEN 600 ELSE GOTO 1720
610 '
    **** dump water ballast ****

620 W=6:VS=40:E=0:A1=.34*C/W:B=9510*W/A
630 '
    **** circle and BEEP if in lift ****

640 PRINT@84," ";:V=VS+5:H=H+L-140*W/6+(U*U-V*V)/23:IFL>LTGOS
UB150
650 U=V:T=T+1:IF H<0 THEN GOTO 560 ELSE GOTO 180
660 '
    **** solve McReady equation ****

670 IF M$<>"A" THEN V=100*V
680 IF V<-K2 THEN V=-K2
690 PRINT@84,USING"####.#";-V;:Z=-V-L:C9=Z/2/A1:Z9=SQR(C9[4+4*(4*B
/3/A1)]3)
700 Z7=(C9*C9+Z9)/2:Z8=-(C9*C9-Z9)/2:P2=Z7[(1/3)-Z8[(1/3)
:P=SQR(P2):IF Z<0 THEN P=-P
710 IF P>0 THEN V=(P+SQR(2*C9/P-P2))/2 ELSE V=VS
720 V=-V*(V>VS)-VS*(V<=VS)
730 IF M$="A" THEN V=(V/2+U/D)/(1/2+1/D)
740 GOTO 510
750 '
    **** autopilot ****

760 J=6080*(D+2)/(H+L+U*U/30):L1=1/C/(3+I/9999):IF J>L1 GOTO 800

770 V=(K-500/C/J)*(.4+.6*(1-L/D/D))
780 IF L>0 THEN V=V-L*(20/J+1/D)
790 GOTO 670
800 Z=20*W+H/10:IF L<230 AND L>130 AND H<K GOTO620
810 IF L>Z GOTO 640
820 V=0-(1+H/10+2*L/D/D):IF V>-1 OR H<K THEN V=-1
830 GOTO 670
840 CLS:PRINT"
*****
*          SAILPLANE SIMULATOR          *
*          by          *
*          Ian Cohn          *
*****"

850 '
    **** initialise constants and poke sound routine ****

860 CLEAR999:DEFINTD,I,X:DIM NA$(99),D(99),V(99),T(99),H(99)
: X=256:X2=999:A$=CHR$(143):E$=" ":F$=CHR$(95):V$=""
:PRINT:FOR I=0 TO 32:READ Z:V$=V$+CHR$(Z):NEXT
870 INPUT"Do you want to read the Flight Manual";Z$:IF LEFT$(Z$,
1)<>"Y"
GOTO 1330 ELSE GOSUB 890:GOTO 1330
880 '
    **** flight manual - first page ****

890 CLS:PRINT"FLIGHT MANUAL";TAB(58)"Page 1":PRINT
900 PRINT"This program simulates cross-country flight in a Sailp
lane."

```

Listing continues

until it registers and appears on the instrument panel. This is not a problem if the audio variometer is switched off.

The main flight-progress calculations are carried out in lines 440-650. The cruise flight routine at lines 530 and 540 increments the time according to the selected speed, subtracts one mile from the distance to go, and calculates the height at the end of the one-mile segment based on the commencing height, the air lift/sink, the sailplane sink rate at the selected speed, and the speed change.

Line 620 dumps the water ballast, and lines 640 and 650 calculate the circling flight parameters. Set the speed to five knots above the stall speed, adjust the height, and increment the time by one minute.

If the sailplane reaches the finish line or lands prematurely, the flight's final results are given (lines 560-600). A set of commands is then available so you can look at the scoreboard, call the next pilot, and so on. The commands routine is at lines 1620-1800. The command H displays all the available commands.

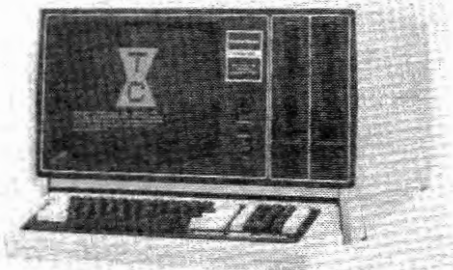
Lines 1820-1880 generate the scoreboard. The results are arranged from best to worst by a simple bubble-sort routine (lines 1900-1960). This sort is slow when many pilots are racing but I leave to modifiers to implement a faster sort.

Another section of the simulator is the optimum-speed generator (originated by Dr. Paul MacReady). The optimum speed needed to fly between thermals depends on the climb rate the pilot achieves in the next thermal. Since the pilot never knows his exact climb rate for the next ascent, he has to estimate. In general, the higher the anticipated climb rate, the faster you fly between climbs. Also, the heavier the sink, the faster you fly. The routine uses both these elements to calculate an estimate of the optimum speed. If you choose this option, the sailplane immediately flies the next mile at the calculated speed.

The autopilot (lines 750-830) uses the optimum-speed routine exclusively to determine the flying speed. The philosophy behind the autopilot is that the higher the sailplane goes, the faster it flies, and the higher it is, the stronger the lift should be before used for climbing.

When the autopilot nears the finish line, it varies the MacReady lift setting to maintain constant glide slope to the finish line. The autopilot algorithm is not optimized, and although it pro-

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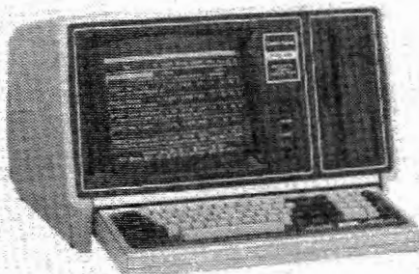
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duces a good average speed, it can be beaten by a human pilot.

The last routine is the sound generator at line 150. This is a modification of Bill Barden's tone subroutine (*80 Micro*, April 1980). I've made the sound generator relocatable and imbedded it in a string so that no memory needs to be reserved.

The sound output goes to the number one cassette port 255, and can be heard by connecting the microphone cable to a small amplifier. ■

Ian Cohn can be reached at 1 Manor St., Brighton, Victoria, Australia.

Glossary of Terms

Sailplane Performance: The universal measure of sailplane performance is the maximum glide ratio. This is the maximum number of distance units traveled for each unit of height lost in still air. For example, a sailplane having a glide ratio of 40 would be able to travel 40 miles from a height of one mile (5,280 feet) in still air.

Water Ballast: Water ballast improves the sailplane's performance at high forward speed. You obtain a lower sink rate at high speed at the expense of a higher sink rate at low speed and a higher stall speed. The net result is that it reduces the climb rate in thermal lift, and also reduces the time spent in cruising between thermals.

Generally, ballast is carried only when strong thermal lift is expected. Under these conditions, the average speed can be maximized by carrying ballast. If weak lift is all that's available, dump the water ballast by opening the taps.

Sailplane Class: Sailplanes are classified according to their performance category. Standard class sailplanes are allowed a maximum wing span of 15 meters and are not allowed to use wing flaps. The 15-meter class sailplanes have only one limitation, which is a wing span of no more than 15 meters. Open class sailplanes have no limitations.

Standard class sailplanes have a maximum glide ratio of between 38 and 40, 15-meter class between 39 and 42, and open class sailplanes between 45 and 50.

Listing continued

```

910 PRINT"The aim of the pilot is to fly to a goal, without"
920 PRINT"landing enroute, preferably in the shortest possible t
ime,"
930 PRINT"using the upcurrents (lift) and downcurrents (sink) in
the"
940 PRINT"simulated atmosphere to the best advantage. The pilot
may race"
950 PRINT"against other pilots or against the inbuilt autopilot
'GEORGE'.":PRINT
960 PRINT"In this program only the leftmost letter is required f
or any"
970 PRINT"alpha response, and defaults are provided.":PRINT
      :PRINT:GOSUB 1590:IF G RETURN
980 '
      **** flight manual - second page ****

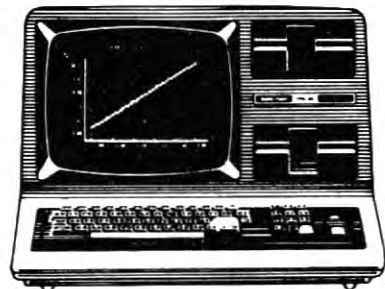
990 CLS:PRINT"FLIGHT MANUAL";TAB(58)"Page 2"
      :PRINT:PRINT"The initial data required is:-":PRINT
1000 PRINT"Audio          Y for sound, N for silence"
1010 PRINT"Sailplane Class  'Open', '15m.', or 'Std.' (Default-
Open)"
1020 PRINT"Water Ballast  'Yes' or 'No' (Default-Yes)"
1030 PRINT"Start Speed    Any speed between the minimum (40 k
t.-dry"
1040 PRINT"                or 45 kt.-wet) and 130 kt. (Default
-120 kt.)"
1050 PRINT"Start Height   Any height (Default-3280 ft.)"
1060 PRINT"Distance to go Any integer distance (Default-50 n.
m.)"
1070 PRINT"Pilot Name     Any name of less than 12 characters

1080 PRINT"                The name 'A' operates the autopilot
'GEORGE'"
1090 GOSUB 1590:IF G RETURN
1100 '
1110 CLS:PRINT"FLIGHT MANUAL";TAB(58)"Page 3";
1120 PRINT"The display now shows the DISTANCE TO GO (D), SPEED (
V), HEIGHT"
1130 PRINT"(H), elapsed TIME (T), and the AIR VERTICAL SPEED (L/
S) for the"
1140 PRINT"next mile. The pilot now has the following options:-"

1150 PRINT" -to cruise for the next mile, input any speed betwee
n the"
1160 PRINT"   the minimum speed and 130 kt. eg; 0 7 5 (3 digits)
for 75 kt."
1170 PRINT" -to circle, preferably in air lift greater than the
Sailplane"
1180 PRINT"   sink rate, input 'O' or 'C'. The Sailplane circling
sink rate"
1190 PRINT"   is 140 FPM (dry) or 187 FPM (wet)."
```

Listing continues

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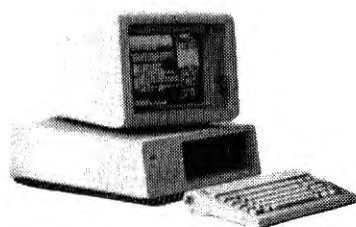
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Listing continued

```

1390 INPUT"Water Ballast - (Y or N)";WS:IF LEFT$(WS,1)="N" THEN
W=6
1400 A=20:VS=25+2.5*W:C=1/80:IF C$="1" THEN C=1/90:A=23
1410 T=0:H=3280:U=120:D=50:IF C$="O" THEN C=.01:A=26
1420 AL=.34*C/W:B=9510*W/A:GOSUB150
1430 INPUT"Start Speed - Knot";U$:IF U$<>" " THEN U=VAL(U$)
1440 V=U:IF U<VS OR U>130 THEN PRINT"ILLEGAL SPEED":GOTO 1430
1450 GOSUB 150:INPUT"Start Height - Ft";H$:IF H$<>" " THEN H=VAL(
H$)
1460 GOSUB 150:INPUT"Distance-to-go - N.M";D$:IF D$<>" " THEN D=V
AL(D$)
1470 RANDOM:N=RND(0):DS=D:GOSUB 150:IF M$="A" THEN Y=Y+3
1480 NS=N:HS=H:VC=V:WS=W:E=V:PI=3.14159:T=0:U=VC
1490 FOR NA=0 TO 99:PRINT:PRINT"Pilot";NA+1;:INPUT"Name";NA$(NA)
:IF NA$(NA)="A" THEN M$="A":NA$(NA)="GEORGE" ELSE M$=""
1500 CLS:B$="### ### ### ### ###":AL=.34*C/W:B=9510*W/A:VS=25+
2.5*W
1510 '
**** provide sky ****

1520 FORZ=0TO4:PRINT@(960-192*Z),USING"# ";2*Z;:PRINTZZ$;:NEXT
1530 PRINT@62,STRING$(61,CHR$(140));:FORI=3TO46:SET(3,I):SET(12
5,I):NEXT
1540 '
**** and instrument panel ****

1550 PRINT@64,"MACREADY SETTING = FPM.":I=INT(4*K+5*K*N)
1560 PRINT@0,"CONVECTION HEIGHT =";I;" FT. D V H T
L/S ";
1570 PRINT@767,"G";:PRINT@831,"O";:PRINT@895,"A";:PRINT@959,"L";

:GOTO170
1580 '
**** another page subroutine ****

1590 PRINT:PRINT"Another page?";
1600 Z$=INKEY$:IF Z$="N" THEN G=-1:RETURN ELSE IF Z$=" " GOTO
1600 ELSE G=0:RETURN
1610 '
**** COMMANDS routine ****

1620 CLS:PRINTTAB(20)"AVAILABLE COMMANDS":PRINT
1630 PRINT"A - Again, no change in pilot"
1640 PRINT"C - Change atmosphere"
1650 PRINT"D - New day"
1660 PRINT"E - Exit program"
1670 PRINT"H - Help, display available COMMANDS"
1680 PRINT"M - Refer to Flight Manual"
1690 PRINT"N - Next pilot"
1700 PRINT"S - Scoreboard display":PRINT:PRINT"COMMAND?";
1710 CC$=INKEY$:IF CC$=" " THEN 1710
1720 IF CC$="S" GOTO 1820
1730 IF CC$="D" THEN NA=99:NEXT:GOTO 1350
1740 IF CC$="M" GOSUB 890
1750 IF CC$="C" THEN NA=99:GOSUB 1880:NEXT:GOTO 1470
1760 IF CC$="H" GOTO 1620
1770 IF CC$="N" GOSUB 1880:NEXT
1780 IF CC$="A" GOSUB 1880:GOTO 1500
1790 IF CC$="E" THEN END
1800 PRINT:PRINT"INVALID COMMAND":FOR Z=0 TO 99:NEXT:GOTO 1620
1810 '
***** scoreboard *****

1820 CLS:PRINTTAB(22)"SCOREBOARD":PRINT
1830 PRINT "PILOT FIN HT. DISTANCE TIME SPEED P
LACE":PRINT
1840 FORZ=0TONA
1850 PRINTUSING"% % ##### ##### ####.# ####.# ##
##";NA$(Z);H(Z);D(Z);T(Z);V(Z);Z+1
1860 NEXTZ:PRINT:PRINT"COMMAND?";
1870 CC$=INKEY$:IF CC$=" " THEN 1870 ELSE PRINT:GOTO 1720
1880 T=0:N=NS:L=888:D=DS:V=VC:U=V:W=WS:VS=25+2.5*W:H=HS:RETURN
1890 '
**** sort routine ****

1900 SW=0:PS=PS+1
1910 FOR J=0 TO NA:Z=J+1:IF D(J)+V(J)>D(Z)+V(Z) GOTO 1950
1920 ZF$=NA$(J):DZ=D(J):TZ=T(J):VZ=V(J):HZ=H(J)
1930 NA$(J)=NA$(Z):D(J)=D(Z):T(J)=T(Z):V(J)=V(Z):H(J)=H(Z)
1940 NA$(Z)=ZF$:D(Z)=DZ:T(Z)=TZ:V(Z)=VZ:H(Z)=HZ:SW=1
1950 NEXT J:IF SW=1 GOTO 1900
1960 RETURN
1970 '
**** data for sound generator ****

1980 DATA 221,33,0,0,17,0,0,1,255,255,213,225,62,1,211,255,9,
56,252,213,225,62,2,211,255,9,56,252,221,9,56,231,201

```

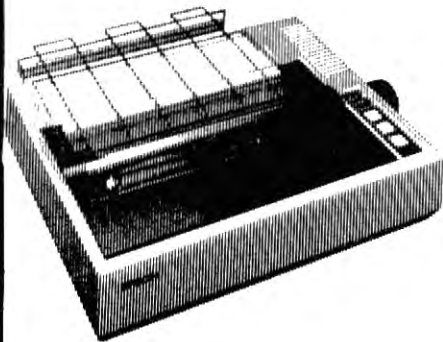
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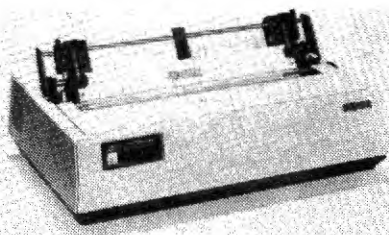
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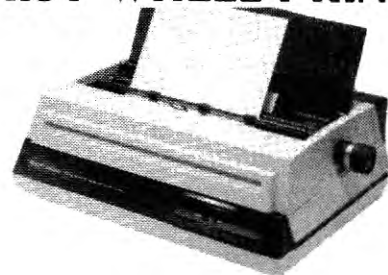
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Catalog Your Files

by Jane Goodale

You need not hassle with filespecs any longer. Instead, install this cataloging routine in programs that maintain sequential filespecs.

I find it very irritating to enter a filespec every time I want to read or write a file. It is much easier to have the filespec in the program. However, it is also very dangerous when running an update program on a sequential file—that is, read a record, change it and write it back under the same filespec.

To avoid this hassle, I chose to install a cataloging routine in all my programs which maintain sequential files. The basic idea is from IBM's technique of generation data sets, though not nearly as elaborate. The procedure requires a driver program which creates and manipulates the catalog, and a standard subroutine in every program using the files to keep the catalog updated and provide the current file names.

The driver program (also used as a menu program) first attempts to read a driver file always called DRIVERX-X/CAT; if not found by DOS it will guide you through creating one. Once the driver file is created, the programs keep track of the names of the current files and the next one to create.

The driver file I use is a one-record file containing the system identifier,

number of files in the system, and for each file in the system, the file name and generation, date created, and the last program to issue that file. It has the format shown in Table 1.

If the system identifier is INV and there will be two files in the system called DETAIL on drive 1 and SUMMARY on drive 2, created by PROGRAMMA and PROGRAMB respectively, the filespecs would be:

```
DETAIL01/INV:1    for the first time created
SUMARY01/INV:2   for the first time created
```

The driver file would look like:

```
INV2DETAIL01111/20/81
PROGRAMASUMARY01201/15/82
PROGRAMB
```

if the detail file was created Nov. 20, 1981 and the summary file created Jan. 15, 1982.

As time passes and you use the files, the names would become something like this after 15 details and 10 summaries have been created:

```
DETAIL15/INV:1
SUMARY10/INV:2
```

and the driver file:

```
INV2DETAIL15102/15/82
PROGRAMA SUMMARY10202/13/82
PROGRAMB
```

Program Listing 1, Catalogs, displays the menu for the applications to follow. It also contains an uncatalog feature which allows you to restart at a previous generation of the file you uncatalog. Program Listings 2 and 3 (called PROGRAMMA and PROGRAMB) illustrate use of the subroutines which maintain the catalog. PROGRAMMA is fully commented in the standard subroutine. PROGRAMB contains the working parts, but no comments within the subroutine.

To try out the system, key in Catalogs and PROGRAMMA. PROGRAMB can be created by modifying PROGRAMMA. Save them as CATALOGS/BAS, PROGRAMMA/BAS and PROGRAMB/BAS. Be sure to set TIMES if you want your files dated. Then put formatted disks in the drives you expect to use and run CATALOGS/BAS. Your system will try to find the driver file (DRIVERXX/CAT); when it can't locate it the On Error routine at line 480 will take you to the routine to establish the catalog at line 170.

The screen will describe briefly how

Position	Definition
1-3	Three-character system identifier
4	Number of files for the system (max = 9)
5-10	Six-character file name
11-12	Two character generation number
13	Drive number assigned
14-21	Date last updated
22-29	Name of program which last issued the file
30-54	Repeat of 5-29 for the second file
55-79	Repeat again for the third file
etc.	Up to nine files

Table 1

```

                ESTABLISH CATALOG
A CONTROL FILE MUST BE BUILT THE FIRST TIME THE PROGRAMS ARE RUN.
ONCE BUILT, IT WILL CONTROL FILE NAMES, DATES, ETC. AND WILL NOT
NEED TO BE ESTABLISHED AGAIN.
NAMING OF FILES WILL BE AS FOLLOWS:
  DRIVERXX/CAT    —DRIVER FILE
  NNNNNNGG/SSS.D —DETAIL FILE
WHERE: NNNNNN IS A 6-CHARACTER USER-ASSIGNED NAME
      GG IS THE GENERATION #
      SSS IS THE SYSTEM IDENTIFIER
      D IS A DRIVE NUMBER ASSIGNED TO THE FILES (0-3)
      GG WILL START AT 01 AND BE INCREMENTED BY ONE AUTOMATICALLY.
      WHEN GG REACHES 99 IT WILL BE RESTARTED AT 01
    
```

Figure 1

The Key Box

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```

1 REM ---- CATALOGS/BAS      JANE N GOODALE
2 REM                        828 NO 121 STREET
3 REM                        OMAHA, NE 68154
10 CLEAR1500:DEFINTA-Z:CLS:PRINT@470,"SYSTEM DRIVER"

20 ONERRORGOTO400
30 GOTO150
31 REM -----SUBROUTINES-----
32 REM ---MISC
42 PRINT@990," ":INPUT"HIT <ENTER> TO CONTINUE";BS;:RETURN
50 AS=INKEY$:IFAS=""THEN50ELSEPRINTAS;:RETURN
60 PRINT@990,"ANY KEY TO RETURN ";:GOSUB50:RETURN
61 REM ---CATALOG STATUS
70 CLS:PRINTTAB(18)"FILE STATUS FOR SYSTEM ";SS:PRINTTAB(12)STRINGS(40," ")
80 PRINTTAB(12)"# FILESPEC";TAB(32)"LAST PGM DATE":PRINTTAB(12)STRINGS(40," ")
90 FORN=1TOF:DX$=DX$(N)
100 NS=LEFT$(DX$,8):DS=MID$(DX$,9,1):DT$=MID$(DX$,10,8):PG$=RIGHT$(DX$,8)
110 PRINTTAB(11)N;TAB(15)NS+ "/" + S$ + " "; "D$";TAB(32)PG$;TAB(43)DT$
120 NEXTN:PRINTTAB(12)STRINGS(13,"-");" END OF FILES ";STRINGS(13,"-"):RETURN
129 REM ---SET DX$(N)
130 FORN=1TOF:DX$(N)=LEFT$(DF$,25):IFN<FTHENDF$=MID$(DF$,26)
140 NEXTN:RETURN
149 REM -----START-----
150 OPEN"1",1,"DRIVERXX/CAT"
160 INPUT#1,DF$:SS=LEFT$(DF$,3):F$=MID$(DF$,4,1):F=VAL(F$):DF$=MID$(DF$,5):GOSUB130:GOTO320
169 REM -----ESTABLISH CATALOG-----
170 CLS:PRINTTAB(20)"ESTABLISH CATALOG":PRINT
180 PRINT" A CONTROL FILE MUST BE BUILT THE FIRST TIME THE PROGRAMS":PRINT"ARE RUN. ONCE BUILT, IT WILL CONTROL FILE NAMES, DATES, ETC.":PRINT"AND WILL NOT NEED TO BE ESTABLISHED AGAIN."
190 PRINT"NAMING OF FILES WILL BE AS FOLLOWS:":PRINTTAB(8)"DRIVERXX/CAT - DRIVER FILE":PRINTTAB(8)"NNNNNGG/SSS:D - DETAIL FILE":PRINT"WHERE : NNNNNN IS A 6 CHARACTER USER ASSIGNED NAME"
200 PRINTTAB(8)"GG IS THE GENERATION #":PRINTTAB(8)"SSS IS THE SYSTEM IDENTIFIER":PRINTTAB(8)"D IS A DRIVE NUMBER ASSIGNED TO THE FILE$(0-3)":PRINT"GG WILL START AT 01 AND BE INCREMENTED BY 1 AUTOMATICALLY."
210 PRINT"WHEN GG REACHES 99 IT WILL BE RESTARTED AT 01":GOSUB40

```

```

220 CLS:PRINTTAB(20)"FILE DEFINITION":PRINT
230 INPUT"ENTER 3 CHAR SYSTEM ID";SS
240 IFLEN(SS)=3THEN250ELSEPRINT"3 CHAR ID PLEASE":GOTO230
250 INPUT"ENTER NUMBER OF FILES FOR THE SYSTEM ( 1 TO 9 )";F$
260 IF(F$<"1")OR(F$>"9")THENPRINT"1 TO 9 PLEASE":GOTO250
270 DF$=SS+F$:F=VAL(F$):PRINT
280 FORN=1TOF:PRINT"FILE # ";N;"DEFINITION"
290 INPUT"ENTER 6 CHAR NAME";N$:IFLEN(N$)=6THEN300ELSEPRINT"6 CHAR NAME PLEASE":GOTO290
300 INPUT"ENTER DRIVE #";DS:IF(DS<"0")AND(DS<"4")THEN310ELSEPRINT"DRIVE # 0 TO 3 PLEASE":GOTO300
310 DF$=DF$+NS+"00"+DS+LEFT$(TIMES,8)+"CATALOGS:FSS=NS+"00"+ "/" + S$ + "": "D$":OPEN"O",2,FSS:PRINT#2,"DUMMY"+FSS:CLOSE2:PRINT:NEXTN:OPEN"O",1,"DRIVERXX/CAT":PRINT#1,DF$:DF$=MID$(DF$,5):GOSUB130:GOTO320
319 REM -----MAIN MENU-----
320 CLS:PRINT"SELECT ONE OF THE FOLLOWING ":PRINT
330 PRINTTAB(8)"1 PRINT CATALOG STATUS":PRINTTAB(8)"2 UNCATALOG A FILE":PRINTTAB(8)"3 RUN PROGRAM A":PRINTTAB(8)"4 RUN PROGRAM B":PRINTTAB(8)"5 RETURN TO SYSTEM COMMAND"
340 PRINT:PRINT"CHOICE (DO NOT HIT <ENTER>)":GOSUB50
350 ONVAL(AS)GOTO390,410,370,380,400
360 PRINT"ILLEGAL RESPONSE":GOSUB60:GOTO320
369 REM -----CHOICES-----
370 CLOSE1:RUN"PROGRAMA/BAS"
380 CLOSE1:RUN"PROGRAMB/BAS"
390 GOSUB70:GOSUB60:GOTO320
400 CLOSE1:CMD"5"
409 REM -----UNCATALOG-----
410 GOSUB70:PRINT@181,"UNCATALOG":PRINT@247,"Y/N";
420 FORN=1TOF:L=55+(N+3)*64
425 PRINT@L,"-":GOSUB50:IF(AS="Y")OR(AS="N")THEN430ELSEPRINT@L+1," ":GOTO425
430 IFAS="Y"THENGOSUB450
440 NEXTN:CLOSE1:OPEN"O",1,"DRIVERXX/CAT":DF$=SS+F$:FORN=1TOF:DF$=DF$+DX$(N):NEXTN:PRINT#1,DF$:CLOSE1:GOTO320
450 GS=MID$(DX$(N),7,2):G=VAL(G$):IFG<0THENG=G-1
460 GS=STR$(G):GS=MID$(GS,2):IFG<10THENG="0"+GS
470 DX$(N)=LEFT$(DX$(N),6)+GS+MID$(DX$(N),9,1)+LEFT$(TIMES,8)+"CATALOGS":RETURN
479 REM -----ON ERROR ROUTINE-----
480 IFERL=150CLOSE1:RESUME170
490 PRINT"ERROR ";ERR/2+1;" IN LINE ";ERL:END

```

Program Listing 1. Catalogs

```

1 REM ---- PROGRAMA/BAS      JANE N GOODALE
2 REM                        828 NO 121 STREET
3 REM                        OMAHA, NE 68154
10 CLEAR3000:DEFINTA-Z:CLS:PRINT@470,"RUNNING PROGRAM A":GOTO200

80 REM -----I/O SUBROUTINE TO MAINTAIN CATALOG-----
81 REM
82 REM -----VARIABLES-----
83 REM ZR$ - DRIVER RECORD
84 REM ZS$ - 3 CHAR SYSTEM IDENTIFIER
85 REM ZF$ - STRING VALUE OF # OF FILES
86 REM ZP$ - NUMERIC VALUE OF # OF FILES
87 REM ZX$ - TEMPORARY HOLDING AREA FOR ZR$
88 REM ZZ$ - FOR/NEXT VARIABLE: POINTER TO FILE NAMES
89 REM ZR$(ZZ%) - ARRAY OF EACH 25 CHAR DEFINITION
90 REM ZG$ - STRING VALUE OF GENERATION #
91 REM ZQ$ - NUMERIC VALUE OF GENERATION #
92 REM ZIS(ZZ%) - ARRAY OF INPUT FILE SPECS
93 REM ZO$(ZZ%) - ARRAY OF OUTPUT FILE SPECS
94 REM
99 REM --- OPEN DRIVER FILE, READ AND GET INPUT FILE NAMES.
100 OPEN"1",1,"DRIVERXX/CAT":INPUT#1,ZR$:CLOSE1:ZS$=LEFT$(ZR$,3):ZF$=MID$(ZR$,4,1):ZP$=VAL(ZF$):ZX$=MID$(ZR$,5)
110 FORZZ%=1TOZF$:ZR$(ZZ%)=LEFT$(ZX$,25):ZIS(ZZ%)=LEFT$(ZR$(ZZ%)

```

```

),8)+ "/" + ZS$ + "": "MID$(ZR$(ZZ%),9,1):IFZZ%<ZF$THENZX$=MID$(ZX$,26)
120 NEXTZZ%:RETURN
121 REM --- GET NEW GENERATION # FOR OUTPUT AND OPEN OUTPUT
122 REM FILES. SET ZZ% TO FILE NUMBER BEFORE GOING INTO
123 REM SUBROUTINE.
130 ZG$=MID$(ZR$(ZZ%),7,2):ZQ$=VAL(ZG$)+1:IFZQ%>99THENZG%=1
140 ZG$=STR$(ZG%):ZQ$=MID$(ZG$,2):IFZQ%<10THENZG$="0"+ZG$
141 REM --- UPDATE FILE # ZZ% PORTION OF DRIVER RECORD.
142 REM PROGRAM NAME SHOULD BE 8 CHAR IN LENGTH OR PADDED
143 REM WITH SPACES.
150 ZR$(ZZ%)=LEFT$(ZR$(ZZ%),6)+ZG$+MID$(ZR$(ZZ%),9,1)+LEFT$(TIMES,8)+"PROGRAMA"
160 ZO$(ZZ%)=LEFT$(ZIS(ZZ%),6)+ZG$+MID$(ZIS(ZZ%),9,1):RETURN
161 REM --- AT END OF JOB, WRITE DRIVER FILE BACK OUT IF ANY
162 REM OUTPUT FILES WERE WRITTEN.
170 ZR$=ZS$+ZF$:FORZZ%=1TOZF$:ZR$=ZR$+ZR$(ZZ%):NEXTZZ%:OPEN"O",1,"DRIVERXX/CAT":PRINT#1,ZR$:CLOSE1:RETURN
195 REM --- DEMONSTRATION PROGRAM WILL OUTPUT FILE #1 AND #3
200 GOSUB100:OPEN"1",1,ZIS(3):ZZ%=1:GOSUB130:ZZ%=3:GOSUB130:OPEN"O",2,ZO$(1):OPEN"O",3,ZO$(3)
210 INPUT#1,RS:PRINT#3,RS:PRINT#2,RS:PRINT#2,RS:IFEOF(1)THEN220ELSEGOTO210
220 CLOSE1,2,3:GOSUB170:CLS:PRINT@470,"END OF PROGRAM A":RUN"CATALOGS/BAS"

```

Program Listing 2. PROGRAMA

the system works (see Fig. 1). The next screen (Fig. 2) will ask for a three character system ID and how many files (different filespecs) you want in the system. Create at least three to use with demonstration program PROGRAMA. You are then prompted to enter a six-character file name and drive number for however many files you have specified. After each response, a dummy file will be generated.

When all files have been described, the catalog is established and you are taken to the main menu, the normal starting point (see Fig. 3). Choose Option 1 to print the catalog status and you will see your files displayed as in

Fig. 4.

Return to the menu by hitting any key and make Selection 3 to run PROGRAMA. When it is finished you will be returned to the Catalogs program menu. Select PROGRAMA several more times. For the examples here I ran PROGRAMA three times. Now select Item 1 again to see the catalog status—it should look something like Fig. 5. PROGRAMA writes only files 1 and 3 so the second file shows no change.

Select Option 2 next to uncatlog. Your screen will look like Fig. 6. If you answer Y to file 1 and N to the rest, your next check of the catalog status

should look like Fig. 7. The generation number of the first file has been decreased by one.

If you return to DOS at this point and check your directory, you will see that all files created are still there (Fig. 8). The uncatlog does not kill the file. However, the driver file will force your program to read the correct file and recreate the next one in line.

Note that PROGRAMB reads the files, but never writes any. In this case, lines 130–170, the output maintenance subroutines, could be removed entirely.

If your DOS allows you to kill files within a Basic program, logic could be installed to kill a file that is uncat-

```

1 REM ---- PROGRAMB/BAS          JANE N GOODALE
2 REM                          828 NO 121 STREET
3 REM                          OMAHA, NE 68154
10 CLEAR3000:DEFINT A-Z:CLS:PRINT@470,"RUNNING PROGRAM B":GOTO200

80 REM -----I/O SUBROUTINE TO MAINTAIN CATALOG-----
100 OPEN"1",1,"DRIVERXX/CAT":INPUT#1,ZR$:CLOSE1:ZSS=LEFT$(ZR$,3)
:ZF$=MID$(ZR$,4,1):ZF%=VAL(ZF$):ZXS=MID$(ZR$,5)
110 FORZZ%=1TOZF%:ZR$(ZZ%)=LEFT$(ZXS,25):ZIS(ZZ%)=LEFT$(ZR$(ZZ%)
,8)+"/"+ZB$+"":+MID$(ZR$(ZZ%),9,1):IFZZ%<ZF%THENZXS=MID$(ZXS,26)

120 NEXTZZ%:RETURN
130 ZG$=MID$(ZR$(ZZ%),7,2):ZG%=VAL(ZG$)+1:IFZG%>99THENZG%=1
140 ZG$=STR$(ZG%):ZGS=MID$(ZG$,2):IFZG%<10THENZG$="0"+ZG$
150 ZR$(ZZ%)=LEFT$(ZR$(ZZ%),6)+ZG$+MID$(ZR$(ZZ%),9,1)+LEFT$(TIME
S,8)+"PROGRAMB"
160 ZOS(ZZ%)=LEFT$(ZIS(ZZ%),6)+ZG$+MID$(ZIS(ZZ%),9):RETURN
170 ZR$=ZS$+ZF$:FORZZ%=1TOZF%:ZR$=ZR$+ZR$(ZZ%):NEXTZZ%:OPEN"0",1
,"DRIVERXX/CAT":PRINT#1,ZR$:CLOSE1:RETURN
195 REM -----DEMONSTRATION PROGRAM WILL READ FILES 1 AND 3
196 REM          AND DISPLAY THEM.
200 GOSUB100:OPEN"I",1,ZIS(1):OPEN"1",2,ZIS(3):CLS:PRINT"FILE 1
FOLLOWS":PRINT
210 INPUT#1,R$:PRINTR$:IFEOF(1)THEN220ELSEGOTO210
220 PRINT:PRINT"FILE 3 FOLLOWS":PRINT
230 INPUT#2,R$:PRINTR$:IFEOF(2)THEN240ELSEGOTO230
240 CLOSE1,2:PRINT:PRINT"END OF PROGRAM B"
250 INPUT"<ENTER> TO CONTINUE":AS:RUN"CATALOGS/BAS"

```

Program Listing 3. PROGRAMB

```

FILE STATUS FOR SYSTEM INV
#  FILESPEC      LAST PGM      DATE      UNCATALOG
Y/N
1  DETAIL03/INV:1  PROGRAMA     11/15/81  -Y
2  INPUT100/INV:2  CATALOGS    11/15/81  -N
3  SUMMARY03/INV:1  PROGRAMA     11/15/81  -
END OF FILES

```

Figure 6

```

FILE STATUS FOR SYSTEM INV
#  FILESPEC      LAST PGM      DATE
1  DETAIL02/INV:1  CATALOGS     11/15/81
2  INPUT100/INV:2  CATALOGS     11/15/81
3  SUMMARY03/INV:1  PROGRAMA     11/15/81
END OF FILES

```

ANY KEY TO RETURN

Figure 7

```

FILE DEFINITION
ENTER 3 CHAR SYSTEM ID? INV
ENTER NUMBER OF FILES FOR THE SYSTEM (1 TO 9)? 3

FILE # 1 DEFINITION
ENTER 6 CHAR NAME? DETAIL
ENTER DRIVE #? 1

FILE # 2 DEFINITION
ENTER 6 CHAR NAME? INPUT1
ENTER DRIVE #? 2

FILE # 3 DEFINITION
ENTER 6 CHAR NAME? SUMMARY
ENTER DRIVE #? 1

```

Figure 2

```

DRIVE 1  DATA0003  11/15/81  39 TRKS  53 FDES  128 GRANS
DRIVERXX/CAT  SUMMARY00/INV  SUMMARY01/INV  SUMMARY02/INV
SUMMARY03/INV  DETAIL00/INV  DETAIL01/INV  DETAIL02/INV
DETAIL03/INV
DRIVE 2  DATA0003  11/15/81  39 TRKS  61 FDES  129 GRANS
INPUT100/INV

```

Figure 8

```

SELECT ONE OF THE FOLLOWING:
1 PRINT CATALOG STATUS
2 UNCATALOG A FILE
3 RUN PROGRAM A
4 RUN PROGRAM B
5 RETURN TO SYSTEM COMMAND

CHOICE (DO NOT HIT <ENTER>):

```

Figure 3

```

FILE STATUS FOR SYSTEM INV
#  FILESPEC      LAST PGM      DATE
1  DETAIL03/INV:1  PROGRAMA     11/15/81
2  INPUT100/INV:2  CATALOGS    11/15/81
3  SUMMARY03/INV:1  PROGRAMA     11/15/81
END OF FILES

ANY KEY TO RETURN

```

Figure 5

```

FILE STATUS FOR SYSTEM INV
#  FILESPEC      LAST PGM      DATE
1  DETAIL00/INV:1  CATALOGS    11/15/81
2  INPUT100/INV:2  CATALOGS    11/15/81
3  SUMMARY00/INV:1  CATALOGS    11/15/81
END OF FILES

ANY KEY TO RETURN

```

Figure 4

logged and kill every file over N generations old.

Trying to uncatalog the 00 version of all files will not restart the system from scratch. In fact, it will do nothing at all. To restart the system, simply kill DRIVER XX/CAT.

Using this system requires that you have one and only one system's data on your data disk. It cannot now handle more than one catalog on the same disk since the catalog, which is the driver file, is called DRIVERXX/ CAT in every case.

A more elaborate cataloging system could be developed to kill files and maintain unique driver files for each system, with names such as DRIVE-INV/CAT, DRIVEPAY/CAT and DRIVEREC/CAT. The number of files per system could be unlimited by using a driver file of more than one record.

However, the maintenance program

and subroutines would be much more complicated. As they are presented here, if compressed and with all comments removed, Catalogs takes 2605 bytes of memory and the I/O subroutine takes 503 bytes of memory.

I keep a raw copy of each of these available for use in any application program systems that will do much file manipulation. The application program is started at line 200 of PROGRAM A or PROGRAM B. Install your own menu driver in Catalogs by changing line 330 and lines 370-380.

So what does all this mean? A file you want to call DETAIL../INV can be called DETAIL00/ INV when the catalog is initialized. More importantly, it will be DETAIL01/INV for the first run, DETAIL02/INV for the second run, DETAIL03/INV for the third run and so on. No operator intervention is necessary once the catalog is established. It also means you always have a file to go back to if you goof the current run, by using the uncatalog feature. ■

Jane Goodale (828 N. 121 St., Omaha, NE 68154) is employed by Western Electric.

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Directory Information, Please

by Charles Knight

No disk directory can suit everyone's needs. But this one, written for LDOS, has enough flexibility to be adapted with relative ease.

Almost on Day 1, the average disk-drive owner finds he needs to catalog his programs and data files. Many programs do the job, but none of them can be all-inclusive.

They range from simple programs that store only a program name and disk number to more elaborate programs that let you add to the file. Some use a simple CMD"DIR" statement and PEEK the filespecs from the screen, severely limiting their usefulness, while others use machine-language disk-read routines and require only a single-density disk with its directory on track 17.

All such disk catalog programs that I've seen use memory to store the information and write the file to disk after sorting and processing the file in memory. This method is fast, but has one major disadvantage: it only lets you store a fixed number of file names at a time. If you have too many, you must break your catalog up into several smaller files. If you use a printout to locate a file, you can spend quite some time to find which of a group of printouts contains the entry for the desired file. You also can't create one large sorted printout of all of your files.

I wrote this database management system to get around this limitation. I did have to make a trade-off though—because the program can deal with a database much larger than available

memory, the data files will take a long time to sort. This is a problem inherent in any hardware design using 5¼-inch floppies, since data must be moved around physically on the disk and disk-access speed is limited. A 5,000-record file can take overnight to sort.

But most of us do sleep and go to work, and you can use these times. Also, most databases don't need constant sorting. I sort at three- to six-month intervals.

And if your database is small (under 800 items), the sort time is only a few seconds.

Requirements

The program had to read and catalog all of my disks whether they were single- or double-density regardless of what operating system created them. I couldn't accommodate the Percom DBLDOS format (which is also the NEWDOS80 standard), but I don't use these two much, anyway. I use LDOS almost exclusively.

I wanted to know at a glance not only which disk my file was on, but also something about that file. Since I often have several versions of a similarly named program, I needed to know the file size and attributes to identify the file. Also, I wanted to know whether the disk it was on was single- or double-density, and whether that disk had any free

space left. In addition, I wanted to print labels for the disks as they were read in by the system so I could label them promptly—before I got them out of order again.

LDOS offered locations in memory where all the information I wanted was kept, and it was a simple matter to extract it and place it within my database. Since I do use an occasional single-density disk formatted under DOSPLUS, NEWDOS80 version 1, and NEWDOS 2.1, I wanted to have my database program handle its repair to LDOS readable status for me.

The one common feature I didn't need was the ability to add user comments about the file, since I'm too lazy to use such a feature anyway.

The database system I came up with consists of these program modules:

- MAGIDEX/CMD—Machine language convenience loader.
- MAGIDEX/BAS—Menu program to call up the other modules.
- DREADER/BAS—Directory reader and database builder.
- SORT/BAS—Sort program for LDOS 5.1.0 and later.
- SORT50/BAS—Sort program for LDOS 5.0.3 and earlier.
- PRINT/BAS—Module for printing out the database.
- UTILITY/BAS—Module for changing the database defaults.

MAGIDEX/CMD is a convenience loader for the rest of the system. You can enter LBasic and simply run MAGIDEX, but that requires more typing and lacks elegance. The source code here is in EDAS format. If you use ED-TASM, you'll have to put each graphics character on a separate line with its own

DEFB statement. This loader uses a jump vector at X'4405' that will load and execute a load file format program. LBasic, of course, is such a program. This vector is in TRSDOS also, but its use is severely limited for Basic programs by those annoying and rarely needed HOW MANY FILES and MEMORY SIZE messages. By pointing the HI register pair to a buffer that contains the command to be executed, followed by a carriage return and a jump to this vector, the command in the buffer will be executed along with any parameters that happen to be with it.

This loader module also displays some pleasing graphics while LBasic is loading and executing. You don't have to type in this machine-language loader, but you'll save time and have a more professional-looking software package.

MAGIDEX/BAS serves as a menu from which the other modules are called, and ties them together into a complete database-management system. It first checks to see if the system has been initialized by searching for a data file named TRANSFER/DAT, which contains all the data items that must be passed from program to program. If TRANSFER/DAT isn't there, MAGIDEX/BAS will assume that the system has not been initialized.

Much of the screen is devoted to a dynamic graphics presentation. This assures you that the machine is still running, and improves the program's appearance. The menu will also display your name, the number of disks, and the number of files currently in the system. If you haven't built your files yet, it'll tell you that instead.

You're given four options. The first is "Enter more disks," which you select if you're running the program for the first time or if you've got some new programs to add. It calls the DREADER/BAS module and sets up the system to read the file names and other disk data from your disks.

The second is "Sort data." This module checks which version of LDOS you're running and calls the proper sort module.

The third option is "Print Disk Data," which loads the printout module that searches the database and prints out the information you've catalogued.

The final option, "End Program," returns you to LDOS command level after displaying a short message. You should always exit MAGIDEX this way to be sure that all files are closed.

DREADER/BAS

The DREADER/BAS module is the

heart of the system. It reads in the disks one at a time, assigns each one a disk number, and builds the database. It also lets you select certain options. If this is the first time you've run the program, or if you're starting a new database, you'll be asked your name, which will become a part of the system and will be used on the printouts and in the menu program.

Next, you're asked if you want to include invisible files. Normally, the only ones you'll have are those that are part of your operating system; you won't want to include them, so answer "N." (You can answer yes or no questions in either upper- or lowercase.)

Now you enter the number of the disk drive you want to use to hold your files. You *must* leave the disk in that drive while you're running the database, or you might lose all your data. You can change drives only by using the UTILITY/BAS program described later.

Next, you're asked if you want to print disk labels as the disks are read in. If you answer "Y," be sure your printer is loaded with standard mailing labels such as those sold by Radio Shack. The information printed on the label will be the disk name and date, amount of free space in both grans and K, disk size and number of sides, single- or double-density, and the number of cylinders on the disk.

Now (and each time the system has finished with a disk) you'll be prompted "Enter the drive containing the disk to be read:" and a blinking question mark for a cursor. If you're finished cataloging disks, answer with "@," and the system will close files and return you to the menu. Do this periodically to be sure that a parity error or some other malfunction doesn't leave you with an unusable set of data files, and a greatly expanded vocabulary as well.

Suppose you answer with "2." At this point, the program will begin reading the GAT sector of the disk in drive 2 to determine its name, date, and amount of free space. This information will be printed at the top of the screen.

Next, the program will open the directory of the target disk as a random file and begin to read in all files, discarding those that have been killed or are system files. As each file is catalogued, it is displayed on the screen, together with its attributes and its size. Two files show on the screen at one time, so if you have a speed-up modification, you'll have to be a fast reader to keep up. When the program finishes reading the disk, you'll get the prompt

again to enter a drive number.

If for any reason LDOS or LBasic can't open the file DIR/SYS on the target disk, you'll receive the prompt "Directory not readable by LDOS, do you wish to attempt to repair it?" If you answer "N," you'll again be prompted to enter the drive number. If you answer "Y," the file REPAIR/CMD, which comes with all versions of LDOS past 5.0.2, must be on one of the disks in the system—preferably in drive 0. This program is then executed; if the repair is successful, the disk can now be read. If not, you'll be told so and returned to the drive number prompt. No harm is done to a disk that cannot be repaired.

If the disk has anything wrong that makes its directory unreadable, you'll reach this part of the program. This option is necessary because TRSDOS and NEWDOS 2.1 write an incorrect hash code for the file DIR/SYS, and the operating system can't find that file. It's worth noting that the hash code for BASIC/CMD on a TRSDOS disk is also incorrect, but this one does work. Under LDOS, the directory data address mark has nothing whatever to do with its ability to read the directory from LBasic as though it were a random data file.

While you're running the DREADER/BAS module, you may want to have MONITOR/CMD from Misosys resident to intercept disk errors and give you a chance to repeat a sector write in the event of an error. This will mess up the nice graphics on the screen, but it may save your data files by giving you second and third tries at a sector write. I also recommend running with SYS1 through SYS3 and SYS8 and SYS10 resident (LDOS 5.1 only), to speed up the disk reading operation. You'll have to get them back out of memory, though, before you try to sort the file.

You will suffer a total program crash if you get a disk I/O error while writing the file TRANSFER/DAT after you've read in all your disks and requested a return to the menu; the program will hang in an error-trap loop. Since TRANSFER/DAT is written to just before returning to the menu, the odds of such a crash happening are slim, so I haven't written code for this possibility.

Manipulating the Data

SORT/BAS and SORT50/BAS are the data-manipulating hands of the system. After you've read in all your disks, it's time to sort your data file into alphabetical order. As mentioned above, if you have more than 800 filespecs in your file, you should allow quite a

while. A 1,000-record file will take about two hours to sort; a 5,000-record file will probably require overnight. The number of disks you have doesn't matter. Only the number of filespecs is important.

I've got some 2,800 records in my library, and it takes about six hours to sort them. I store the records on a single-density system disk, so you can imagine the total capacity of the system.

The sort can be postponed for now and the printout module will still work, but the printout won't be sorted. In fact, it will be a printout by disk in the order in which they were read. You can still use the sequential search features in the system, though. If the file is less than 800 records, the entire file is brought into memory for the sort. In either event, you should back up the files before trying to sort them because of the large amount of disk I/O going on. The module for LDOS 5.0 uses a shell-sort algorithm and the LSET statement to by-pass Microsoft's garbage-collection routines. Because all of the strings being sorted are the same length (32 bytes), this LSET technique is the fastest, and it's a whole lot easier than using VARPTR and POKE. If you're using LDOS 5.1, the records are pulled into memory and the CMD"O" machine-language sort of LBasic is used.

The versatility built into these sort modules keeps you in control of the tradeoffs necessary due to memory limitation. If you restrict yourself to short files as other catalog programs require, the sort will be quick; if you prefer a larger database, you can have that as well. You can't quite have your cake and eat it too, but you've got more flexibility than with most software.

PRINT/BAS

Think of PRINT/BAS as the mouth of the database system. From this module, you get hard copy and video. The ultimate function of any database-management system is the printout. This module provides several options.

Option 1—Print file to printer. This sends the entire file to the printer in the order in which it is stored on the disk. (Either as the files were read or alphabetically, depending on whether you've sorted the file.) You're asked for a starting and an ending record number. If you press enter twice, you send the entire file to the printer. The output is formatted to print nine filespecs per page, and each filespec is outdented from the rest of the information for easy reference. You can print the entire file once and keep the information in a binder.

This printout contains nearly all the information in the directory about the file except its location on the disk. Of course, the inventive programmer can add that, too, but I don't need that much information. Each page is numbered and has a title header printed at its top. You can select the short-form printout option to save paper or if you have a slow printer, but the printout won't contain nearly as much information about the files. The long-form printout is the reason for this program and is what makes it unique among directory management systems.

Option 2—Search for a specific file. This option lets you search for a particular filespec, partspec, or extension. It is an instring sequential search.

You're asked to enter the filespec or partspec to be searched for. For example, if you input /BAS, you'll find all files that have /BAS as an extension. BAS finds BASCOM, HELP/BAS, and BASIC/CMD. Use only uppercase, since that's how the filespecs are stored.

Then you're asked if you want output to your printer. Any input other than "Y" or "y" outputs to the screen only. Each file is displayed on the screen; if you don't specify printer output, you're prompted to press enter for the next record. Should the search not find anything, you're automatically returned to the menu. Whenever the flashing "enter" appears on the screen, you can press the up arrow instead of enter and return to the print module menu. Most printouts also abort to the menu if you hold the up arrow down. Disk I/O and other errors return to the menu too, but you're told that first and asked to press the enter key.

Option 3—Printout of all files to the screen. This is the same as option 1 except that output is to the video only. Pressing enter displays the next record; pressing the up arrow aborts back to the print module menu. The lower part of the screen clears just before the display of each file.

Option 4—Return to master menu. This is the proper way to exit the print module and return to the database master-menu. Note that the number 4 is used in both the print module and the menu for the exit option (making it easier to remember).

Option 5—Printout of header data. This option prints out information about the disks only, not about the files on them. The printout is such that you can cut it out and file it with or on the disk jacket.

Option 6—Printout of files by disk. This is a sequential search and printout

routine. It asks for the starting and ending disk number; pressing enter twice here defaults to print the entire file. Each record comes from the HEADER/DAT file, and the DIRECTORY/DAT file is searched for files that match this disk number. The output is directed to the screen or both printer and screen. The defaults output the entire file to the screen only.

Since this sequentially searches the whole file once for each disk, it can take quite a while to perform for all disks on a very large file. If you're making a printout, you won't mind taking time out for a Coke or watching something on tv while the computer does the dirty work for you.

All of the program modules include a routine used on initialization. You must determine if a file called TRANSFER/DAT exists. If not, some of the modules return to the menu. In the case of the menu itself, it displays certain messages to note that the system is not yet initialized. In the MAGIDEX/BAS program, this routine is at lines 160 to 280. By placing the open statement after an ON ERROR GOTO statement, you can determine the existence of the file TRANSFER/DAT and take appropriate action.

The routine for blinking all the graphics blocks in MAGIDEX/BAS is a loop at lines 720 to 820. This loop executes until you press a key between 1 and 4. Each time the loop executes, the value of CK increases by two. If that value exceeds 30, it sets to 5 to keep the flashing graphics bars within the limits of the screen. The PEEK in line 880 checks the OSVER\$ within LDOS to determine which of the two sort modules should be loaded.

In SORT/BAS, the first order of business is to determine the length of the data file. This value is contained within TRANSFER/DAT and is read into the variable IN. Regardless of the actual number of records in DIRECTORY/DAT, the system assumes that the value read in is the length of the file. Thus, you should make sure that you always use the correct TRANSFER/DAT to keep from ruining your database. If you have more than 800 files, the external sort in lines 520 to 720 runs. If not, the routine at 780 to 1020 executes. If you meet an out-of-memory error, the program tells you that the SYSGEN is probably too large and reminds you to reduce it by aborting to line 1040. If you are running under LDOS 5.0, the module SORT50/BAS executes instead of SORT/BAS. The major difference is in lines 820 to 1300. SORT0/BAS has a

shell-sort algorithm. Although you can't run SORT50/BAS under LDOS 5.1, the sort is slightly slower; instead of taking about a minute for 800 files, it takes about six. Since LBasic has the CMD"O" function, it's foolish not to use it. They both perform the same on files longer than 800 records. You may elect not to key in the sort routine you don't need, but MAGIDEX/BAS must have its line 880 modified accordingly.

The DREADER/BAS module is where most of the work is done. The AB\$ array is set to the attributes a file can have. Should you ever receive the display of "*****" for a file's attributes, copy it to another disk: its directory entry has been clobbered. Bits 0, 1, and 2 of the first byte of a file primary directory entry, or FPDE, contain the attributes of a file. The value thus obtained is used as the subscript to print out the correct text to match the attributes of a file. The same technique is used with MO\$ to select the text for the month.

Lines 280 and 300 define two functions that will be called often during program execution. Line 280 removes the right blanks from a filespec that is less than eight characters long, while line 300 defines the function for adding the colon before the drive specification.

The main directory-read loop begins

at line 640. First, the file DIR/SYS on the requested drive opens with a logical record length of 1 and the subroutine at line 1680 reads its granule allocation, or GAT table. Then the directory reopens with a logical record length of 32 bytes. As soon as the disk is read, the drive code table, or DCT, contains all the information about density, size, etc. and all you need to do is PEEK it out. Since the DCT is exactly 10 bytes long, just multiply the drive number by 10 and add the result to the start of the DCT to get the DCT for the correct drive.

The DCT for drive 0 begins at 18176, but the first byte you're concerned with is at 18179. This byte contains the density and size of the disk just accessed. Based on the value of the proper bit, SDS is set to indicate the correct condition in line 680 and D8\$ is set in line 700. Bit 5 in the next byte tells you that the disk is two-sided if it is set. The Device command in LDOS reads the DCTs in a similar manner and reports on their status, which LDOS remembers according to the last disk accessed by that drive. By adding 1 to the number PEEKed from 18182, you can see how many cylinders were on the last disk read.

After fielding the buffer in line 820 to match the bytes in the directory you want to read, the program enters a loop

beginning at line 860. Line 900 tests bits 4 and 7 to determine that the file hasn't been killed or that the entry is not a file extended directory entry, or FXDE. The next line tests bit 3 and the flag to indicate whether invisible files are to be included and exits if both tests pass. You won't normally want to include system files in the directory, so they're eliminated in line 940. After the program decides that the file is to be included, the filespec is constructed in line 960 by adding a slash after the filespec and before the extension. At this time, two subroutines are called to determine the file's attributes and unpack the data into a format more recognizable by us humans. The logical record length is adjusted in line 1040. This value will be the actual LRL if it is anything but zero, but if it's zero, then the true LRL is 256. By checking the password hash codes in lines 1060 and 1100, the program sees whether the file is password protected and, if so, whether its password is PASSWORD. Of course, if you had all day to read each directory you could decode each password to one that would work, but that isn't the purpose of a disk directory management program.

The code in line 1140 removes the slash mark added earlier if the file has no extension. Then a subroutine is called which calculates the size of the

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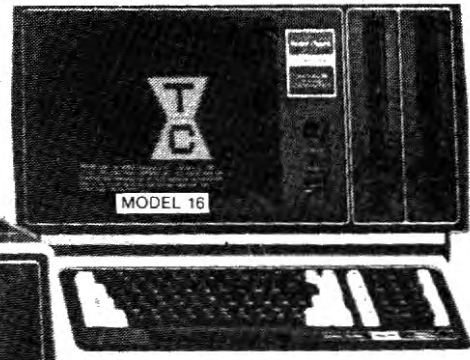
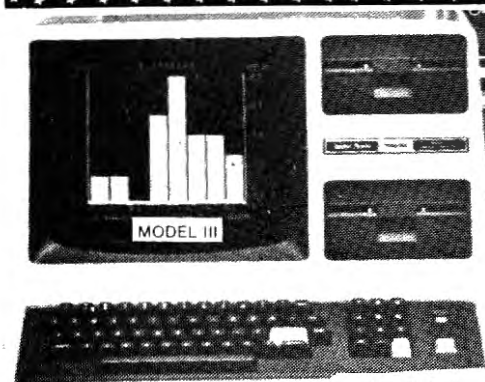
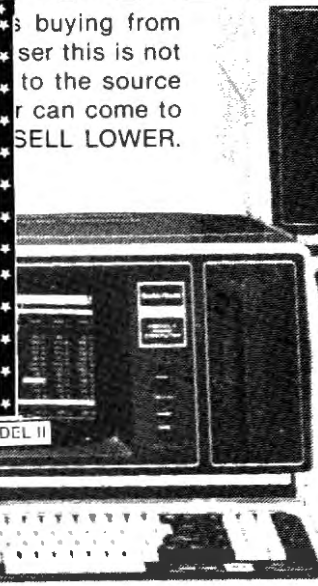
CHRISTMAS BONUS

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file both in granules and kilobytes. At this point, after the information appears on the screen, the data is written into the file DIRECTORY/DAT and the procedure repeats for the next directory entry. When the directory has been completely read, the files are closed to update the EOF pointer so that the files won't be completely lost if an I/O error occurs. Then control is passed back to line 540, where the process can be repeated on the next disk in your library.

The subroutine at line 1860 calculates the free space on the disk by reading the GAT table and checking each bit of each byte to determine if the granule it represents is allocated or free. Only the high four bits are checked, since this is all that LDOS uses. In line 2120, the number of free granules is converted into K and the subroutine returns with EE equal to the number of free grans and EK equal to the amount of free space.

The subroutine at line 2180 writes the data to the file DIRECTORY/DAT, which contains information about the files, while the subroutine at line 2340 handles writes to the file HEADER/DAT, which contains information about the disk. As you can see, the relative sizes of these two data files will vary depending on how many files are on

each disk. A pointer stored within DIRECTORY/DAT points to the correct data in HEADER/DAT. This is why it's not possible to calculate exactly how many disks may be stored in a given amount of disk space. I'll wager, though, that a double-density 40-track data disk will hold more files than you'll ever have.

The screen graphics routine is next at line 2620. This is called at program initialization; the screen is redrawn each time you call the program REPAIR/CMD, since it clears the screen before executing. The data-input routine is at line 2700. This versatile routine accepts only a predetermined amount of characters, and returns with the input stored in TT\$ only after you hit the enter key. Before you call it, S and E must be loaded with the starting and ending points on the screen where input is to be accepted. The length of the input string is the difference between them. The routine takes care of calculating this and keeps the result stored in C.

The file TRANSFER/DAT is written to in the routine at line 3020. The data stored in this file is VI, the flag indicating whether or not the operator wants to include invisible files; D2 and D2\$, the drive number that the data files will be

written on; DN, the current highest disk number assigned; IN, the number of filespecs currently stored in the system; and KT\$, your name. This file will never occupy more than a granule of disk space, but it must be present to let the programs communicate with each other.

The rest of the program contains the error-trapping routines. If an error occurs that the program hasn't planned for, control passes to line 3340, which jumps to 3020, the exit routine. The screen shows the error-code number while the menu program is loading. This procedure assures you that all files are closed and have their directory properly maintained, should recovery be necessary.

I dislike reconstructing data files, so I exit the DREADER/BAS program after every 15 or 20 disks have been read and make a back-up of all three data files.

PRINT/BAS

PRINT/BAS is the longest of the modules. It reads the data files created by DREADER/BAS and outputs them to the screen or printer. After you initialize, control passes to line 980, which displays a menu on the screen. Line 1220 is a loop that prints a moving ar-



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row as a prompt. The ON...GOTO statement in line 1360 goes to the proper routine; otherwise, the position of the arrow advances and the loop repeats.

The routines at line 1400 and line 300 are similar. They print the entire file, though part of the file can be printed if you know the record number range. I wrote these routines separately to let you modify the printout format without affecting the video. The code is longer, but more versatile.

Line 2040 provides pagination, so I recommend that no printer filter be resident or that you do a RESET *PR before running this program. You might wish to add line 30 in PRINT/BAS to read: 30 CMD"RESET *PR. The printout never exceeds 64 characters in width, and six filespecs are printed on each page.

The search routine beginning at line 2160 is a sequential search using the INSTR function of LBasic. I could have used a tree search that would be faster, but such a search would require a sorted file. This short routine finds any filespec that contains the sequence of entered characters regardless of where in the filespec that sequence occurs. Line 2420 samples the keyboard during each compare and aborts if you press the up arrow.

The subroutine at line 3720 paginates by checking the current line number stored in the printer device control block, or DCB, and comparing it with 50 to see if a full page has been printed. If so, a form feed goes to the printer and a new header prints across the top of the page. You can select the range of disk numbers to be retrieved; press enter twice to default to print the entire file.

The routines beginning at line 3820 are a copy of the other file-scanning routines, but with the statements in a different order and a somewhat different format. This lets you print out the files by their disk number rather than alphabetically. If you've sorted your database, the files will be alphabetized within each group; otherwise, they'll be in the order in which they were read from the disk's directory.

The error trap in this module (line 5000) is not as complicated as that in the DREADER/BAS module. Its purpose is to return you to the menu if any error should occur. To let you debug, the error code and line number are displayed, and you must press the enter key to return to the menu.

Even though it is less than a full sector in total length, the file TRANSFER/DAT contains information that the program modules cannot function

without. If this file does not exist somewhere in the system, all of the modules will assume that you haven't initialized the system yet. Some will abort back to the main menu; others will prompt you to initialize. In any case, if you have any other file named TRANSFER/DAT, the program will read it; if it isn't the right one, pandemonium will break loose. In fact, this file is so important that nothing in the system can be accessed without it.

A disadvantage of the system is that if you buy another drive and wish to change the disk you're storing your data on, you can't do so without modifying the data within this file. You also might be faced with a reconstruct of one of the other files, so I included a utility to deal with these needed changes to TRANSFER/DAT. Since you won't normally be entering this module as part of running this program, this utility has no special menu selection. You type RUN"UTILITY/BAS"; it will prompt you through its operation. You can change any of the system data here that you want to; the changes are not permanent until you exit the program. Know what you are doing and work on a backup of the file! Even though you can abort without making your changes permanent, you can destroy all your files if you aren't careful. When you're finished editing TRANSFER/DAT, the utility will return you to the main menu.

MAGIDEX/CMD

The sole purpose of the file MAGIDEX/CMD is to load and execute LBasic and then load and execute the program MAGIDEX/BAS. You need not key in this part of the program if you don't want to or if you don't know how to use an editor/assembler. It is presented here in the format used by EDAS, and will have to be modified for EDTASM. You'll need to change lines such as 210 into two separate line numbers, each with one byte and one DEFB opcode. Lines to be changed are 180, 210, 220, 230, 240, 250, 260, 270, 280, 290, and 300. Lines 120, 130, and 140 should be deleted since EDTASM does not recognize these pseudo-ops. This loader sets up a temporary buffer at X'B000' for the command LBasic RUN "MAGIDEX/BAS" and a concluding carriage return. Since no part of this buffer can be clobbered by the loaded program, I have OR'ed it in the middle of RAM, well out of harm's way. This loader merely places some graphics and a message on the screen and jumps to X'4405' with the HL register pair pointing to the command to be executed.

This vector is in TRSDOS and NEW-DOS, and I think in all the other DOSes, and can be used as a way to protect your programs from prying eyes. Here I've used it for convenience, as the programs can be executed from LDOS Ready and will return to command level when finished. Even in this simplified form, such a loader could confuse the new computer user into thinking that your program is tamper-proof, especially if you add passwords to all the modules.

If you're using a Model III, you'll have to change a couple of lines. Do not key in SORT50/BAS because there never was an LDOS 5.0 for the Model III. In the module MAGIDEX/BAS, make line 880 read: RUN"SORT/BAS". In the SORT/BAS module, delete lines 160 and 180. In the module PRINT/BAS, you may want to change the up arrow to one of the special characters available on your computer, because a flashing left bracket is not particularly attractive. This should be done in line 1260. The address X'4405' will have to be changed to the correct one for the Model III also. Consult your LDOS manual for the address of the @RUN vector. These should be the only changes required for operation on a Model II under LDOS 5.1.

If you decide to key in these programs, I recommend that you make each statement that contains an ON ERROR GOTO statement into a REM so that the error traps won't throw you when you're debugging your typing. This is good advice for any program, but particularly this one, since an error can cause an immediate return to the menu module and the unrecoverable loss of the program you're trying to debug. After you've corrected all your typing mistakes, you can remove the REM tokens.

Be sure to name the programs exactly as shown, because each module calls the other and they must have the right name. If you're running an LDOS earlier than 5.1.2, you should name the menu module simply MAGIDEX instead of MAGIDEX/BAS to allow for the difference in default extension handling in LDOS 5.1.2.

Disk-drive catalog programs are like spouses: there's only one that's just right for you. This one is exactly right for me, but I've tried to make it easy to modify so that you can make it just right for you. ■

Charles Knight can be reached at 2708 Roberts Circle, Arlington, TX 76010.

Tiger Graphics

by Barbara Clinger

Use the IDS-445 Paper Tiger to print graphics using Basic, Pascal, and Assembly language.

My selection of a printer was based on three things: quality, price, and graphics capabilities. The IDS-445—often called the Paper Tiger—gave me everything I wanted in a printer except lowercase descenders. However, there

is a great difference between having a printer with graphics capabilities and actually using it to draw graphs.

The programs in this article illustrate how to use the full graphics capabilities of the Tiger by controlling the individual dots. In fact, these programs graph functions as they would appear on standard graph paper with one-quarter-inch grids.

This article is in two sections; the programs in the first part are written in Level II Disk Basic using NEWDOS80, but will run under TRSDOS 2.3 as well as NEWDOS+. With some modifications they will run with Level II Basic and at least 16K of memory. The

Program Listing 1

```

5 'EXAMPLE 1
10 DEFUSR0=&H7C08:DEFUSR1=&H7D17:DEFUSR2=&H7D65
20 DEFUSR3=&H7C01:CLS
30 DEFINT I,J,T,U,V
40 I6=16:I8=18:P5=.5
50 INPUT"INPUT H";H:POKE&H7DF7,H:POKE&H7DF8,0
60 INPUT"INPUT K";K:POKE&H7DF9,K:POKE&H7DFA,0
70 INPUT"INPUT PHIGH";I:POKE 32239,I:POKE 32240,0:V5=I8*I
80 INPUT"INPUT PWIDE";I:POKE 32241,I:POKE 32242,0
90 Z=USR0(W)
100 DEF FNY(X)=2*X-3
110 INPUT"ENTER THE DOMAIN";A1,A2
120 I1=INT(I6*(A1+H)+P5):I2=INT(I6*(A2+H)+P5)
130 FOR U=I1 TO I2:Z=USR3(U)
140 V=INT(I8*(K+FNY(U/I6-H))+P5)
150 IF V<0 OR V> V5 THEN 210 ELSE Z=USR1(V)
160 IF U=I1 THEN 210
170 IF ABS(T-V)<3 THEN 210
180 IF T>V THEN J1=V+1:J2=T-1
190 IF T<V THEN J1=T+1:J2=V-1
200 FOR I3=J1 TO J2 STEP 2:Z=USR1(I3):NEXT I3
210 T=V
220 NEXT U
225 Z=USR2(W)
230 END
    
```

The Key Box

**Model I
32K RAM
105-445 Printer
Pascal 80
Tiny Pascal**

Program Listing 2

```

00001 ;TIGERGRAPH
00002 ;BARBARA CLINGER
00003 ;DEPARTMENT OF MATHEMATICS
00004 ;WHEATON COLLEGE
00005 ;NORTON, MASS. 02766
00006 ;
00007 ;
7C01 00010 ORG 7C01H ;START OF GETU
7C01 CD7F0A 00020 GETU CALL 0A7FH
7C04 22FB7D 00030 LD (U),HL
7C07 C9 00040 RET ;END OF GETU
7C08 00050 ORG $ ;START OF AXES
7C08 ED5BEF7D 00060 AXES LD DE,(PHIGH) ;X-Y AXES AT (H0,K0) IN
    
```

Listing 2 continues

```

7C0C 3E12      00070      LD      A,18      ; THE PAGE
7C0E 0E00      00080      LD      C,0
7C10 CDDE7D    00090      CALL    MULT      ;PAGEH=18*PHIGH
7C13 22F57D    00100      LD      (PAGEH),HL
7C16 ED5BF17D  00110      LD      DE,(PWIDE)
7C1A 3E10      00120      LD      A,16
7C1C 0E00      00130      LD      C,0
7C1E CDDE7D    00140      CALL    MULT      ;PAGEW=16*PWIDE
7C21 22F37D    00150      LD      (PAGEW),HL
7C24 7D        00160      LD      A,L
7C25 4C        00170      LD      C,H
7C26 ED5BEF7D  00180      LD      DE,(PHIGH)
7C2A CDDE7D    00190      CALL    MULT      ;3*(PAGEW)*(PHIGH) EQUALS
7C2D EB        00200      EX      DE,HL      ; THE NUMBER OF BYTES IN
7C2E 3E03      00210      LD      A,3        ;THE PAGE
7C30 0E00      00220      LD      C,0
7C32 CDDE7D    00230      CALL    MULT      ;(HL)=3*(PAGEW)*(PHIGH)
7C35 44        00240      LD      B,H
7C36 4D        00250      LD      C,L
7C37 2100A0    00260      LD      HL,PAGE    ;ZERO THE PAGE
7C3A 3600      00270      LD      (HL),0     ZLOOP
7C3C 23        00280      INC     HL
7C3D 0B        00290      DEC     BC
7C3E 78        00300      LD      A,B
7C3F B1        00310      OR      C
7C40 20F8      00320      JR      NZ,ZLOOP   ;SEE IF PAGE IS ZEROED
7C42 3E00      00330      LD      A,0
7C44 32FB7D    00340      LD      (U),A      ;U MAKES LEFT HASH MARK
7C47 3E20      00350      LD      A,20H     ; ON THE Y-AXIS
7C49 32FD7D    00360      LD      (V),A      ;V MAKES THE RIGHT HASH
7C4C 3AF77D    00370      LD      A,(H0)     ; MARK ON Y-AXIS
7C4F FE00      00380      CP      0          ;SEE IF Y-AXIS = V-AXIS
7C51 CA597C    00390      JP      Z,ISEQU
7C54 3E20      00400      LD      A,20H
7C56 32FB7D    00410      LD      (U),A
7C59 2AF37D    00420      LD      HL,(PAGEW) ISEQU
7C5C 7D        00430      LD      A,L
7C5D 4C        00440      LD      C,H
7C5E 110300    00450      LD      DE,3
7C61 CDDE7D    00460      CALL    MULT      ;FIND 3*PAGEW=NO. SPACES
7C64 E5        00470      PUSH   HL         ;BETWEEN Y MARKS
7C65 3E10      00480      LD      A,16
7C67 0E00      00490      LD      C,0
7C69 ED5BF77D  00500      LD      DE,(H0)
7C6D CDDE7D    00510      CALL    MULT      ;FIND 16*H
7C70 1100A0    00520      LD      DE,PAGE
7C73 19        00530      ADD    HL,DE      ;PAGE+16*H
7C74 E5        00540      PUSH   HL
7C75 2AEF7D    00550      LD      HL,(PHIGH) ;# OF Y HASH MARKS
7C78 45        00560      LD      B,L
7C79 E1        00570      POP    HL
7C7A D1        00580      POP    DE
7C7B 22037E    00590      LD      (TEMP),HL MARKY
7C7E DD2A037E   00600      LD      IX,(TEMP) ;IX POINTER TO Y-AXIS
7C82 3AFB7D    00610      LD      A,(U)
7C85 DD77FF    00620      LD      (IX+255),A ;MARK LEFT OF Y-AXIS
7C88 3AFD7D    00630      LD      A,(V)
7C8B DD7701    00640      LD      (IX+1),A   ;MARK RIGHT OF Y-AXIS
7C8E 19        00650      ADD    HL,DE      ;FOR NEXT HASH MARK
7C8F 10EA      00660      DJNZ   MARKY
7C91 2AF37D    00670      LD      HL,(PAGEW) ;BEGIN TO MARK X-AXIS
7C94 7D        00680      LD      A,L
7C95 4C        00690      LD      C,H
7C96 ED5BF97D  00700      LD      DE,(K0)
7C9A CDDE7D    00710      CALL    MULT      ;FIND K*PAGEW
7C9D 110300    00720      LD      DE,3
7CA0 7D        00730      LD      A,L

```

7CA1	4C	00740		LD	C,H	
7CA2	CDDE7D	00750		CALL	MULT	; (HL)=PAGE+3*K*(PAGEW)
7CA5	1100A0	00760		LD	DE,PAGE	; POINTS X-AXIS
7CA8	19	00770		ADD	HL,DE	
7CA9	2B	00780		DEC	HL	
7CAA	E5	00790		PUSH	HL	
7CAB	110F00	00800		LD	DE,15	
7CAE	A7	00810		AND	A	
7CAF	ED52	00820		SBC	HL,DE	
7CB1	111000	00830		LD	DE,16	
7CB4	E5	00840		PUSH	HL	; (HL)=PAGE+3*K*(PAGEW)-16
7CB5	2AF17D	00850		LD	HL,(PWIDE)	; LEFTMOST PART OF X-AXIS
7CB8	45	00860		LD	B,L	
7CB9	05	00870		DEC	B	; # HASH MARKS ON X-AXIS
7CBA	E1	00880		POP	HL	; IS (PAGEW)-1
7CBB	7E	00890	MARKX	LD	A,(HL)	
7CBC	F602	00900		OR	2	; MAKE DOT OVER X-AXIS
7CBE	77	00910		LD	(HL),A	
7CBF	E5	00920		PUSH	HL	
7CC0	D5	00930		PUSH	DE	
7CC1	ED5BF37D	00940		LD	DE,(PAGEW)	
7CC5	19	00950		ADD	HL,DE	
7CC6	22037E	00960		LD	(TEMP),HL	
7CC9	DD2A037E	00970		LD	IX,(TEMP)	
7CCD	DD7E00	00980		LD	A,(IX)	
7CD0	F620	00990		OR	20H	; MAKE DOT UNDER X-AXIS
7CD2	DD7700	01000		LD	(IX),A	
7CD5	D1	01010		POP	DE	
7CD6	E1	01020		POP	HL	
7CD7	A7	01030		AND	A	
7CD8	ED52	01040		SBC	HL,DE	; MOVE LEFT FOR NEXT MARK
7CDA	10DF	01050		DJNZ	MARKX	
7CDC	2AEF7D	01060	YAXIS	LD	HL,(PHIGH)	
7CDF	7D	01070		LD	A,L	
7CE0	4C	01080		LD	C,H	
7CE1	110300	01090		LD	DE,3	
7CE4	CDDE7D	01100		CALL	MULT	; 3*(PHIGH)=# OF BYTES FOR
7CE7	E5	01110		PUSH	HL	; Y-AXIS
7CE8	3E10	01120		LD	A,16	
7CEA	0E00	01130		LD	C,0	
7CEC	ED5BF77D	01140		LD	DE,(H0)	
7CF0	CDDE7D	01150		CALL	MULT	; FIND 16*H
7CF3	1100A0	01160		LD	DE,PAGE	
7CF6	19	01170		ADD	HL,DE	; PAGE+3*(H) POINTS TO
7CF7	D1	01180		POP	DE	; START OF Y-AXIS
7CF8	43	01190		LD	B,E	
7CF9	ED5BF37D	01200		LD	DE,(PAGEW)	
7CFD	363F	01210	YLOOP	LD	(HL),3FH	; 3FH MAKES COLUMN 6 DOTS
7CFF	19	01220		ADD	HL,DE	
7D00	10FB	01230		DJNZ	YLOOP	
7D02	2AF37D	01240		LD	HL,(PAGEW)	; START OF X-AXIS
7D05	2B	01250		DEC	HL	
7D06	44	01260		LD	B,H	
7D07	4D	01270		LD	C,L	
7D08	E1	01280		POP	HL	
7D09	7E	01290	XLOOP	LD	A,(HL)	
7D0A	F601	01300		OR	1	; MAKES ONE DOT FOR AXIS
7D0C	77	01310		LD	(HL),A	
7D0D	2B	01320		DEC	HL	; MOVE LEFT FOR NEXT DOT
7D0E	0B	01330		DEC	BC	; DECREASE COUNTER
7D0F	78	01340		LD	A,B	
7D10	B1	01350		OR	C	
7D11	FE00	01360		CP	0	
7D13	C2097D	01370		JP	NZ,XLOOP	; SEE IF DONE WITH X-AXIS
7D16	C9	01380		RET		; END OF AXES
7D17		01390		ORG	\$	; BEGIN OF PLOT
7D17	CD7F0A	01400	PLOT	CALL	0A7FH	; GET V FROM BASIC


```

7D1A 7C      01410      LD      A,H      ;TO PLOT (U,V)--DIVIDE V
7D1B 4D      01420      LD      C,L      ;BY 6, GET Q AND R THEN
7D1C 1E06    01430      LD      E,6      ;SET BIT 5-R IN BYTE
7D1E 1600    01440      LD      D,0      ;PAGE+Q*(PAGEW)+U
7D20 CDC87D  01450      CALL   DIVIDE
7D23 57      01460      LD      D,A
7D24 59      01470      LD      E,C
7D25 ED53FF7D 01480      LD      (QUOT),DE ;SAVE Q
7D29 22017E  01490      LD      (RMDER),HL ;SAVE R
7D2C 3AF37D  01500      LD      A,(PAGEW)
7D2F 0E00    01510      LD      C,0      ; DIVISOR ON DE
7D31 ED5BFF7D 01520      LD      DE,(QUOT) ;ON EXIT QUOTIENT IN AD
7D35 CDDE7D  01530      CALL   MULT      ; REMAINDER IN HL
7D38 ED4BFB7D 01540      LD      BC,(U)
7D3C 09      01550      ADD    HL,BC
7D3D 0100A0  01560      LD      BC,PAGE
7D40 09      01570      ADD    HL,BC      ;ADD ADDR OF PAGE
7D41 22037E  01580      LD      (TEMP),HL
7D44 DD2A037E 01590      LD      IX,(TEMP)
7D48 210500  01600      LD      HL,5
7D4B ED5B017E 01610      LD      DE,(RMDER) ;FIND 5 MINUS RMDER
7D4F A7      01620      AND    A        ;DETERMINE WHICH BIT
7D50 ED52    01630      SBC    HL,DE    ; TO SET
7D52 1601    01640      LD      D,1
7D54 7D      01650      LD      A,L
7D55 B7      01660      OR     A
7D56 2805    01670      JR     Z,RDONE  ;GO NO MORE ROTATES
7D58 47      01680      LD      B,A
7D59 CB22    01690      RLOOP SLA      D      ;ROTATE TO SET BIT
7D5B 10FC    01700      DJNZ  RLOOP
7D5D DD7E00  01710      RDONE LD      A,(IX)  ;GET CONTENTS OF BYTE
7D60 B2      01720      OR     D        ;INSERT NEW INFO IN BYTE
7D61 DD7700  01730      LD      (IX),A  ;STORE BACK INTO BYTE
7D64 C9      01740      RET
7D65        01750      ORG    $
7D65 3E03    01760      PRINT LD      A,3
7D67 CDBD7D  01770      CALL  OUTCHR
7D6A 0E00    01780      LD      C,0
7D6C ED5BEF7D 01790      LD      DE,(PHIGH)
7D70 CDDE7D  01800      CALL  MULT
7D73 2B      01810      PLOOP DEC    HL      ;COUNTER VERTICALLY IS
7D74 22FB7D  01820      LD      (U),HL  ;(U)=3*(PHIGH)-1
7D77 EB      01830      EX     DE,HL
7D78 2AF37D  01840      LD      HL,(PAGEW)
7D7B 7D      01850      LD      A,L
7D7C 4C      01860      LD      C,H
7D7D CDDE7D  01870      CALL  MULT      ;(HL)=U*(PAGEW)
7D80 1100A0  01880      LD      DE,PAGE
7D83 19      01890      ADD    HL,DE    ;(HL)=PAGE+U*(PAGEW)
7D84 110000  01900      LD      DE,0    ;IS THE COUNTER ACROSS
7D87 7E      01910      GETCHR LD      A,(HL)
7D88 FE03    01920      CP     3        ;**IF CHAR=3,PRINT TWICE
7D8A CCBD7D  01930      CALL  Z,OUTCHR  ;SEND CHARACTER
7D8D CDBD7D  01940      CALL  OUTCHR  ;SEND CHARACTER
7D90 13      01950      INC   DE      ;INCREASE POINTER
7D91 23      01960      INC   HL      ;INCREASE POINTER
7D92 E5      01970      PUSH  HL      ;SAVE POINTER
7D93 2AF37D  01980      LD      HL,(PAGEW) ;CHECK-SEE IF LINE DONE
7D96 2B      01990      DEC   HL
7D97 A7      02000      AND   A
7D98 ED52    02010      SBC   HL,DE
7D9A 7C      02020      LD   A,H
7D9B B5      02030      OR   L
7D9C E1      02040      POP  HL
7D9D C2877D  02050      JP   NZ,GETCHR ;CONTINUE IF NOT DONE
7DA0 3E03    02060      LD   A,3      ;**SEND END OF LINE SIGNAL
7DA2 CDBD7D  02070      CALL  OUTCHR

```

```

7DA5 3E0B      02080      LD      A,0BH      ;**
7DA7 CDBD7D    02090      CALL    OUTCHR
7DAA 2AFB7D    02100      LD      HL,(U)     ;CHECK-SEE IF PAGE DONE
7DAD 7C        02110      LD      A,H
7DAE B5        02120      OR      L
7DAF C2737D    02130      JP      NZ,PLOOP  ;CONTINUE IF NOT DONE
7DB2 3E03      02140      LD      A,3        ;**SIGNAL TO EXIT GRAPHICS
7DB4 CDBD7D    02150      CALL    OUTCHR
7DB7 3E02      02160      LD      A,2        ;**
7DB9 CDBD7D    02170      CALL    OUTCHR
7DBC C9        02180      RET      ;RET TO CALLING PROG
7DBD F5        02190      OUTCHR PUSH    AF      ;SUBR TO SEND CHAR
7DBE CDD105    02200      CHCKP  CALL    5D1H   ;CHECK STATUS OF PRINTER
7DC1 20FB      02210      JR      NZ,CHCKP  ;WAIT IF NOT READY
7DC3 F1        02220      POP     AF
7DC4 32E837    02230      LD      (37E8H),A ;SEND IT
7DC7 C9        02240      RET      ;RET TO PRINT
7DC8 210000    02250      DIVIDE LD      HL,0      ;FROM ZAKS
7DCB 0610      02260      LD      B,16     ;ON ENTRY DIVIDEND IN AC
7DCD CB11      02270      DLOOP  RL        C      ;          DIVISOR IN HL
7DCF 17        02280      RLA
7DD0 ED6A      02290      ADC     HL,HL    ;ON EXIT QUOTIENT IN AC
7DD2 ED52      02300      SBC     HL,DE    ;          REMAINDER IN HL
7DD4 3001      02310      JR      NC,$+3
7DD6 19        02320      ADD     HL,DE
7DD7 3F        02330      CCF
7DD8 10F3      02340      DJNZ   DLOOP
7DDA CB11      02350      RL      C
7DDC 17        02360      RLA
7DDD C9        02370      RET      ;END OF DIVIDE SUBROUTINE
7DDE 0610      02380      MULT  LD      B,16   ;FROM ZAKS
7DE0 210000    02390      LD      HL,0     ;ON ENTRY (A)=LSB MULTCND
7DE3 CB39      02400      MLOOP SRL     C      ;          (C)=MSB MULTCND
7DE5 1F        02410      RRA      ;          (DE)=MULTIPLIER
7DE6 3001      02420      JR      NC,MLOOP1 ;ON EXIT (HL)=PRODUCT
7DE8 19        02430      ADD     HL,DE
7DE9 EB        02440      MLOOP1 EX     DE,HL
7DEA 29        02450      ADD     HL,HL
7DEB EB        02460      EX     DE,HL
7DEC 10F5      02470      DJNZ   MLOOP
7DEE C9        02480      RET      ;END OF MULT SUBROUTINE
7DEF 02490     PHIGH EQU     $
0002 02500     DEFS   2
7DF1 02510     PWIDE EQU     $
0002 02520     DEFS   2
7DF3 02530     PAGEW EQU     $
0002 02540     DEFS   2
7DF5 02550     PAGEH EQU     $
0002 02560     DEFS   2
7DF7 02570     H0    EQU     $
0002 02580     DEFS   2
7DF9 02590     K0    EQU     $
0002 02600     DEFS   2
7DFB 02610     U    EQU     $
0002 02620     DEFS   2
7DFD 02630     V    EQU     $
0002 02640     DEFS   2
7DFE 02650     QUOT EQU     $
0002 02660     DEFS   2
7E01 02670     RMDER EQU     $
0002 02680     DEFS   2
7E03 02690     TEMP  EQU     $
0002 02700     DEFS   2
A000 02710     PAGE  EQU     0A000H
0000 02720     END
00000 TOTAL ERRORS

```

changes for Level II Basic are given at the end of this section.

The second section introduces new techniques and examples of graphing. However, these applications are developed in Pascal-80 rather than Basic. The Tigergraph program is modified to be used with Pascal-80.

Part I

The graphics dot-plotting mode provides the capability to control through software each print needle during horizontal scans of the print head across a page. The Tiger enters the graphics mode when the control character ASCII ETX (control C or hexadecimal 03) is received. In the graphics mode, the printer uses a raster scan technique allowing a vertical column of seven dots across a



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page (the seventh dot being repetitive unless printing the bottom row). Bit 7 is not used in the graphics mode and the remaining seven dot positions correspond to bits 0-6 of a memory byte organized as shown in Figs. 1 and 2.

When the printer is in the graphics mode, each control character must be preceded by the control character 03H. For example, to exit graphics mode the characters 03H followed by 02H must be sent to the printer. Consequently, when you want to send 03H as data and not have it be interpreted as a control code, it is necessary to send 03H to the printer twice. The control characters used in this article are 03H to enter the graphics mode, 0BH for vertical tab (end-of-line signal), and 02H to exit graphics.

The initial outline for the program consisted of the step-by-step process I use when I draw a graph. The resulting programs ended up closely following that process. The procedure goes as follows: First take a clean piece of graph paper (I prefer to use graph paper with one-quarter-inch grids.) On this paper draw the coordinate axes and mark off units. Second, plot enough points to determine the shape of the curve. Finally, fill in the sketch using the points as guides.

The three main portions of Tiger-graph (Program Listing 2) follow the original outline closely. The Axis routine zeros the page (clean paper), draws the coordinate axes, and marks off the units. The Plot routine does just that; it plots individual points, and the Print routine sends the information to the Tiger. Surprisingly enough, even when plotting points in adjacent spaces, if the graph is rising or falling rapidly, it is necessary to do some vertical filling in of points on the graph.

Now let's discuss the physical properties of the Tiger and define some terms I find useful. Visualize a blank page containing many spaces, each of which must either remain blank or have a dot printed in it. The term "page" will refer to a rectangular array of spaces of a pre-determined size. In fact, page is a memory block and contains the information

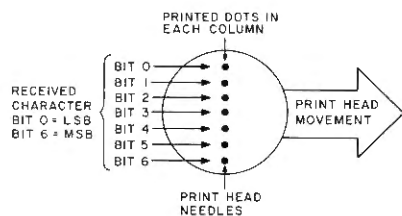


Figure 1

```

5 'POLAR EQUATIONS
6 'CHANGE LINE 100 TO DESIRED POLAR EQUATION
10 DEFUSR0=&H7C08:DEFUSR1=&H7D17:DEFUSR2=&H7D65
20 DEFUSR3=&H7C01:CLS
30 DEFINT I,J,T,U,V
40 I6=16:I8=18:P5=.5
50 INPUT"INPUT H";H:POKE&H7DF7,H:POKE&H7DF8,0
60 INPUT"INPUT K";K:POKE&H7DF9,K:POKE&H7DFA,0
70 INPUT"INPUT PHIGH";I:POKE 32239,I:POKE 32240,0:V5=I8*I
80 INPUT"INPUT PWIDE";I:POKE 32241,I:POKE 32242,0
90 Z=USR0(W)
100 DEF FN R(A)=2*(1 - COS(A))
130 FOR A=0 TO 6.2 STEP .05
140 U=INT(I6*(H+FN R(A)*COS(A))+P5):Z=USR3(U)
145 V=INT(I8*(K+FN R(A)*SIN(A))+P5):Z=USR1(V)
220 NEXT A
225 Z=USR2(W)

```

Program Listing 3

```

10 'PROGRAM CONICS/BAS
15 'BARBARA CLINGER
20 'DEPARTMENT OF MATHEMATICS
25 'WHEATON COLLEGE
30 'NORTON, MASS. 02766
40 DEFUSR0=&H7C08:DEFUSR1=&H7D17:DEFUSR2=&H7D65
45 DEFUSR3=&H7C01
50 DEFINT I,J,T,U,V
55 I6=16:I8=18:P5=.5
57 PRINT"PHIGH = PAGE HEIGHT PWIDE = PAGE WIDTH
60 INPUT"INPUT PHIGH";I:POKE 32239,I:POKE 32240,0:V5=I8*I
65 INPUT"INPUT PWIDE";I:POKE 32241,I:POKE 32242,0
70 INPUT"INPUT H0";H:POKE&H7DF7,H:POKE&H7DF8,0
75 INPUT"INPUT K0";K:POKE&H7DF9,K:POKE&H7DFA,0
80 Z=USR0(W)
85 INPUT"CHOICES (1) INPUT CONIC (2) DRAW (3) END";I
90 ON I GOTO 100,95,725
95 Z=USR2(W):GOTO 85 'ZERO PAGE AND DRAW AXES
100 PRINT"CHOICES OF CONICS TO GRAPH:";TAB(30)"(1) LINE
105 PRINT TAB(30);"(2) PARABOLA
110 PRINT TAB(30);"(3) CIRCLE
115 PRINT TAB(30);"(4) ELLIPSE
120 PRINT TAB(30);"(5) HYPERBOLA
125 INPUT"ENTER THE APPROPRIATE NUMBER ";J
130 IF J<1 OR J>5 THEN 100
135 ON J GOTO 150,320,450,450,565
145 'DRAW LINE
150 PRINT"OPTIONS FOR FORM OF LINE:";TAB(30)"(1) TWO-POINT
155 PRINT TAB(30);"(2) POINT-SLOPE
160 INPUT" ENTER THE APPROPRIATE NUMBER";I
165 IF I<1 OR I>2 THEN 150
170 INPUT"ENTER X1 AND Y1";X1,Y1
175 IF I=1 THEN 195
180 INPUT"ENTER THE SLOPE";M
185 X2=X1+1:Y2=Y1+M
190 GOTO 205
195 INPUT"ENTER X2 AND Y2";X2,Y2
200 IF X1=X2 THEN 270
205 IF X1<X2 THEN 215 ELSE X3=X1:X1=X2:X2=X3
210 Y3=Y1:Y1=Y2:Y2=Y3
215 U1=I6*(X1+H):V1=I8*(Y1+K)
220 U2=I6*(X2+H):V2=I8*(Y2+K)
225 M=(V2-V1)/(U2-U1):B=(U2*V1-U1*V2)/(U2-U1)
230 INPUT "ENTER DOMAIN";A1,A2
235 I1=INT(I6*(A1+H)+P5):I2=INT(I6*(A2+H)+P5)
240 FOR I=I1 TO I2
245 Z=USR3(I)
250 V=INT(M*I+B+P5)
255 GOSUB 685
260 NEXT I
265 GOTO 85
270 INPUT"LINE IS PARALLEL TO Y-AXIS, INPUT RANGE OF Y'S";Y1,Y2
275 J1=INT(I8*(Y1+K)+P5):J2=INT(I8*(Y2+K)+P5)
280 U=INT(I6*(X1+H)+P5):Z=USR3(U)
285 FOR I3=J1 TO J2
290 IF I3>V5 OR I3<0 THEN 300
295 Z=USR1(I3)
300 NEXT I3
305 GOTO 85
315 'GRAPH PARABOLA
320 PRINT"TWO OPTIONS: (1) OPENS UP/DOWN (2) OPENS LEFT/RIGHT"
325 PRINT"(1) (X-H1)[2=M(Y-K1) (2) (Y-K1)[2=M(X-H1)

```

Listing 4 continues

for the axes and the graph.

The vertical spacing of dots is constant for all characters per inch and is

fixed at .014 inch per dot. The horizontal spacing must be chosen to give spacing as close to .014 as possible. The

print density of a line (characters per inch) controls the horizontal dot spacing, the options being 8.3, 10, and 12 cpi (16 cpi is not recommended for graphics). At 12 cpi the spacing is .0156 inch per dot and is the option nearest to .014 inch. The vertical spacing of .014 inch per dot gives 72 dots per inch. Thus, 18 vertical dots give a unit of one-quarter inch. At 12 characters per inch, the horizontal spacing is .0156 per dot (64.2 dots per horizontal inch) giving a 16-dot-per-one-quarter-inch unit. The error this scale produces is minimal; for example, if a page is to be a square with 6 inches on each side, the difference in the dimensions is only .0576 of an inch—certainly not obvious to the human eye. Thus, using 12 cpi is satisfactory to produce the desired units.

In order to simplify the placement of a dot within a space in a page, I have introduced a set of u-v coordinates where the units are horizontal and vertical spaces. This system is only for reference and is never printed. The origin of the u-v system is at the bottom left corner of the page.

In addition to referring to rows of spaces or columns of spaces, the term "line" is introduced. Since each pass of the print head controls six vertical dots, the term line is defined to be six rows of spaces, i.e., six spaces high by the number of columns in a page. In fact, a line corresponds to one pass of the print head. The problem of placing a dot in a page is simply one of selecting the line and column in which a dot is located, then setting the appropriate bit.

In Fig. 3 the page is two inches square and has eight units in each direction. Thus there are $8 \times 16 = 128$ columns in the u direction, $8 \times 18 = 144$ rows in the

Listing 4 continued

```
330 INPUT"ENTER APPROPRIATE NUMBER";J
335 INPUT"ENTER THE CONSTANTS H1, K1, AND M";H1,K1,M
340 INPUT"ENTER THE DOMAIN ";I1,I2
345 I1=INT(I6*(I1+H)+P5):I2=INT(I6*(I2+H)+P5)
350 IF J=2 THEN 385
355 A=9/(128*M)
360 FOR I=I1 TO I2:Z=USR3(I)
365 V=INT(I8*(K+K1)+A*(I-I6*(H+H1)) [2+P5)
370 GOSUB 685
375 NEXT I
380 GOTO 85
385 IF M>0 AND I1<I6*(H+H1) THEN I1=I6*(H+H1)
390 IF M<0 AND I2>I6*(H+H1) THEN I2=I6*(H+H1)
395 FOR I=I1 TO I2:Z=USR3(I)
400 V=INT(I8*(K+K1)+(I8/SQR(I6))*SQR(M*(I-I6*(H+H1))))+P5)
405 GOSUB 685
410 NEXT I
415 FOR I=I1 TO I2:Z=USR3(I)
420 V=INT(I8*(K+K1)-(I8/SQR(I6))*SQR(M*(I-I6*(H+H1))))+P5)
425 GOSUB 685
430 NEXT I
435 GOTO 85
445 'GRAPH CIRCLE OR ELLIPSE
450 INPUT"ENTER THE COORDINATES OF THE CENTER";H1,K1
455 U=INT(I6*(H+H1)+P5):V=INT(I8*(K+K1)+P5)
460 Z=USR3(U):Z=USR1(V) 'PLOT THE CENTER
465 IF J=3 THEN INPUT"ENTER THE RADIUS SQUARED";A:B=A:GOTO475
470 INPUT"ENTER A AND B SQUARED";A,B
475 INPUT"ENTER THE DOMAIN";A1,A2
480 IF A1<H1-SQR(A) THEN A1=H1-SQR(A)
485 IF A2>H1+SQR(A) THEN A2=H1+SQR(A)
490 I1=INT(I6*(H+A1)+P5):I2=INT(I6*(H+A2)+P5)
495 M=(9*SQR(B))/(8*SQR(A)):M1=I6[2*A:M2=I6*(H+H1)
500 FORI=I1 TO I2:Z=USR3(I)
505 IF M1<(I-M2) [2 THEN V=INT(I8*(K+K1)+P5):GOTO 515
510 V=INT(I8*(K+K1)-M*SQR(M1-(I-M2) [2)+P5)
511 IF I=I1 THEN T1=V
512 IF I=I2 THEN T2=V
515 GOSUB 685
520 NEXT I
525 FOR I=I1 TO I2:Z=USR3(I)
530 IF M1<(I-M2) [2 THEN V=INT(I8*(K+K1)+P5):GOTO 540
535 V=INT(I8*(K+K1)+M*SQR(M1-(I-M2) [2)+P5)
536 IF I=I1 THEN T3=V
537 IF I=I2 THEN T4=V
540 GOSUB 685
545 NEXT I
546 I=I1+1:T=T2:V=T4:GOSUB 685
547 Z=USR3(I1):T=T1:V=T3:GOSUB 685
550 GOTO 85
555 'GRAPH GRAPH HYPERBOLA
565 PRINT"TWO OPTIONS: (1) REAL AXIS PARALLEL TO X-AXIS
570 PRINT" (2) REAL AXIS PARALLEL TO Y-AXIS
575 INPUT"INPUT APPROPRIATE INTEGER";J
580 INPUT"ENTER THE CONSTANTS H1 AND K1";H1,K1
585 INPUT"INPUT A AND B SQUARED";A,B
590 INPUT"ENTER DOMAIN";A1,A2
595 M=((-1) [J]*I6[2*A:M1=(I8*SQR(B))/(I6*SQR(A))
600 M2=I6*(H+H1):M3=INT(I6*(H+H1-SQR(A))+P5):M4=INT(I6*(H+H1+SQR(A))+P5)
605 I1=INT(I6*(H+A1)+P5):I2=INT(I6*(H+A2)+P5)-1
610 FOR I=I1 TO I2
615 IFJ=1 AND I>M3 AND I<M4 THEN I=M4:T=INT(I8*(K+K1)+M1*SQR((I-M2) [2+M)+P5)
620 Z=USR3(I)
625 V=INT(I8*(K+K1)+M1*SQR((I-M2) [2+M)+P5)
630 GOSUB 685
635 NEXT I
637 IF I=I2 THEN T4=V
640 FOR I=I1 TO I2
645 IFJ=1 AND I>M3 AND I<M4 THEN I=M4:T=INT(I8*(K+K1)-M1*SQR((I-M2) [2+M)+P5)
650 Z=USR3(I)
655 V=INT(I8*(K+K1)-M1*SQR((I-M2) [2+M)+P5)
660 GOSUB 685
665 NEXT I
670 GOTO 85
680 'SUBROUTINE TO FILL, IF NECESSARY
685 IF V<0 OR V>V5 THEN 715 ELSE Z=USR1(V)
690 IF I=I1 THEN 715
695 IF ABS(T-V)<3 THEN 715
700 IF T>V THEN J1=V+1:J2=T-1
705 IF T<V THEN J1=T+1:J2=V-1
710 FOR I3=J1 TO J2 STEP 2:Z=USR1(I3):NEXT I3
715 T=V
720 RETURN
725 END
```

v direction, and $144/6 = 24$ lines—each line containing 128 bytes. The dot A in Fig. 3 that is in the 18th column, 10th row of the page has for its u-v coordinates (18, 10). You must set bit 1 in byte 146 and send it to the printer to print this dot. When an entire page is sent to the printer, it will be sent from the top line down to line 0.

To compute the memory requirements for a page, multiply the number of columns by the number of lines. In a 2-by-2 page, the memory requirement is $128 \times 24 = 3,072$ (C00 in hexadecimal). In the case of a 16K machine, the maximum size page is approximately 2-by-2 square inches with eight units in each direction. Another limitation on the page size results from the POKE statements in Basic—the second argument (the value) must be an integer and must be less than 256. For the program Tigergraph as listed, the dimensions of the page should be no more than 15 units wide by 14 units high since $15 \times 16 = 240$ is less than 256 and $14 \times 18 = 252$ is also less than 256.

In most cases these maximum dimensions are adequate since they give a page measuring 3.75 inches wide by 3.5 inches high. However, in Tigergraph all variables are double-precision integers; so by POKEing both the least-significant and most-significant bytes of the coordinates of a point into memory, you can use a larger page. In Tigergraph the starting location of page is A000H (40,960 in decimal) and the origin is 7C01H (31,745 in decimal). For a machine with 16K memory, use 7000H (28,672 in decimal) for page and 7C01H for the origin.

Using the definitions above, the crux of the problem is to make specific dots print. Not printing in a space is simple—send a zero for that bit. Printing a dot in a given space uses two simple concepts: integer division and the greatest-integer function.

In elementary school, the first type of division you encounter is integer division; an integer A divided by a nonzero integer B gives a quotient Q and a remainder R, where R is equal to or greater than zero and less than B. For example, 10 divided by 6 gives a quotient 1 and a remainder of 4. Notice that the quotient is given by the greatest-integer function, denoted in Basic by INT. That is, $\text{INT}(10/6)$ equals $\text{INT}(1.666\dots)$ equals 1.

By definition, the greatest-integer function (INT) is defined to be the largest integer not exceeding the argument of the function:

$$\text{INT}(2.49) = 2$$

$$\text{INT}(2.999) = 2$$

$$\text{INT}(3.001) = 3$$

$$\text{INT}(3) = 3$$

A second property of the Basic INT function is: Given a real number x, the integer nearest x is found by $\text{INT}(x + .5)$. For example, the integer nearest 2.49 is 2, and $\text{INT}(2.49 + .5)$ equals $\text{INT}(2.99)$ equals 2. The integer nearest 2.51 is 3, and $\text{INT}(2.51 + .5)$ equals

$\text{INT}(3.01)$ equals 3.

More information on the greatest-integer function and its properties can be found in most number-theory texts.

Two examples illustrate the procedure by which dots can be printed. Continuing with the example of a 2-by-2 page, the points A and B marked on Fig. 3 correspond to Examples 1 and 2, respectively.

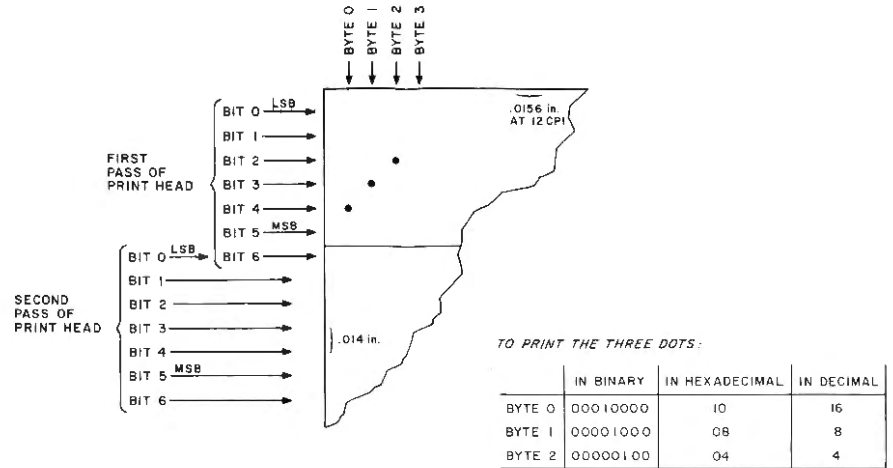


Figure 2

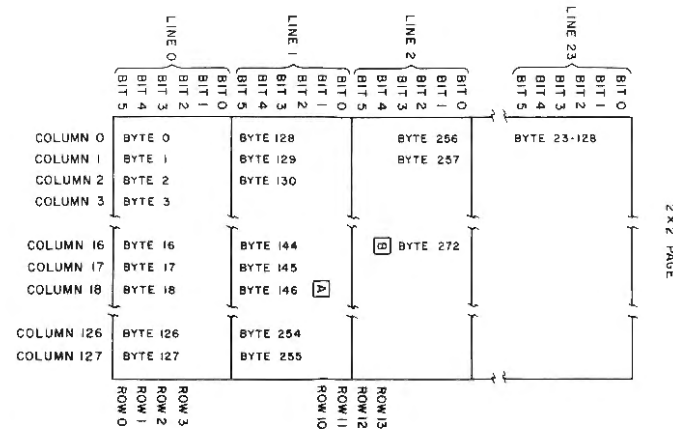


Figure 3

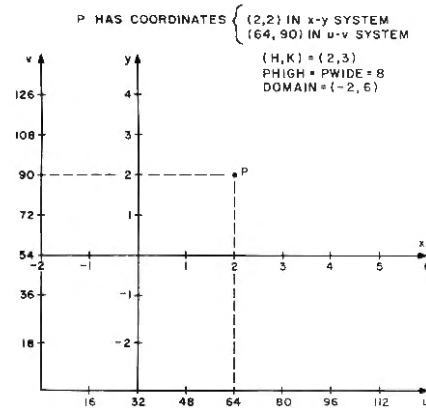
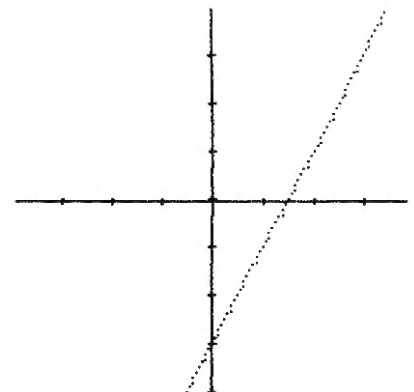


Figure 4



INPUT H? 4
 INPUT K? 4
 INPUT PHIGH? 8
 INPUT PWIDE? 8
 ENTER THE DOMAIN? -4,4

Figure 5

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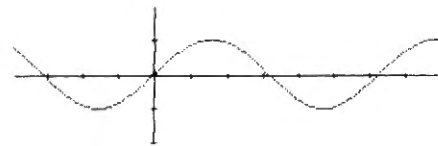
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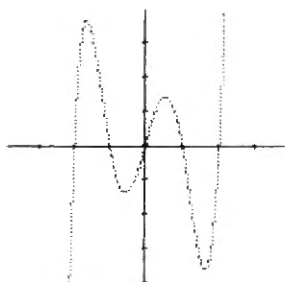
Example 1

Suppose the dot A in the page is 18 spaces in the u direction and 10 spaces up, i.e., $A(u,v)=(18,10)$. A is in line 1 and column 18; so, you want to set bit 1 of byte number 146. In fact, the quotient (found by the greatest-integer function) gives you the means to determine which byte a given point is in. In this example, divide 10 by 6 getting the quotient $Q=1$ and $R=4$. (Six is used as a divisor because there are six rows per



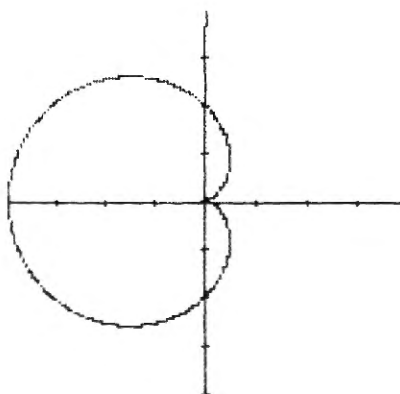
```
INPUT H? 4
INPUT K? 2
INPUT PHIGH? 4
INPUT PWIDE? 12
ENTER THE DOMAIN? 4,8
Y = SIN(X)
```

Figure 6



```
INPUT H? 4
INPUT K? 4
INPUT PHIGH? 8
INPUT PWIDE? 8
ENTER THE DOMAIN? 4,4
Y = X*(X-2)*(X-1)*(X+1)*(X+2)
```

Figure 7



```
INPUT H? 4
INPUT K? 4
INPUT PHIGH? 8
INPUT PWIDE? 8
```

Figure 8

line.) The quotient 1 gives the line in which the byte is located, and five minus the remainder ($5-4=1$) is the bit we wish to set. In order to set bit 1 of that byte, we store 00000010 in binary (2 in decimal) into it. Since each line of the page consists of 128 bytes, the byte in line 1, column 18 is $1 \times 128 + 18 = 146$ th byte into the page.

Example 2

The point $B(u,v)=(16,13)$ is in line 2, column 16. You must insert a 1 in bit 4 of byte 272. Dividing 13 by 6, you find the quotient is 2 and the remainder is 1. Thus, the point B (in line 2) is in byte $2 \times 128 + 16 = 272$ and the bit to be set is $5-1=4$.

In both examples the bytes would be offset by the starting address of the page. For example, if the starting address of page is 7000H, the byte of Example 2 is $28672 + 2 \times 128 + 16$.

In general, to plot an arbitrary point (A,B) , proceed as follows: Divide B by 6; get the quotient Q and the remainder R. Insert 1 into bit $(5-R)$ of the byte in the page given by $(PAGE)+Qx$ $(PAGEW)+A$, where $(PAGEW)$ is the number of columns in page and $(PAGE)$ is the starting address in memory of the page.

Unfortunately, graphs in the u-v coordinate system are too small to be useful. Besides, we think of points in terms of an x-y system. Beginning with a point in the x-y system necessitates a change of coordinates to the u-v system in order to plot the specific point. Before going into more detail on the transformation of coordinates—found in most texts in analytic geometry or introduction to calculus—an example is helpful. Continuing with the square 2-by-2 page, suppose I want the x-y coordinate axes to be two quarter-inch units to the right of the v axis and three quarter-inch units above the u axis. (See Fig. 4.)

Since each vertical unit is 18 spaces, the x axis is $3 \times 18 = 54$ spaces up from the bottom of the page. Similarly, the y axis is $2 \times 16 = 32$ spaces from the left edge of the page. To plot the point P, whose coordinates are (2,2) in the x-y coordinate system, you see that the point is a total of four units or $4 \times 16 = 64$ spaces in the u direction and is five units or $5 \times 18 = 90$ spaces in the v direction. Hence, to plot the point (2,2) in the x-y system, you actually plot the point (64,90) in the u-v system.

In changing from the x-y coordinate system to the second coordinate system (the u-v coordinate system), with the origin of the second system at the point

$(-H, -K)$ (H and K are positive integers given in terms of the x-y coordinates), the change of coordinates would be $u = x + H$ and $v = y + K$.

However, not only are you translating the axes, but you also want to shrink the units from quarter-inch units horizontally and vertically to one space in each direction in the u-v system. That transformation of coordinates is given by $u = 16(x + H)$ and $v = 18(y + K)$.

The following convention is followed throughout the programs in this article:

The integers H and K for the placement of the x-y coordinate system into a page are positive integers. H equals the number of units the y axis is to the right of the v axis and K equals the number of units the x axis is above the u axis. Thus, the transformation of coordinates are: First, to change from the u-v system to the x-y system, $u = 16(x + H)$ and $v = 18(y + K)$. Second, to change from the x-y system to the u-v system: $x = (u/16) - H$ and $y = (v/18) - K$. (Don't panic—the programs do this for you.)

Once the coordinate system has been changed, it is also necessary to change the variables in the defining relation of the function. That is, if I graph the function $y = f(x)$ in the x-y system, then the equivalent function in the u-v system will be $(v/18) - K = f((u/16) - H)$, or equivalently $v = 18(K + f(u/16 - H))$.

For example, for $(H,K)=(2,3)$ and for the function given by the equation $y = 3x + \sin(x)$, substituting $x = u/16 - 2$ and $y = v/18 - 3$ gives $v/18 - 3 = 3(u/16 - 2) + \sin(u/16 - 2)$.

Simplifying the last equation gives $v = 18(3 + 3(u/16 - 2) + \sin(u/16 - 2))$.

The values of u and v are calculated in a Basic program and sent to the Plot routine in Tigergraph. The values for u generated in the Basic program are generated as integers, but the values of v computed using the formula above usually are not. Since u and v represent spaces, you must send the nearest integer value for v. As pointed out above, this is accomplished by using the INT function: $v = \text{INT}(18*(K + f(u/16 - H)) + .5)$, or in general, $v = \text{INT}(v + .5)$.

For example, Program Listing 1 (EXAMPLE1/BAS) is a Basic program that uses Tigergraph to draw the line $y = 2x - 3$. The equation of this function is defined in line 100, and values of v are computed in line 140.

Prior to running EXAMPLE1/BAS, load TIGER/OBJ, and then call Basic. The memory size should be set to 31,743, then when the program is run, six numbers must be supplied in response to the input statements in lines 50, 60, 70, 80, and 110. The values for

H, K, PHIGH, and PWIDE must be positive integers, but the values for the domain can be real numbers. (H and K are defined above, PHIGH, PWIDE, and the domain are defined in the next paragraph.) A list of the responses and the resulting graph are shown in Fig. 5.

Here is a brief description of the Basic program. Lines 10 and 20 give the starting addresses of the four routines of Tigergraph. The first routine, called by USR0, inserts zeros into the page and draws the x and y coordinate axes with hash marks at quarter-inch intervals. USR3 and USR1 send the appropriate values of u and v, respectively, into the Plot routine. USR2 sends the page to the Tiger. Line 20 also clears the screen.

Line 30 defines all variables with names beginning with I, J, T, U, and V to be integer variables. Line 40 defines the variables I6, I8, and P5 to be 16, 18, and .5, respectively. Using variable names, the program runs faster than it would if the specific values were used in the computational portions of the program. (See the section on speeding up execution in the *Level II Basic Reference Manual*.)

Lines 50 and 60 ask for the coordinates (H,K), which place the x-y axes as described above. In the Tigergraph listing and CONICS/BAS, H and K are represented by H0 and K0.

Lines 70 and 80 ask for values that define the length of the page in memory. In particular, PHIGH is the number of units for the y axis, each unit being one-quarter inch. Thus, the answer of eight units makes the y axis 2 inches high. PWIDE is the number of units for the x axis, and again an answer of eight gives an x axis 2 inches wide. In Tigergraph these numbers are double-precision integers, so the values are POKEd into the least-significant byte and zero is POKEd into the most-significant byte.

Line 90 calls USR0, which zeros the PAGE and draws the axes. Line 100 defines the function to be graphed.

Line 110 asks for the domain of the function. That is, it asks for the range of the x value for which the graph is to be drawn. These values must be equal to or greater than -H and less than or equal to PWIDE - H.

Line 120 converts the domain of the function in terms of x to the equivalent domain in terms of u. These values for the domain of u are then used in line 130, u going from the lower limit to the upper limit of the domain. Also in this line, USR3 sends the current value of u to the Plot routine of Tigergraph. The function must be defined for all x values in its domain.

Line 140 computes the corresponding values for v. Line 150 tests the value of v to be sure that it lies within the upper and lower boundaries of the page. Specifically, v must be nonnegative and less than or equal to the number of rows in the page, which is 18 times (PHIGH). Only if the value of v is within these limits is it sent into Plot.

Lines 160-210 test for the vertical separation between consecutive v values, and if they are too widely spaced, points are plotted to fill in the gap. Specifically, line 160 tests to see if the current v value is the first point or not. If it is the first point, no filling is necessary. Otherwise, when the last computed value of v (stored in variable T) is more than two spaces from the current v value, the gap is filled in. Lines 180 and 190 determine whether the fill goes up or down, and line 200 does the filling. Line 210 saves the current v value in T to be the previous value next time through this loop.

Line 220 ends the loop begun in line 130. Line 225 uses the Tigergraph's Print routine to print the page.

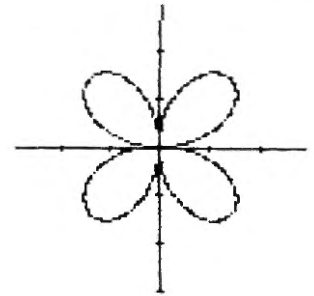
This program can be run for functions that are defined for all x's in the domain and, at least piecewise, continuous—that is, continuous at all but a finite number of points. All functions must give y explicitly as a function of x. By definition, a function is single valued. In order to graph other functions, simply change the definition in line 100. (See Figs. 6 and 7.) It is possible to graph several functions on the same graph. In order to do this, run the Basic program as it is for the first function. Next, edit the Basic program by deleting line 90; otherwise, the first graph will be erased. Then change line 100 to define the new function and run the program again.

Tigergraph has four main routines, labeled in the listing as Getu, Axes, Plot, and Print. The role of each routine has been discussed above. The variables within the program are PHIGH, the number of units for the y axis; PWIDE, the number of units for the x axis; PAGEW, the number of spaces for the u axis ($16 \times \text{PWIDE}$); PAGEH, the number of spaces for the v axis ($18 \times \text{PHIGH}$); H0 and K0, the placement of the x and y axes in the page; U and V, the point to be placed into the page; and PAGE, the starting memory address for the page.

Other routines in Tigergraph are for computational purposes. The subroutines for double-precision addition and multiplication are from *How to Program the Z80* by Rodney Zaks.

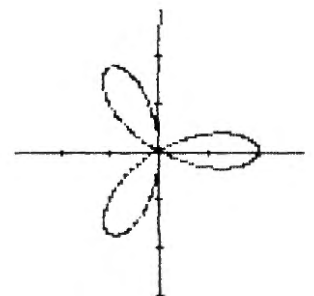
Now that the specifics of the programming techniques are completed, there are two Basic programs that I find useful. The first is POLAR/BAS (Program Listing 3) and the second is CONICS/BAS (Program Listing 4).

A particularly tedious type of function to graph is one that is given in terms



```
INPUT H? 3
INPUT K? 3
INPUT PHIGH? 6
INPUT PWIDE? 6
R = 2*SIN(2*A)
```

Figure 9



```
INPUT H? 3
INPUT K? 3
INPUT PHIGH? 6
INPUT PWIDE? 6
R = 2*COS(3*A)
```

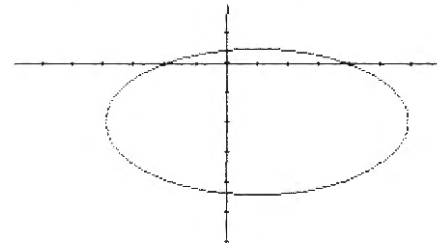
Figure 10

Standard Form of Conics

- (1) Parabola: vertex at (h,k)
 - (a) $(x - h)^2 = M(y - k)$ opens up if $M > 0$
opens down if $M < 0$
 - (b) $(y - k)^2 = M(x - h)$ opens right if $M > 0$
opens left if $M < 0$
- (2) Circle: Center at (h,k), radius r
 $(x - h)^2 + (y - k)^2 = r^2$
- (3) Ellipse: center at (h,k)
 $\frac{(x - h)^2}{a^2} + \frac{(y - k)^2}{b^2} = 1$
major axis parallel to x axis if $a > b$
major axis parallel to y axis if $a < b$
- (4) Hyperbola: center at (h,k)
 - (a) $\frac{(x - h)^2}{a^2} - \frac{(y - k)^2}{b^2} = 1$
real axis parallel to x axis
 - (b) $-\frac{(x - h)^2}{a^2} + \frac{(y - k)^2}{b^2} = 1$
real axis parallel to y axis

Figure 11

of polar coordinates. The program POLAR/BAS graphs the equation $R = 2(1 - \cos(A))$, and the resulting graph is given in Fig. 8. In POLAR/BAS, the polar equation is defined in line 100. Lines 140 and 145, in addition to changing to the u-v coordinate system, also change from polar coordinates to rectangular coordinates. Recall that this change of coordinates is given by



```
>RUN
INPUT H? 7
INPUT K? 6
INPUT PHIGH? 8
INPUT PWIDE? 14
CHOICES (1) INPUT CONIC
(2) DRAW (3) END? 1
CHOICES OF CONICS TO GRAPH:
(1) LINE
(2) PARABOLA
(3) CIRCLE
(4) ELLIPSE
(5) HYPERBOLA
ENTER THE APPROPRIATE NUMBER? 4
ENTER THE COORDINATES OF THE
CENTER? 1, -2
ENTER A AND B SQUARED? 24.6
ENTER THE DOMAIN? -7,7
```

Figure 12

$$x = r \cos A$$

$$y = r \sin A$$

where A is the angle (in radians) going from the polar axis to the line segment joining (x,y) and the origin. Therefore, lines 140 and 145 result from the following: First, changing from polar to rectangular coordinates gives

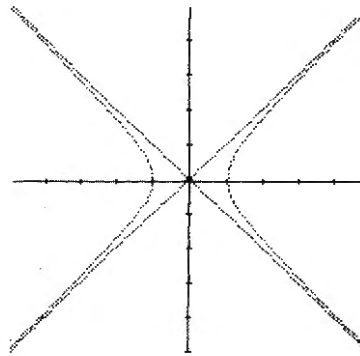
$$x = 2(1 - \cos A)\cos A$$

$$y = 2(1 - \cos A)\sin A$$

Then changing to the u-v coordinates using $x = u/16 - H$ and $y = v/18 - K$ gives

$$\frac{u}{16} - H = 2(1 - \cos A)\cos A$$

$$\frac{v}{18} - K = 2(1 - \cos A)\sin A$$



HYPERBOLA $x^2 - y^2 = 1$
ASYMPTOTES $y = \pm x$

Figure 13

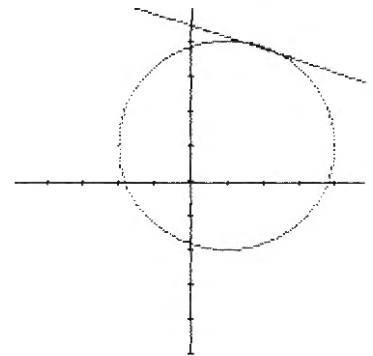
and this simplifies to

$$u = 16[H + 2(1 - \cos A)\cos A]$$

$$v = 18[K + 2(1 - \cos A)\sin A]$$

The final program (CONICS/BAS) draws the various conic sections. This program lets you graph any combination of lines, parabolas, circles, ellipses, and hyperbolas using one set of coordinate axes. To use this program, it is necessary to have the equation of a conic in its standard form. (See Fig. 11 for a summary of the standard forms of the conics.) Since the program is rather long, I have kept its prompts as brief as possible.

The program to line 80 is identical to the corresponding portions in Program Listing 1, and the discussion of CON-



CIRCLE $(x - 1)^2 + (y - 1)^2 = 9$
TANGENT LINE AT (2,3,83)

Figure 14

Program Listing 5

```
00001 ;TIGERGRAPH
00002 ;BARBARA CLINGER
00003 ;DEPARTMENT OF MATHEMATICS
00004 ;WHEATON COLLEGE
00005 ;NORTON, MASS. 02766
00006 ;
00007 ;
7C01 00010 ORG 7C01H
7C01 CD7F0A 00012 CALL 0A7FH ;GET NUMBER
7C04 7D 00013 LD A,L
7C05 FE00 00014 CP 0 ;COMPARE IT TO ZERO
7C07 C20E7C 00016 JP NZ,NOTZ ;JUMP IF NOT ZERO
7C0A CD1C7C 00018 CALL AXES
7C0D C9 00020 RET
7C0E FE01 00022 NOTZ CP 1 ;COMPARE IT TO ONE
7C10 C2177C 00024 JP NZ,NOTO ;JUMP IF NOT ONE
7C13 CD2C7D 00026 CALL PLOT
7C16 C9 00028 RET
7C17 CD7B7D 00030 NOTO CALL PRINT ;MUST BE 3
7C1A C9 00032 RET
7C1B 00 00050 NOP ;START OF AXES
7C1C ED5B057E 00060 AXES LD DE,(PHIGH) ;X-Y AXES AT (H0,K0) IN
7C20 3E12 00070 LD A,18 ; THE PAGE
7C22 0E00 00080 LD C,0
```

Listing 5 continues

```

7C24 CDF47D 00090 CALL MULT ;PAGEH=18*PHIGH
7C27 220B7E 00100 LD (PAGEH),HL
7C2A ED5B077E 00110 LD DE,(PWIDE)
7C2E 3E10 00120 LD A,16
7C30 0E00 00130 LD C,0
7C32 CDF47D 00140 CALL MULT ;PAGEW=16*PWIDE
7C35 22097E 00150 LD (PAGEW),HL
7C38 7D 00160 LD A,L
7C39 4C 00170 LD C,H
7C3A ED5B057E 00180 LD DE,(PHIGH)
7C3E CDF47D 00190 CALL MULT ;3*(PAGEW)*(PHIGH) EQUALS
7C41 EB 00200 EX DE,HL ; THE NUMBER OF BYTES IN
7C42 3E03 00210 LD A,3 ;THE PAGE
7C44 0E00 00220 LD C,0
7C46 CDF47D 00230 CALL MULT ;(HL)=3*(PAGEW)*(PHIGH)
7C49 44 00240 LD B,H
7C4A 4D 00250 LD C,L
7C4B 210070 00260 ZERO LD HL,PAGE ;ZERO THE PAGE
7C4E 3600 00270 ZLOOP LD (HL),0
7C50 23 00280 INC HL
7C51 0B 00290 DEC BC
7C52 78 00300 LD A,B
7C53 B1 00310 OR C
7C54 20F8 00320 JR NZ,ZLOOP ;SEE IF PAGE IS ZEROED
7C56 3E00 00330 LD A,0
7C58 32117E 00340 LD (U),A ;U MAKES LEFT HASH MARK
7C5B 3E20 00350 LD A,20H ; ON THE Y-AXIS
7C5D 32137E 00360 LD (V),A ;V MAKES THE RIGHT HASH
7C60 3A0D7E 00370 LD A,(H0) ; MARK ON Y-AXIS
7C63 FE00 00380 CP 0 ;SEE IF Y-AXIS = V-AXIS
7C65 CA6D7C 00390 JP Z,ISEQU
7C68 3E20 00400 LD A,20H
7C6A 32117E 00410 LD (U),A
7C6D 2A097E 00420 ISEQU LD HL,(PAGEW)
7C70 7D 00430 LD A,L
7C71 4C 00440 LD C,H
7C72 110300 00450 LD DE,3
7C75 CDF47D 00460 CALL MULT ;FIND 3*PAGEW=NO. SPACES
7C78 E5 00470 PUSH HL ;BETWEEN Y MARKS
7C79 3E10 00480 LD A,16
7C7B 0E00 00490 LD C,0
7C7D ED5B0D7E 00500 LD DE,(H0)
7C81 CDF47D 00510 CALL MULT ;FIND 16*H
7C84 110070 00520 LD DE,PAGE
7C87 19 00530 ADD HL,DE ;PAGE+16*H
7C88 E5 00540 PUSH HL
7C89 2A057E 00550 LD HL,(PHIGH) ;# OF Y HASH MARKS
7C8C 45 00560 LD B,L
7C8D E1 00570 POP HL
7C8E D1 00580 POP DE
7C8F 22197E 00590 MARKY LD (TEMP),HL
7C92 DD2A197E 00600 LD IX,(TEMP) ;IX POINTER TO Y-AXIS
7C96 3A117E 00610 LD A,(U)
7C99 DD77FF 00620 LD (IX+255),A ;MARK LEFT OF Y-AXIS
7C9C 3A137E 00630 LD A,(V)
7C9F DD7701 00640 LD (IX+1),A ;MARK RIGHT OF Y-AXIS
7CA2 19 00650 ADD HL,DE ;FOR NEXT HASH MARK
7CA3 10EA 00660 DJNZ MARKY
7CA5 2A097E 00670 LD HL,(PAGEW) ;BEGIN TO MARK X-AXIS
7CA8 7D 00680 LD A,L
7CA9 4C 00690 LD C,H
7CAA ED5B0F7E 00700 LD DE,(K0)
7CAE CDF47D 00710 CALL MULT ;FIND K*PAGEW
7CB1 110300 00720 LD DE,3
7CB4 7D 00730 LD A,L
7CB5 4C 00740 LD C,H
7CB6 CDF47D 00750 CALL MULT ;(HL)=PAGE+3*K*(PAGEW)

```

```

7CB9 110070 00760 LD DE,PAGE ; POINTS X-AXIS
7CBC 19 00770 ADD HL,DE
7CBD 2B 00780 DEC HL
7CBE E5 00790 PUSH HL
7CBF 110F00 00800 LD DE,15
7CC2 A7 00810 AND A
7CC3 ED52 00820 SBC HL,DE
7CC5 111000 00830 LD DE,16
7CC8 E5 00840 PUSH HL ;(HL)=PAGE+3*K*(PAGEW)-16
7CC9 2A077E 00850 LD HL,(PWIDTH) ; LEFTMOST PART OF X-AXIS
7CCC 45 00860 LD B,L
7CCD 05 00870 DEC B ;# HASH MARKS ON X-AXIS
7CCE E1 00880 POP HL ;IS (PAGEW)-1
7CCF 7E 00890 MARKXX LD A,(HL)
7CD0 F602 00900 OR 2 ;MAKE DOT OVER X-AXIS
7CD2 77 00910 LD (HL),A
7CD3 E5 00920 PUSH HL
7CD4 D5 00930 PUSH DE
7CD5 ED5B097E 00940 LD DE,(PAGEW)
7CD9 19 00950 ADD HL,DE
7CDA 22197E 00960 LD (TEMP),HL
7CDD DD2A197E 00970 LD IX,(TEMP)
7CE1 DD7E00 00980 LD A,(IX)
7CE4 F620 00990 OR 20H ;MAKE DOT UNDER X-AXIS
7CE6 DD7700 01000 LD (IX),A
7CE9 D1 01010 POP DE
7CEA E1 01020 POP HL
7CEB A7 01030 AND A
7CEC ED52 01040 SBC HL,DE ;MOVE LEFT FOR NEXT MARK
7CEE 10DF 01050 DJNZ MARKXX
7CF0 2A057E 01060 YAXIS LD HL,(PHIGH)
7CF3 7D 01070 LD A,L
7CF4 4C 01080 LD C,H
7CF5 110300 01090 LD DE,3
7CF8 CDF47D 01100 CALL MULT ;3*(PHIGH)=# OF BYTES FOR
7CFB E5 01110 PUSH HL ; Y-AXIS
7CFC 3E10 01120 LD A,16
7CFE 0E00 01130 LD C,0
7D00 ED5B0D7E 01140 LD DE,(H0)
7D04 CDF47D 01150 CALL MULT ;FIND 16*H
7D07 110070 01160 LD DE,PAGE
7D0A 19 01170 ADD HL,DE ;PAGE+3*(H) POINTS TO
7D0B D1 01180 POP DE ; START OF Y-AXIS
7D0C 43 01190 LD B,E
7D0D ED5B097E 01200 LD DE,(PAGEW)
7D11 363F 01210 YLOOP LD (HL),3FH ;3FH MAKES COLUMN 6 DOTS
7D13 19 01220 ADD HL,DE
7D14 10FB 01230 DJNZ YLOOP
7D16 2A097E 01240 LD HL,(PAGEW) ;START OF X-AXIS
7D19 2B 01250 DEC HL
7D1A 44 01260 LD B,H
7D1B 4D 01270 LD C,L
7D1C E1 01280 POP HL
7D1D 7E 01290 XLOOP LD A,(HL)
7D1E F601 01300 OR 1 ;MAKES ONE DOT FOR AXIS
7D20 77 01310 LD (HL),A
7D21 2B 01320 DEC HL ;MOVE LEFT FOR NEXT DOT
7D22 0B 01330 DEC BC ;DECREASE COUNTER
7D23 78 01340 LD A,B
7D24 B1 01350 OR C
7D25 FE00 01360 CP 0
7D27 C21D7D 01370 JP NZ,XLOOP ;SEE IF DONE WITH X-AXIS
7D2A C9 01380 RET ;END OF AXES
7D2B 00 01390 NOP ;BEGIN OF PLOT
7D2C 2A137E 01400 PLOT LD HL,(V) ;LOAD V INTO HL
7D2F 7C 01410 LD A,H ;TO PLOT (U,V)--DIVIDE V
7D30 4D 01420 LD C,L ;BY 6, GET Q AND R THEN

```

ICS/BAS begins at line 85. Note, as mentioned above, that H0 and K0 refer to the placement of the axes. Line 85 gives the prompt

CHOICES (1) INPUT CONIC (2) DRAW
(3) END

Entering a 3 stops the program and returns to Basic's ready prompt. A reply of 2 sends the page to the printer and returns to line 85. The first option lets you select the type of conic and enter it into the page. This case also returns to the prompt at line 85.

Line 90 is a three-way branch; the action taken depends upon the response to line 85. Lines 100-125 determine the type of conic to be graphed. The options are line, parabola, circle, ellipse, or hyperbola. Line 130 is an error trap to ensure a proper reply at this point of the program.

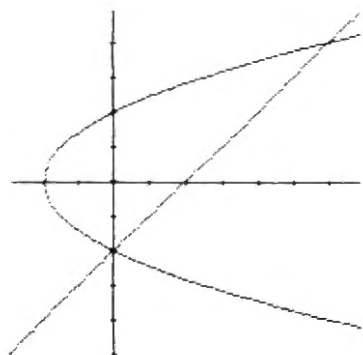
Line 135 is a five-way branch, and the action taken depends upon the response made to line 125. Since each branch is essentially a subprogram to graph one of the conics, I will discuss each branch individually. For each option, the final prompt is for the domain. When necessary, the program restricts the domain to values of x for which the function is defined. The final step of each option is a jump to line 85. Lines 145-305 branch for a straight line.

Selecting the line option initiates a series of prompts; the first is

OPTIONS FOR FORM OF LINE:

- (1) TWO-POINT
- (2) POINT-SLOPE

If the two-point form is selected, then the coordinates of the points must be entered. There is a prompt for each point and the data is entered in the form X,Y (first coordinate, comma, second coordinate, enter). If the x coordinates



PARABOLA $y^2 = 2(x + 2)$
LINE $y = x - 2$

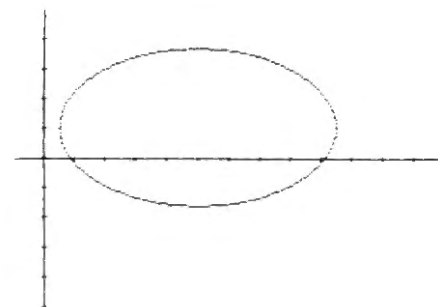
Figure 15

of both points are the same, then the line is parallel to the y axis. This is the only way such a line can be entered. If this is the case, the prompt "Line is parallel to the y axis, input range of y's" is given. In response, enter the smallest value of y, then the largest value of y (separated by a comma) for which this line is to be graphed.

If the second option is selected, there are two prompts: one for the coordinates of the point and the other for the slope of the line.

The program does not accept lines given in the y-intercept form ($y = mx + b$). This form is a special case of the point-slope form, using the slope m and the point (0,b). It also does not accept lines in the form $ax + by = c$. This form also can be entered using the point-slope form where the point is (0, c/b) and the slope is given by $m = (-a/b)$. The remainder of this branch is devoted to the task of inserting the line into the page.

Lines 315-435 branch for a parabola. Selecting the option for the parabola gives the prompt "(1) Opens Up/Down (2) Opens Left/Right." There are two forms for the equation of a parabola with its vertex at the point (H1,K1), they are $(X - H1)^2 = M(Y - K1)$, which opens up if M is greater than zero or down if M is less than zero, and $(Y - K1)^2 = M(X - H1)$, which opens to the



PHIGH = PAGE HEIGHT
PWIDE = PAGE WIDTH
INPUT PHIGH? 10
INPUT PWIDE? 14
INPUT H0? 1
INPUT K0? 5
CHOICES (1) INPUT CONIC
(2) DRAW (3) END? 1
CHOICES OF CONICS TO GRAPH:
(1) LINE
(2) PARABOLA
(3) CIRCLE
(4) ELLIPSE
(5) HYPERBOLA
ENTER THE APPROPRIATE NUMBER? 4
ENTER THE COORDINATES OF THE
CENTER? 5,1
ENTER A AND B SQUARED? 20,7
ENTER THE DOMAIN? -1,13

Figure 16

right if M is greater than zero or left if M is less than zero. Next, a prompt for the values H1, K1, and M is given. Enter the three values on the same line, separated by commas. If the parabola opens left or right, it requires two functions to graph it—one for the upper half and one for the lower half. Lines 360-375 do the computations for up/down parabolas and lines 385-435 do the left/right ones.

Lines 445-550 branch for a circle or ellipse. The standard form for the circle with its center at (H1,K1) and radius R is given by $(X - H1)^2 + (Y - K1)^2 = R^2$.

The standard form for the ellipse with its center at (H1,K1) is:

$$\frac{(X - H1)^2}{A^2} + \frac{(Y - K1)^2}{B^2} = 1$$

In the equation of an ellipse, if A is greater than B, the major axis is parallel to the x axis. If A is less than B, the major axis is parallel to the y axis. If A equals B, the figure is a circle. Using these relations between A and B, I combined the computations for a circle and an ellipse into one routine. The test for which type conic is done in line 465. The first prompt in this routine is for the center: "Enter the coordinates of the center."

Enter the values for H1 and K1, separated by a comma. If the conic is a circle, the next data entered must be the square of the radius. This allows the use of a radius such as $\sqrt{3}$ without having to enter its decimal approximation. If the conic is an ellipse, then the squares of A and B must be entered—for the same reason the square of the radius is given. Circles and ellipses require two functions—one for the upper half and one for the lower half. The lower portion is drawn in lines 500-515 and the upper part in lines 525-545.

Lines 555-670 branch for a hyper-

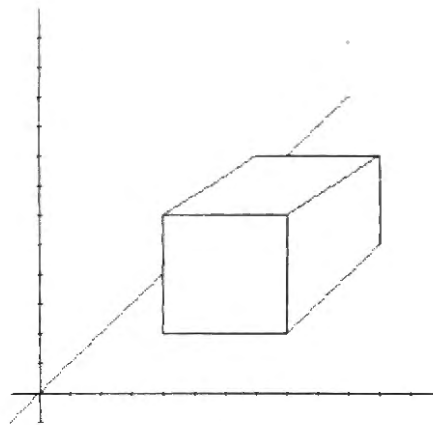


Figure 17

```

7D31 1E06      01430      LD      E,6          ;SET BIT 5-R IN BYTE
7D33 1600      01440      LD      D,0          ;PAGE+Q*(PAGEW)+U
7D35 CDDE7D    01450      CALL   DIVIDE
7D38 57        01460      LD      D,A
7D39 59        01470      LD      E,C
7D3A ED53157E  01480      LD      (QUOT),DE    ;SAVE Q
7D3E 22177E    01490      LD      (RMDER),HL   ;SAVE R
7D41 3A097E    01500      LD      A,(PAGEW)
7D44 0E00      01510      LD      C,0          ; DIVISOR ON DE
7D46 ED5B157E  01520      LD      DE,(QUOT)    ;ON EXIT QUOTIENT IN AD
7D4A CDF47D    01530      CALL   MULT          ; REMAINDER IN HL
7D4D ED4B117E  01540      LD      BC,(U)
7D51 09        01550      ADD    HL,BC
7D52 010070    01560      LD      BC,PAGE
7D55 09        01570      ADD    HL,BC          ;ADD ADDR OF PAGE
7D56 22197E    01580      LD      (TEMP),HL
7D59 DD2A197E  01590      LD      IX,(TEMP)
7D5D 210500    01600      LD      HL,5
7D60 ED5B177E  01610      LD      DE,(RMDER)   ;FIND 5 MINUS RMDER
7D64 A7        01620      AND    A              ;DETERMINE WHICH BIT
7D65 ED52      01630      SBC    HL,DE          ; TO SET
7D67 1601      01640      LD      D,1
7D69 7D        01650      LD      A,L
7D6A B7        01660      OR     A
7D6B 2805      01670      JR     Z,RDONE        ;GO NO MORE ROTATES
7D6D 47        01680      LD      B,A
7D6E CB22      01690      RLOOP SLA            D              ;ROTATE TO SET BIT
7D70 10FC      01700      DJNZ   RLOOP
7D72 DD7E00    01710      RDONE LD      A,(IX)        ;GET CONTENTS OF BYTE
7D75 B2        01720      OR     D              ;INSERT NEW INFO IN BYTE
7D76 DD7700    01730      LD      (IX),A        ;STORE BACK INTO BYTE
7D79 C9        01740      RET
7D7A 00        01750      NOP
7D7B 3E03      01760      PRINT LD      A,3          ;**
7D7D CDD37D    01770      CALL   OUTCHR         ;PUT 445 INTO GRAPHICS
7D80 0E00      01780      LD      C,0
7D82 ED5B057E  01790      LD      DE,(PHIGH)
7D86 CDF47D    01800      CALL   MULT
7D89 2B        01810      PLOOP DEC    HL          ;COUNTER VERTICALLY IS
7D8A 22117E    01820      LD      (U),HL        ;(U)=3*(PHIGH)-1
7D8D EB        01830      EX     DE,HL
7D8E 2A097E    01840      LD      HL,(PAGEW)
7D91 7D        01850      LD      A,L
7D92 4C        01860      LD      C,H
7D93 CDF47D    01870      CALL   MULT          ;(HL)=U*(PAGEW)
7D96 110070    01880      LD      DE,PAGE
7D99 19        01890      ADD    HL,DE          ;(HL)=PAGE+U*(PAGEW)
7D9A 110000    01900      LD      DE,0          ;IS THE COUNTER ACROSS
7D9D 7E        01910      GETCHR LD      A,(HL)
7D9E FE03      01920      CP     3              ;**IF CHAR=3,PRINT TWICE
7DA0 CCD37D    01930      CALL   Z,OUTCHR       ;SEND CHARACTER
7DA3 CDD37D    01940      CALL   OUTCHR       ;SEND CHARACTER
7DA6 13        01950      INC    DE              ;INCREASE POINTER
7DA7 23        01960      INC    HL              ;INCREASE POINTER
7DA8 E5        01970      PUSH   HL             ;SAVE POINTER
7DA9 2A097E    01980      LD      HL,(PAGEW)   ;CHECK-SEE IF LINE DONE
7DAC 2B        01990      DEC    HL
7DAD A7        02000      AND    A
7DAE ED52      02010      SBC    HL,DE
7DB0 7C        02020      LD      A,H
7DB1 B5        02030      OR     L
7DB2 E1        02040      POP    HL
7DB3 C29D7D    02050      JP     NZ,GETCHR     ;CONTINUE IF NOT DONE
7DB6 3E03      02060      LD      A,3          ;**SEND END OF LINE SIGNAL
7DB8 CDD37D    02070      CALL   OUTCHR
7DBB 3E0B      02080      LD      A,0BH        ;**
7DBD CDD37D    02090      CALL   OUTCHR

```

Listing 5 continued

7DC0	2A117E	02100	LD	HL, (U)		;CHECK-SEE IF PAGE DONE
7DC3	7C	02110	LD	A,H		
7DC4	B5	02120	OR	L		
7DC5	C2897D	02130	JP	NZ,PLOOP		;CONTINUE IF NOT DONE
7DC8	3E03	02140	DONE	LD	A,3	;**SIGNAL TO EXIT GRAPHICS
7DCA	CDD37D	02150	CALL	OUTCHR		
7DCD	3E02	02160	LD	A,2		;**
7DCF	CDD37D	02170	CALL	OUTCHR		
7DD2	C9	02180	RET			;RET TO CALLING PROG
7DD3	F5	02190	OUTCHR	PUSH	AF	;SUBR TO SEND CHAR
7DD4	CDD105	02200	CHCKP	CALL	5D1H	;CHECK STATUS OF PRINTER
7DD7	20FB	02210	JR	NZ,CHCKP		;WAIT IF NOT READY
7DD9	F1	02220	POP	AF		
7DDA	32E837	02230	LD	(37E8H),A		;SEND IT
7DDD	C9	02240	RET			;RET TO PRINT
7DDE	210000	02250	DIVIDE	LD	HL,0	;FROM ZAKS
7DE1	0610	02260	LD	B,16		;ON ENTRY DIVIDEND IN AC
7DE3	CB11	02270	DLOOP	RL	C	; DIVISOR IN HL
7DE5	17	02280	RLA			;ON EXIT QUOTIENT IN AC
7DE6	ED6A	02290	ADC	HL,HL		; REMAINDER IN HL
7DE8	ED52	02300	SBC	HL,DE		
7DEA	3001	02310	JR	NC,\$+3		
7DEC	19	02320	ADD	HL,DE		
7DED	3F	02330	CCF			
7DEE	10F3	02340	DJNZ	DLOOP		
7DF0	CB11	02350	RL	C		
7DF2	17	02360	RLA			
7DF3	C9	02370	RET			;END OF DIVIDE SUBROUTINE
7DF4	0610	02380	MULT	LD	B,16	;FROM ZAKS
7DF6	210000	02390	LD	HL,0		;ON ENTRY (A)=LSB MULTCND
7DF9	CB39	02400	MLOOP	SRL	C	; (C)=MSB MULTCND
7DFB	1F	02410	RRA			; (DE)=MULTIPLIER
7DFC	3001	02420	JR	NC,MLOOP1		;ON EXIT (HL)=PRODUCT
7DFE	19	02430	ADD	HL,DE		
7DFE	EB	02440	MLOOP1	EX	DE,HL	
7E00	29	02450	ADD	HL,HL		
7E01	EB	02460	EX	DE,HL		
7E02	10F5	02470	DJNZ	MLOOP		
7E04	C9	02480	RET			;END OF MULT SUBROUTINE
7E05	02490	PHIGH	EQU	\$		
0002	02500	DEFS	2	0002	02620	DEFS 2
7E07	02510	PWIDE	EQU	\$	7E13	02630 V EQU \$
0002	02520	DEFS	2	0002	02640	DEFS 2
7E09	02530	PAGEW	EQU	\$	7E15	02650 QUOT EQU \$
0002	02540	DEFS	2	0002	02660	DEFS 2
7E0B	02550	PAGEH	EQU	\$	7E17	02670 RMDER EQU \$
0002	02560	DEFS	2	0002	02680	DEFS 2
7E0D	02570	H0	EQU	\$	7E19	02690 TEMP EQU \$
0002	02580	DEFS	2	0002	02700	DEFS 2
7E0F	02590	K0	EQU	\$	7000	02710 PAGE EQU 7000H
0002	02600	DEFS	2	0000	02720	END
7E11	02610	U	EQU	\$	00000	TOTAL ERRORS

bola. The hyperbola has two possible forms for its equation:

TWO OPTIONS:

- (1) REAL AXIS PARALLEL TO X AXIS
- (2) REAL AXIS PARALLEL TO Y AXIS

The equation for the real axis parallel to the x axis is

$$\frac{(X - H1)^2}{A^2} - \frac{(Y - K1)^2}{B^2} = 1$$

and for the real axis parallel to the y

axis is

$$-\frac{(X - H1)^2}{A^2} + \frac{(Y - K1)^2}{B^2} = 1$$

After selecting option 1 or 2, enter the center's coordinates. In the case of the hyperbola, the center is the midpoint of the line joining the two vertices of the hyperbola. Then, as was the case for the ellipse, enter the squares of the constants A and B. It takes two functions to draw a hyperbola that opens up and

down, namely one for the upper portion and one for the lower portion. For a hyperbola that opens left and right, it takes four functions—upper and lower parts of both branches. Obviously, this is the slowest type of function to graph. Using variables M1 through M4, as defined in lines 595 and 600, I condensed the computational portions of this segment of the program. These same constants also were used to redefine the domain of the hyperbola that opens left and right, if necessary.

Consider the following example. Given the equation for the ellipse: $X^2 + 4Y^2 - 2X + 16Y = 7$. First, put the equation into standard form by collecting the terms as shown, then completing the square:

$$\begin{aligned}(x^2 - 2x) + 4(y^2 + 4y) &= 7 \\(x^2 - 2x + 1) + 4(y^2 + 4y + 4) &= 7 + 1 + 16 \\(x - 1)^2 + 4(y + 2)^2 &= 24\end{aligned}$$

Dividing by 24 gives the standard form

$$\frac{(x - 1)^2}{24} + \frac{(y + 2)^2}{6} = 1.$$

This equation, in standard form, gives the values of $(H1, K1) = 1, -2$, $A^2 = 24$, and $B^2 = 6$. Use the values $H0 = 7$

and $K0 = 6$ to place the x-y axes. Figure 12 shows the prompts, the answers, and the graph of this ellipse. The time the program takes to insert the ellipse into the page is about 80 seconds. Figures 13-17 give various examples of graphing conic sections using CONICS/BAS.

The changes necessary for a 16K Level II machine are not difficult. These changes result from the difference between the USR calls in Disk Basic and Level II Basic, and the lack of the DEF-FN command. The program segment given in Listing 5 modifies Tigergraph to Tiger16K. (Insert or change the lines as necessary.) The portion that replaces Getu is a subprogram designed to call the appropriate routines. In particular, when the command USR(N) is given from Basic, the argument N (N must be 0, 1, or 2) is entered into Tiger16K with the command CALL 0A7FH. If N is zero, the Axes subroutine is called. If N is one, the Plot subroutine is called. Otherwise, N must be two and the Print subroutine is called.

If any other changes are made, the addresses that are POKEd into the Ba-

sic program must be changed to match the resulting addresses of the variables H, K, PHIGH, and PWIDE when Tiger16K is compiled.

Program Listing 6 is equivalent to Program Listing 1, except it is compatible with Level II Basic. The differences are: Line 10 POKEs the starting address of the Tiger16K. Line 20 is deleted. Line 90 is changed to $Z = \text{USR}(0)$, where the argument being zero causes the page to be zeroed and the coordinate axes to be drawn.

Line 100 is deleted. Line 130 $Z = \text{USR3}(U)$ is replaced by two POKE statements. These statements POKE U into the appropriate memory locations. Line 140 defines the function to be graphed and changes it to the u-v coordinate system. Lines 150 and 200 replace $Z = \text{USR1}(V)$ by two POKE statements. These statements POKE V into the appropriate memory page locations.

With page's starting address at 7000H, the page size must be less than or equal to 0C00H, or 3,072 in decimal. The page size (number of bytes) is computed by $3(\text{PHIGH})(16)(\text{PWIDE})$. Since this number should not exceed 3,072, $(\text{PHIGH}) \times (\text{PWIDE})$ must be less than or equal to 64.

Tigergraph can be adapted to a different printer, as long as it operates similarly to the Paper Tiger. (Compare the control codes and Figs. 1 and 2 with your owner's manual.) All output is done in the Print routine; I have marked the lines that are Tiger control codes with a double asterisk in the comment column. One word of caution: If changes are made in Tigergraph, then it might be necessary to change the POKE statements that correspond to H, K, PHIGH, and PWIDE, to the new addresses for those variables.

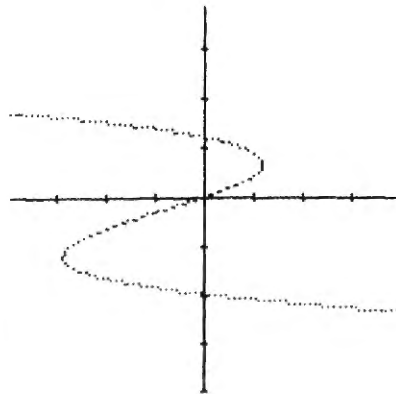
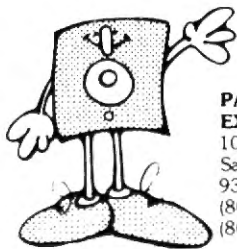


Figure 19

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Program Listing 6

```
10 POKE 16526,01:POKE 16527,124
30 DEFINT I,J,T,U,V
40 I6=16:I8=18:P5=.5
50 INPUT"INPUT H";H:POKE 32269,H:POKE 32270,0
60 INPUT"INPUT K";K:POKE 32271,K:POKE 32272,0
70 INPUT"INPUT PHIGH";I:POKE32261,I:POKE32262,0:V5=I8*I
80 INPUT"INPUT PWIDE";I:POKE32263,I:POKE32264,0
90 Z=USR(0)
110 INPUT"ENTER THE DOMAIN";A1,A2
120 I1=INT(I6*(A1+H)+P5):I2=INT(I6*(A2+H)+P5)
130 FOR U=I1 TO I2:POKE 32273,U:POKE 32274,0
140 V=INT(I8*(K+2*(U/I6-H)-3)+P5)
150 IFV<0 OR V>V5 THEN 210ELSEPOKE32275,V:POKE32276,0:Z=USR(1)
160 IF I=I1 THEN 210
170 IF ABS(T-V)<3 THEN 210
180 IF T>V THEN J1=V+1:J2=T-1
190 IF T<V THEN J1=T+1:J2=V-1
200 FOR I3=J1 TO J2 STEP 2:POKE32275,V:POKE32276,0:Z=USR(1)
210 T=V
220 NEXT U
225 Z=USR(2)
230 END
```


Part II

Tiger Graphics with Pascal-80

Pascal-80 is a standard version of Pascal. It has omitted a few features of standard Pascal, but the omissions are offset by several extra, very useful features.

The system operates under TRSDOS and NEWDOS40, but not NEW-DOS80. Pascal-80 is distributed

through TSE-Hardside, 6 South Street, Milford, NH 03055 and costs \$99.95.

The manual provided with Pascal-80 is brief; in fact, it is too brief. Because of the minimal documentation, the best way to become familiar with Pascal-80 is to select a book on standard Pascal and to try each feature. However, even this method has its problems. For example, in the section describing the exten-

sions to standard Pascal, the Call function is described:

CALL(ADDRESS,VALUE) places a value (0-255) into the A register, and calls the address. It returns the contents of the A register after the call (type INTEGER).

However, the manual fails to give the very important information that if a machine-language subprogram uses the

```
0000 PROGRAM TABS;
0003 VAR X: ARRAY(.1..55.) OF CHAR;
0016 BEGIN
001B CLS;
001C X:='1234567890123456789012345678901234567890123456789012345';
005A WRITELN(X);
006B WRITELN(CHR(201),'A',CHR(201),'B',CHR(201),'C')
0089 END.
```

Program Listing 7

Program Listing 8

```
00010 ;TIGERPAS
00020 ;BARBARA CLINGER
00030 ;DEPARTMENT OF MATHEMATICS
00040 ;WHEATON COLLEGE
00050 ;NORTON, MASS. 02766
00060 ;
00070 ;TO OPERATE FROM PASCAL-80 PROGRAMS
00080 ;JULY 2, 1982
00090 ;
F500 00100 ORG 0F500H
F500 C321F5 00110 JP START
F503 00120 PHIGH EQU $ ;NO. OF UNITS FOR Y-AXIS
F505 00130 PWIDE EQU $+2 ;NO. OF UNITS FOR X-AXIS
F507 00140 H0 EQU $+4 ;FIRST COORDINATE OF ORIGIN
F509 00150 K0 EQU $+6 ;SECOND COORDINATE OF ORIGIN
F50B 00160 U EQU $+8 ;1ST COORD. OF POINT TO PLOT
F50D 00170 V EQU $+10 ;2ND COORD. OF POINT TO PLOT
F50F 00180 PAGEH EQU $+12 ;#OF DOTS FOR Y-AXIS
F511 00190 PAGEW EQU $+14 ;# OF DOTS FOR X-AXIS
F513 00200 TEMP EQU $+16
F515 00210 QUOT EQU $+18
F517 00220 RMDER EQU $+20
F519 00230 LINES EQU $+22 ;# OF LINES IN A PAGE
0012 00240 I8 EQU 18 ;# OF DOTS PER (1/4) IN. VERTICAL
0010 00250 I6 EQU 16 ;# OF DOTS PER (1/4) IN HORIZONTAL
0006 00260 DOTS EQU 6 ;# DOTS PER 1 PASS PRINT HEAD
D000 00270 PAGE EQU 0D000H
001E 00280 DEFS 30
00290 ; FIRST PART OF PROGRAM DECIDES WHICH PORTION OF PROGRAM
00300 ; TO EXECUTE-- 0=ZERO THE PAGE
00310 ; 1=DRAW THE AXES
00320 ; 2=PLOT POINT (U,V)
00330 ; 3=SEND PAGE TO PRINTER
F521 FE00 00340 START CP 0
F523 C22AF5 00350 JP NZ,NOTZER ;JUMP IF NOT ZERO
F526 CD40F5 00360 CALL ZERO
F529 C9 00370 RET
```

Listing 8 continues

```

F52A FE01      00380 NOTZER CP      1      ;COMPARE IT TO ONE
F52C C233F5   00390          JP      NZ,NOTONE ;JUMP IF NOT ONE
F52F CD90F5   00400          CALL   AXES
F532 C9        00410          RET
F533 FE02      00420 NOTONE CP      2      ;COMPARE IT TO TWO
F535 C23CF5   00430          JP      NZ,NOTTWO
F538 CD48F6   00440          CALL   PLOT
F53B C9        00450          RET
F53C CD9EF6   00460 NOTTWO CALL   PRINT ;MUST BE THREE
F53F C9        00470          RET
F540 00        00480 ZERO   NOP      ;START OF ZERO
                00490 ;ZERO SETS ALL MEMORY IN PAGE TO ZERO. IT ALSO CALCULATES
                00500 ;SOME OF THE VARIABLES FOR THE REST OF THE PROGRAM. ZERO
                00510 ;MUST BE CALLED BEFORE USING OTHER ROUTINES IN THIS
                00520 ;PROGRAM.
F541 ED5B03F5 00530          LD      DE,(PHIGH)
F545 3E12      00540          LD      A,I8
F547 0E00      00550          LD      C,0
F549 CD17F7   00560          CALL   MULT      ;FIND PAGEH=I8*PHIGH
F54C 220FF5   00570          LD      (PAGEH),HL
F54F ED5B05F5 00580          LD      DE,(PWIDE)
F553 3E10      00590          LD      A,I6
F555 0E00      00600          LD      C,0
F557 CD17F7   00610          CALL   MULT      ;FIND PAGEW=I6*PWIDE
F55A 2211F5   00620          LD      (PAGEW),HL
F55D 2A0FF5   00630          LD      HL,(PAGEH) ;FIND NUMBER OF LINES
F560 7C        00640          LD      A,H ;IN PAGE=# DOTS VERTICAL
F561 4D        00650          LD      C,L ;DIVIDED BY DOTS, ROUND
F562 110600   00660          LD      DE,DOTS ;UP IF NECESSARY
F565 CD01F7   00670          CALL   DIVIDE
F568 57        00680          LD      D,A
F569 59        00690          LD      E,C ;QUOT INTO DE
F56A 7D        00700          LD      A,L ;SEE IF RMDER IS ZERO
F56B B4        00710          OR      H
F56C FE00      00720          CP      0
F56E CA72F5   00730          JP      Z,LINER ;IF RMDER=0, LINES=QUOT
F571 13        00740          INC     DE ;OTHERWISE LINES=QUOT+1
F572 ED5319F5 00750 LINER LD      (LINES),DE
F576 2A11F5   00760          LD      HL,(PAGEW) ;FIND NO. OF BYTES IN
F579 7D        00770          LD      A,L ;PAGE = (LINES)*(PAGEW)
F57A 4C        00780          LD      C,H
F57B ED5B19F5 00790          LD      DE,(LINES)
F57F CD17F7   00800          CALL   MULT      ;(HL)=(LINES)*(PAGEW)
F582 44        00810          LD      B,H
F583 4D        00820          LD      C,L
F584 2100D0   00830          LD      HL,PAGE ;ZERO THE PAGE
F587 3600      00840 ZLOOP LD      (HL),0
F589 23        00850          INC     HL
F58A 0B        00860          DEC     BC
F58B 78        00870          LD      A,B
F58C B1        00880          OR      C
F58D 20F8     00890          JR      NZ,ZLOOP ;SEE IF PAGE IS ZEROED
F58F C9        00900          RET
F590 00        00910 AXES   NOP      ;BEGIN OF AXES
                00920 ;THIS DRAWS THE COODINATE AXES WITH ORIGIN (H0,K0)
                00930 ;THE X-AXIS IS I8*K0 UNITS UP FROM BOTTOM OF PAGE
                00940 ;THE Y-AXIS IS I6*H0 UNITS FROM LEFT OF PAGE
                00950 ;HASH MARKS ARE MADE EVERY I6 DOTS ON X-AXIS AND EVERY
                00960 ;I8 DOTS ON THE Y-AXIS
F591 ED5B09F5 00970 XAXIS LD      DE,(K0)
F595 3E12      00980          LD      A,I8
F597 0E00      00990          LD      C,0
F599 CD17F7   01000          CALL   MULT
F59C 220DF5   01010          LD      (V),HL ;(HL)=I8*K0=UNITS UP
F59F 2A11F5   01020          LD      HL,(PAGEW)
F5A2 2B        01030          DEC     HL

```

IX register, it is necessary to save the value in the register upon entry into the subprogram and to restore it before returning to the calling program.

Another item not in the manual is the ability to use CHR to perform a tab—similar to its use in Tiny Pascal and Basic. Specifically, a tab on the video screen is accomplished by using the control codes 192–255 as follows: If *x* is an integer from 192–255 (inclusive), then the command CHR(*x*) in a write statement causes the cursor to be moved *X* spaces to the right. That is, CHR(192) does not move the cursor, CHR(193) moves the cursor one place right, CHR(194) moves it two places to the right, and so forth. In Tabs (Program Listing 7) an example of using tabs is given. It illustrates printing in columns 10, 20, and 30.

At the left of each line in the Pascal-80 listing there is a hexadecimal number. It gives the number of bytes of code compiled to that point. Although these are not real line numbers, at times I will refer to specific lines in a program using these numbers.

Changes to Tigergraph

The changes to adapt Tigergraph to be used with a Pascal-80 program result from the differences in the Call commands between Basic and Pascal-80. Recall that in the Level II and Disk Basic, the argument of the Call command must be in the range from -32,786 to 32,767 inclusive, and it is passed into the HL register pair by the special ROM Call—Call 0A7FH. In Pascal-80 the argument must be in the range from 0–255 inclusive, and it is automatically placed in the A register.

In the Tigerpas listing (Program Listing 8), the variables are defined in the first few lines of the program. The short routine immediately following the definitions of the variables gives Tigerpas a single entry point. The origin of Tigerpas is 0F500H (decimal 62,720) and this address is used in the Call command from a Pascal-80 program. Just as in a

POKE statement in Basic, when an address is greater than 32767, the address is calculated by $-(65536 - \text{real address})$. Thus, the address used in a Pascal-80 program for Tigerpas is $-(65536 - 62720) = -2816$.

In the Pascal-80 programs, the constant TIGER = -2816 is defined and the Call to Tigerpas has the form Z: = CALL(TIGER, N) $0 \leq N \leq 3$. The argument N is placed in the A register and Tigerpas begins execution at Start. The value of N determines which subroutine in Tigerpas is to be used.

If N=0, the Zero subprogram is called and the memory-page block is set to zero. (Page is defined in Part I to be the memory area for the graph.) This routine also initializes variables for the remaining subroutines and must be called first.

If N=1, the Axes subprogram is executed and the x-y coordinate axes are inserted into page. Zero and Axes were one subroutine in Tigergraphics.

If N=2, the Plot subprogram is executed and a point is inserted into the page. Prior to making this Call, the values of U and V must be POKEd into their respective locations in memory. The ROM Call 022CH has been added to Plot. This ROM routine blinks an asterisk on the screen in the upper right hand corner of the monitor. The purpose of this call is to provide a signal during the execution that the program is running and has not wandered off into the nether world. Care should be used with this ROM Call since it uses all registers.

If N=3, the Print subprogram is executed and the page is sent to the printer.

The last changes in Tigergraph were made to adapt Tigerpas so it could be used with other dot-matrix printers with graphics capabilities. These changes allow flexibility in the number of dots per unit on the x-y coordinate axes and the number of vertical dots printed by a sin-

gle pass of the print head.

Memory Allocations

Pascal-80 resides in memory from 21,760–40,639 (5500H–9EBFH). Programs are stored beginning at 40,704 (9F00H) in what I assume is the text-editor buffer area, and compiled programs are stored immediately after that area. The placement of the Page and the machine-language program Tigerpas is made in such a way to maximize the memory available to Pascal-80 programs. In particular, Tigerpas begins at 62,720 (F500H) and the page starts at 53,248 (D000H). This choice for the page results from the memory requirement for a 14-by-14 page (9,408 bytes).

If these allocations result in problems for the Pascal programs, there are two options:

Reduce the size of the page and in Tigerpas equate page to the appropriate larger number, or

Save and run the Pascal programs using the W and X commands. The W command from the monitor saves a machine-code "object" program file, and the X command executes an object pro-

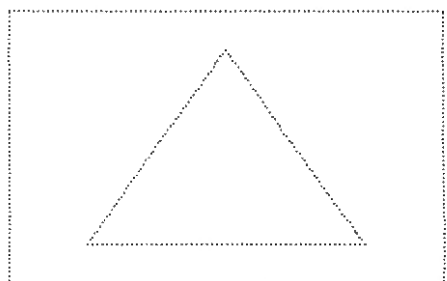
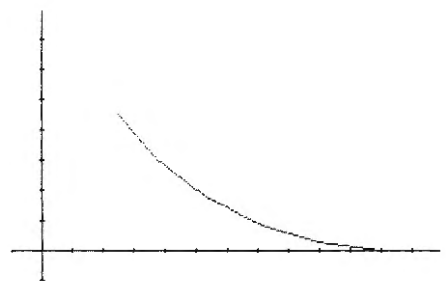
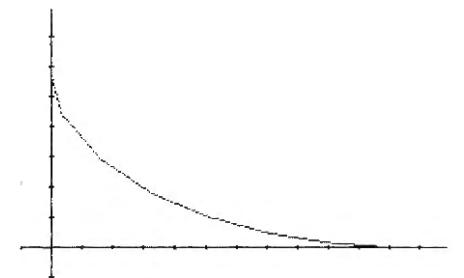


Figure 18



CAT GOT TO THE TREE
VELOCITY OF DOG: 2 VELOCITY OF CAT: 1.5
ORIGIN AT (1,1)
PHIGH: 9 PWIDE: 14

Figure 20



DOG GOT CAT AT (0.5,5.9999999999997)
VELOCITY OF DOG: 2 VELOCITY OF CAT: 0.8
ORIGIN AT (1,1)
PHIGH: 9 PWIDE: 14

Figure 21

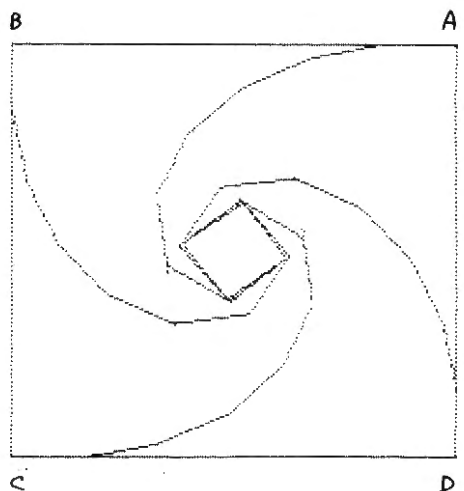


Figure 22

F5A3	220BF5	01040	LD	(U),HL	;U RANGES FROM (PAGEW) TO
F5A6	211000	01050	LD	HL,I6	;ZERO FOR X-AXIS
F5A9	2B	01060	DEC	HL	
F5AA	E5	01070	PUSH	HL	
F5AB	CD48F6	01080	CALL	PLOT	
F5AE	E1	01090	POP	HL	
F5AF	7D	01100	LD	A,L	
F5B0	FE00	01110	CP	0	
F5B2	CAB9F5	01120	JP	Z,LOOPX	
F5B5	2B	01130	DEC	HL	
F5B6	C3D9F5	01140	JP	TESTU	
F5B9	2A0DF5	01150	LD	HL,(V)	
F5BC	2B	01160	DEC	HL	
F5BD	220DF5	01170	LD	(V),HL	
F5C0	CD48F6	01180	CALL	PLOT	
F5C3	2A0DF5	01190	LD	HL,(V)	
F5C6	23	01200	INC	HL	
F5C7	23	01210	INC	HL	
F5C8	220DF5	01220	LD	(V),HL	
F5CB	CD48F6	01230	CALL	PLOT	
F5CE	2A0DF5	01240	LD	HL,(V)	
F5D1	2B	01250	DEC	HL	
F5D2	220DF5	01260	LD	(V),HL	
F5D5	211000	01270	LD	HL,I6	
F5D8	2B	01280	DEC	HL	
F5D9	E5	01290	PUSH	HL	
F5DA	2A0BF5	01300	LD	HL,(U)	
F5DD	7D	01310	LD	A,L	
F5DE	B4	01320	OR	H	
F5DF	FE00	01330	CP	0	
F5E1	CAEBF5	01340	JP	Z,ENDX	
F5E4	2B	01350	DEC	HL	
F5E5	220BF5	01360	LD	(U),HL	
F5E8	C3ABF5	01370	JP	XLOOP	
F5EB	E1	01380	POP	HL	
F5EC	ED5B07F5	01390	LD	DE,(H0)	
F5F0	3E10	01400	LD	A,I6	
F5F2	0E00	01410	LD	C,0	
F5F4	CD17F7	01420	CALL	MULT	
F5F7	220BF5	01430	LD	(U),HL	; (HL)=I6*H0=UNITS LEFT
F5FA	2A0FF5	01440	LD	HL,(PAGEH)	;V RANGES FROM (PAGEH) TO
F5FD	2B	01450	DEC	HL	;ZERO FROM Y-AXIS
F5FE	220DF5	01460	LD	(V),HL	
F601	211200	01470	LD	HL,I8	
F604	2B	01480	DEC	HL	
F605	E5	01490	PUSH	HL	
F606	CD48F6	01500	CALL	PLOT	
F609	E1	01510	POP	HL	
F60A	7D	01520	LD	A,L	
F60B	FE00	01530	CP	0	
F60D	CA14F6	01540	JP	Z,LOOPY	
F610	2B	01550	DEC	HL	
F611	C334F6	01560	JP	TESTV	
F614	2A0BF5	01570	LD	HL,(U)	
F617	2B	01580	DEC	HL	
F618	220BF5	01590	LD	(U),HL	
F61B	CD48F6	01600	CALL	PLOT	
F61E	2A0BF5	01610	LD	HL,(U)	
F621	23	01620	INC	HL	
F622	23	01630	INC	HL	
F623	220BF5	01640	LD	(U),HL	
F626	CD48F6	01650	CALL	PLOT	
F629	2A0BF5	01660	LD	HL,(U)	
F62C	2B	01670	DEC	HL	
F62D	220BF5	01680	LD	(U),HL	
F630	211200	01690	LD	HL,I8	
F633	2B	01700	DEC	HL	

```

F634 E5      01710 TESTV  PUSH   HL
F635 2A0DF5  01720      LD    HL,(V)
F638 7D      01730      LD    A,L
F639 B4      01740      OR    H
F63A FE00    01750      CP    0
F63C CA46F6  01760      JP    Z,ENDY
F63F 2B      01770      DEC  HL
F640 220DF5  01780      LD    (V),HL
F643 C306F6  01790      JP    YLOOP
F646 E1      01800      ENDY  POP  HL
F647 C9      01810      RET
F648 DDE5    01820      PLOT  PUSH  IX          ;END OF AXES
                                ;BEGIN OF PLOT
                                01830 ;THIS ROUTINE INSERTS POINT (U,V) INTO PAGE. VALUES
                                01840 ;FOR U AND V MUST BE INSERTED INTO (U) AND (V) PRIOR
                                01850 ;TO CALLING THIS ROUTINE.
F64A CD2C02  01860      CALL  022CH          ;CAUSES * TO BLINK
F64D 2A0DF5  01870      LD    HL,(V)        ;LOAD V INTO HL
F650 7C      01880      LD    A,H          ;TO PLOT (U,V)--DIVIDE V
F651 4D      01890      LD    C,L          ;BY DOTS,GET Q AND R THEN
F652 1E06    01900      LD    E,DOTS       ;SET BIT R IN BYTE
F654 1600    01910      LD    D,0          ;PAGE+Q*(PAGEW)+U
F656 CD01F7  01920      CALL  DIVIDE
F659 57      01930      LD    D,A
F65A 59      01940      LD    E,C
F65B ED5315F5 01950      LD    (QUOT),DE    ;SAVE Q
F65F 2217F5  01960      LD    (RMDER),HL  ;SAVE R
F662 3A11F5  01970      LD    A,(PAGEW)
F665 0E00    01980      LD    C,0          ; DIVISOR IN DE
F667 ED5B15F5 01990      LD    DE,(QUOT)   ;ON EXIT QUOTIENT IN AD
F66B CD17F7  02000      CALL  MULT         ; REMAINDER IN HL
F66E ED4B0BF5 02010      LD    BC,(U)
F672 09      02020      ADD  HL,BC
F673 0100D0  02030      LD    BC,PAGE
F676 09      02040      ADD  HL,BC          ;ADD ADDR OF PAGE
F677 2213F5  02050      LD    (TEMP),HL
F67A DD2A13F5 02060      LD    IX,(TEMP)
F67E 210600  02070      LD    HL,DOTS      ;DOTS-1 =# PRINT NEEDLES
F681 2B      02080      DEC  HL
F682 ED5B17F5 02090      LD    DE,(RMDER)  ;5-(RMDER) DETERMINES
F686 A7      02100      AND  A             ;WHICH BIT TO SET
F687 ED52    02110      SBC  HL,DE
F689 1601    02120      LD    D,1
F68B 7D      02130      LD    A,L
F68C B7      02140      OR    A
F68D 2805    02150      JR   Z,RDONE      ;GO NO MORE ROTATES
F68F 47      02160      LD    B,A
F690 CB22    02170      RLOOP SLA         D          ;ROTATE TO SET BIT
F692 10FC    02180      DJNZ RLOOP
F694 DD7E00  02190      RDONE LD    A,(IX)      ;GET CONTENTS OF BYTE
F697 B2      02200      OR    D            ;INSERT NEW INFO IN BYTE
F698 DD7700  02210      LD    (IX),A      ;STORE BACK INTO BYTE
F69B DDE1    02220      POP  IX
F69D C9      02230      RET
F69E 3E03    02240      PRINT LD    A,3         ;END OF PLOT
                                ;PUT 445 INTO GRAPHICS
F6A0 CDF6F6  02250      CALL  OUTCHR      ;SEND 3
F6A3 0E00    02260      LD    C,0
F6A5 ED5B03F5 02270      LD    DE,(PHIGH)
F6A9 CD17F7  02280      CALL  MULT
F6AC 2B      02290      PLOOP DEC        HL          ;COUNTER VERTICALLY IS
F6AD 220BF5  02300      LD    (U),HL      ;(U)=3*(PHIGH)-1
F6B0 EB      02310      EX   DE,HL
F6B1 2A11F5  02320      LD    HL,(PAGEW)
F6B4 7D      02330      LD    A,L
F6B5 4C      02340      LD    C,H
F6B6 CD17F7  02350      CALL  MULT        ;(HL)=U*(PAGEW)
F6B9 1100D0  02360      LD    DE,PAGE

```

gram created by the W command. This gives maximum memory during execution since the system loads the program into memory on top of the compiler and

monitor sections of Pascal-80.

To get a rough idea of the memory requirements of a Pascal-80 program, consider the program Liner (Program

Listing 9). This program has approximately 70 lines of text, not counting the blank lines used for cosmetic spacing. The text of Liner is from 40,704-43,362

Listing 8 continued

```

F6BC 19      02370      ADD     HL,DE      ; (HL) =PAGE+U*(PAGEW)
F6BD 110000  02380      LD      DE,0      ; IS THE COUNTER ACROSS
F6C0 7E      02390  GETCHR  LD      A,(HL)
F6C1 FE03    02400      CP
F6C3 CCF6F6  02410      CALL   Z,OUTCHR   ; IF CHAR=3, SEND IT TWICE
F6C6 CDF6F6  02420      CALL   OUTCHR     ; SEND CHARACTER
F6C9 13      02430      INC    DE         ; INCREASE POINTER
F6CA 23      02440      INC    HL         ; INCREASE POINTER
F6CB E5      02450      PUSH  HL         ; SAVE POINTER
F6CC 2A11F5  02460      LD     HL,(PAGEW) ; CHECK-SEE IF LINE DONE
F6CF 2B      02470      DEC    HL
F6D0 A7      02480      AND   A
F6D1 ED52    02490      SBC   HL,DE
F6D3 7C      02500      LD     A,H
F6D4 B5      02510      OR    L
F6D5 E1      02520      POP   HL
F6D6 C2C0F6  02530      JP    NZ,GETCHR   ; CONTINUE IF NOT DONE
F6D9 3E03    02540      LD     A,3        ; SEND END OF LINE SIGNAL
F6DB CDF6F6  02550      CALL  OUTCHR
F6DE 3E0B    02560      LD     A,0BH
F6E0 CDF6F6  02570      CALL  OUTCHR
F6E3 2A0BF5  02580      LD     HL,(U)     ; CHECK-SEE IF PAGE DONE
F6E6 7C      02590      LD     A,H
F6E7 B5      02600      OR    L
F6E8 C2ACF6  02610      JP    NZ,PLOOP    ; CONTINUE IF NOT DONE
F6EB 3E03    02620  DONE   LD     A,3        ; SIGNAL TO EXIT GRAPHICS
F6ED CDF6F6  02630      CALL  OUTCHR
F6F0 3E02    02640      LD     A,2
F6F2 CDF6F6  02650      CALL  OUTCHR
F6F5 C9      02660      RET
F6F6 F5      02670  OUTCHR PUSH  AF         ; RET TO CALLING PROG.
F6F7 CDD105  02680  CHCKP  CALL  5D1H       ; SUBR TO SEND CHAR
F6FA 20FB    02690      JR    NZ,CHCKP   ; CHECK STATUS OF PRINTER
F6FC F1      02700      POP   AF         ; WAIT IF NOT READY
F6FD 32E837  02710      LD     (37E8H),A ; SEND IT
F700 C9      02720      RET
F701 210000  02730  DIVIDE LD     HL,0      ; RET TO PRINT
F704 0610    02740      LD     B,16      ; FROM ZAKS
F706 CB11    02750  DLOOP  RL      C        ; ON ENTRY DIVIDEND IN AC
F708 17      02760      RLA
F709 ED6A    02770      ADC   HL,HL     ; DIVISOR IN DE
F70B ED52    02780      SBC   HL,DE     ; ON EXIT QUOTIENT IN AC
F70D 3001    02790      JR    NC,$+3    ; REMAINDER IN HL
F70F 19      02800      ADD   HL,DE
F710 3F      02810      CCF
F711 10F3    02820      DJNZ  DLOOP
F713 CB11    02830      RL      C
F715 17      02840      RLA
F716 C9      02850      RET
F717 0610    02860  MULT   LD     B,16     ; END OF DIVIDE SUBROUTINE
F719 210000  02870      LD     HL,0      ; FROM ZAKS
F71C CB39    02880  MLOOP  SRL     C        ; ON ENTRY (A)=LSB MULTCND
F71E 1F      02890      RRA
F71F 3001    02900      JR    NC,MLOOP1 ; (C)=MSB MULTCND
F721 19      02910      ADD   HL,DE     ; (DE)=MULTIPLIER
F722 EB      02920  MLOOP1 EX     DE,HL     ; ON EXIT (HL)=PRODUCT
F723 29      02930      ADD   HL,HL
F724 EB      02940      EX     DE,HL
F725 10F5    02950      DJNZ  MLOOP
F727 C9      02960      RET
0000      02970      END
00000 TOTAL ERRORS

```

```

0000 PROGRAM LINER;
0003 CONST TIGER=-2816;ADRU=-2805;ADRV=-2803;
000C I6=16;I8=18;
000C VAR I,J,U,V,Z,WIDTH,HEIGHT,H0,K0,INCREMENT:INTEGER;
0034     H1,K1,X,Y:REAL;
0044     ANSWER:CHAR;
0048
0048 PROC INIT(VAR PWIDE,PHIGH,H0,K0:INTEGER);
0061 CONST ADRH0=-2809;ADRK0=-2807;ADRPHIGH=-2813;ADRPWIDE=-2811;
0062 BEGIN
0067     WRITELN('HOW MANY UNITS FOR X-AXIS AND FOR Y-AXIS');
009C     READ(PWIDE,PHIGH);
00A9     POKE(ADRPHIGH,PHIGH); POKE(ADRPHIGH+1,0);
00BC     POKE(ADRPWIDE,PWIDE); POKE(ADRPWIDE+1,0);
00CF     WRITELN('ENTER H0 AND K0 TO PLACE THE ORIGIN');
00FF     READ(H0,K0);
010C     POKE(ADRH0,H0); POKE(ADRH0+1,0);
011F     POKE(ADRK0,K0); POKE(ADRK0+1,0)
0132 END;(*INIT*)
0133
0133 FUNC MIN(X,Y:INTEGER):INTEGER;
013F BEGIN
0145     IF X<Y THEN MIN:=X ELSE MIN:=Y
0169 END;(*MIN*)
016C
016C FUNC MAX(X,Y:INTEGER):INTEGER;
0178 BEGIN
017E     IF X<Y THEN MAX:=Y ELSE MAX:=X
01A2 END;(*MAX*)
01A5
01A5 PROC FILL(X,Y:INTEGER);
01B1 VAR A1,A2,V:INTEGER;
01BE     BEGIN
01C3         A1:=MAX(MIN(X,Y),0)+1;
01E0         A2:=MIN(MAX(X,Y),HEIGHT)-1;
0201         V:=A1;
020B         WHILE V<=A2 DO
021A             BEGIN
021A                 POKE(ADRV,V); POKE(ADRV+1,0);
022D                 V:=V+2;
023C                 Z:=CALL(TIGER,2)
0246             END
0248         END;(*FILL*)
024C
024C PROC LINE;
0250 VAR A1,A2,U,V,OLDV:INTEGER;
0265     X1,Y1,X2,Y2,M,B:REAL;
027D BEGIN
0282     WRITELN('ENTER COORDINATES OF FIRST POINT');
02AF     READ(X1,Y1);
02BC     WRITELN('ENTER COORDINATES OF SECOND POINT');
02EA     READ(X2,Y2);
02F7     WHILE (X1<>X2) OR (Y1<>Y2) DO
0313     BEGIN
0313     IF Y1=Y2 THEN INCREMENT:=2 ELSE INCREMENT:=1;
0335     IF (X1<>X2) THEN
0344     BEGIN
0344         A1:=MIN(ROUND(I6*(X1+H0)),ROUND(I6*(X2+H0)));
0373         A2:=MAX(ROUND(I6*(X1+H0)),ROUND(I6*(X2+H0)));
03A2         M:=(Y1-Y2)/(X1-X2);
03C1         B:=(X1*Y2-X2*Y1)/(X1-X2);
03EE         U:=A1;
03F8         WHILE U<=A2 DO
0407             BEGIN
0407                 V:=ROUND(I8*(K0+M*(U/I6-H0)+B));
0439                 IF (V>=0) AND (V<=HEIGHT) THEN

```

Listing 9 continues

```

0451          BEGIN
0451          IF V=HEIGHT THEN V:=HEIGHT-1;
046F          POKE(ADRU,U); POKE(ADRU+1,0);
0482          POKE(ADRV,V); POKE(ADRV+1,0);
0495          Z:=CALL(TIGER,2)
049F          END;
04A1          IF(U =A1) THEN OLDV:=V;
04BA          IF(ABS(V-OLDV)>3) THEN FILL(V,OLDV);
04DD          U:=U+INCREMENT;
04EE          OLDV:=V
04F6          END
04F8          END
04FB          ELSE
04FE          BEGIN
04FE          U:=ROUND(I6*(X1+H0));
0516          IF U=WIDTH THEN U:=U-2;
0534          POKE(ADRU,U); POKE(ADRU+1,0);
0547          FILL(ROUND(I8*(Y1+K0)), ROUND(I8*(Y2+K0)))
0570          END;
0570          X1:=X2;Y1:=Y2;
0584          WRITELN('ENTER NEXT POINT--TO END THIS SEQUENCE OF LINES');
05C0          WRITELN('ENTER THE SAME POINT TWICE');
05E7          READ(X2,Y2)
05F4          END
05F4          END;(*LINE*)
05F8
05F8          BEGIN
05F8          WRITELN('THIS PROGRAM ALLOWS YOU TO DRAW A SEQUENCE OF');
0632          WRITELN('LINES. TO END A SEQUENCE, ENTER THE SAME POINT');
066D          WRITELN('TWICE. THEN YOU HAVE THE OPTION OF STARTING A');
06A7          WRITELN('NEW SEQUENCE OF LINES OR PRINTING THE GRAPH');
06DF          INIT(WIDTH,HEIGHT,H0,K0);
06EE          WIDTH:=I6*WIDTH; HEIGHT:=I8*HEIGHT;
070C          Z:=CALL(TIGER,0);
0716          WRITELN('DO YOU WANT AXES DRAWN (Y OR N)');
0742          REPEAT ANSWER:=INKEY UNTIL ANSWER<>CHR(0);
0756          IF ANSWER = 'Y' THEN Z:=CALL(TIGER,1);
076F          LINE;
0772          REPEAT
0772          BEGIN
0772          WRITELN('DO YOU WANT TO DO ANOTHER SEQUENCE OF LINES?');
07AB          WRITELN('(Y OR N)--N PRINTS THE PAGE AND ENDS THIS');
07E1          WRITELN('PROGRAM. ');
07F6          REPEAT ANSWER:=INKEY UNTIL ANSWER<>CHR(0);
080A          IF ANSWER='Y' THEN LINE;
081A          END;
081A          UNTIL ANSWER='N';
0827          Z:=CALL(TIGER,3)
0831          END.

```

Program Listing 10

```

0000 PROGRAM SCALER;
0003 CONST TIGER=-2816;ADRU=-2805;ADRV=-2803;
000C I6=16;I8=18;
000C TYPE POINT=ARRAY(.1..2.) OF REAL;
0012 VAR I,J,U,V,Z,WIDTH,HEIGHT,H0,K0,OLDV: INTEGER;
003A     XSCALER,YSCALER: REAL;
0042     ANSWER: CHAR;
0046
0046 PROC INIT(VAR PWIDE,PHIGH,H0,K0: INTEGER);
005F CONST ADRH0=-2809;ADRK0=-2807;ADRPHIGH=-2813;ADRPWIDE=-2811;
0060 BEGIN

```

Listing 10 continues


```

0065 WRITELN('HOW MANY UNITS FOR X-AXIS AND FOR Y-AXIS');
009A READ(PWIDE,PHIGH);
00A7 POKE(ADRPHIGH,PHIGH); POKE(ADRPHIGH+1,0);
00BA POKE(ADRPWIDE,PWIDE); POKE(ADRPWIDE+1,0);
00CD WRITELN('ENTER H0 AND K0 TO PLACE THE ORIGIN');
00FD READ(H0,K0);
010A POKE(ADRH0,H0); POKE(ADRH0+1,0);
011D POKE(ADRK0,K0); POKE(ADRK0+1,0)
0130 END;(*INIT*)
0131
0131 FUNC MIN(X,Y:INTEGER):INTEGER;
013D BEGIN
0143 IF X<Y THEN MIN:=X ELSE MIN:=Y
0167 END;(*MIN*)
016A
016A FUNC MAX(X,Y:INTEGER):INTEGER;
0176 BEGIN
017C IF X<Y THEN MAX:=Y ELSE MAX:=X
01A0 END;(*MAX*)
01A3
01A3 PROC FILL(X,Y:INTEGER);
01AF VAR A1,A2,V:INTEGER;
01BC BEGIN
01C1 A1:=MAX(MIN(X,Y),0)+1;
01DE A2:=MIN(MAX(X,Y),HEIGHT)-1;
01FF V:=A1;
0209 WHILE V<=A2 DO
0218 BEGIN
0218 POKE(ADRV,V); POKE(ADRV+1,0);
022B V:=V+2;
023A Z:=CALL(TIGER,2)
0244 END
0246 END;(*FILL*)
024A
024A FUNC F(X:REAL):REAL;
0252 BEGIN F:=(X-6)*X*(X+10)
0276 END;(*FUNC F*)
027B
027B BEGIN
027B INIT(WIDTH,HEIGHT,H0,K0);
028A WIDTH:=I6*WIDTH; HEIGHT:=I8*HEIGHT;
02A8 Z:=CALL(TIGER,0);
02B2 WRITELN('DO YOU WANT AXES DRAWN (Y OR N)');
02DE REPEAT ANSWER:=INKEY UNTIL ANSWER<>CHR(0);
02F2 IF ANSWER = 'Y' THEN Z:=CALL(TIGER,1);
030B WRITELN('ENTER THE SCALE FACTOR FOR X-AXIS');
0339 READ(XSCALER);
0340 WRITELN('ENTER THE SCALE FACTOR FOR Y-AXIS');
036E READ(YSCALER);
0375
0375 FOR U:=0 TO WIDTH DO
0389 BEGIN
0389 V:=ROUND(18*(K0+(1/YSCALER)*F(XSCALER*(U/16-H0))));
03C4 IF (V>=0) AND (V<=HEIGHT) THEN
03DC BEGIN
03DC POKE(ADRU,U); POKE(ADRU+1,0);
03EF POKE(ADRV,V); POKE(ADRV+1,0);
0402 Z:=CALL(TIGER,2)
040C END;
040E IF U=0 THEN OLDV:=V;
0423 IF ABS(V-OLDV)>2 THEN FILL(V,OLDV);
0446 OLDV:=V
044E END;
0453 Z:=CALL(TIGER,3)
045D END.

```

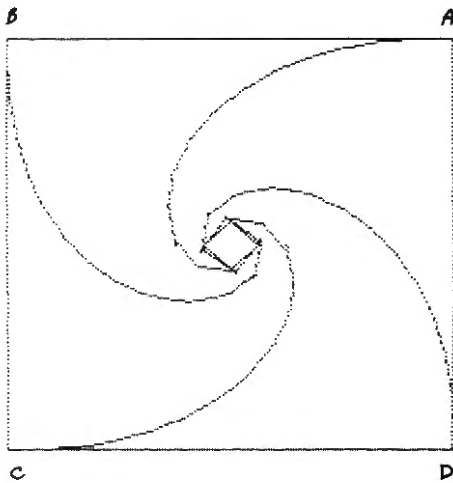


Figure 23

(9F00H-A962H), and its compiled version is from 43,520-45,290 (AA00H-BOEAH). This leaves the memory area from 45,290 to 53,248 free. All the programs in this article fit within these limits and it is not necessary to use the W

and X commands.

Pascal-80 Programs for Graphing

In the following Pascal-80 programs, certain procedures and functions are equivalent to segments of the Basic programs in Part I. I have tried, as much as possible, to keep the same names for the variables as in the Basic programs. Limer incorporates the functions and procedures common to the Pascal-80 programs that call Tigerpas. These procedures are described below.

Procedure INIT initializes the variables. HO, KO, PHIGH, and PWIDE have the same meaning as in the Basic programs in Part I, namely for the placement of the x-y coordinate axes and for the number of units for the lengths of the x and y axes. Their values are entered using a read statement and the four values are POKEd into the appropriate memory locations. The addresses for these variables are defined in

the CONST declaration statement.

Functions MIN and MAX each have two arguments X and Y, and return the minimum and maximum of X and Y, respectively.

Procedure Fill is similar to the subroutine in the Basic programs. It is used to fill the vertical gaps in graphs that are rising or falling rapidly. The statements defining the values A1 and A2 find the vertical range of the v values to be filled and keep their values within the boundaries of the page. For example, in finding the lower limit A1, first find the minimum of $X = V$ and $Y = \text{OLDV}$. To keep the v values nonnegative, take the maximum of the $\text{MIN}(X, Y)$ and 0. Similarly, the upper limit A2 is found. The Pascal-80 function Round finds the integer nearest its argument. The equivalent statement in the Basic programs is $\text{INT}(\text{argument} + .5)$. Once A1 and A2 have been determined, the rest of the procedure sends the appropriate values to the Plot subroutine.

Program Listing 11

```

0000 PROGRAM DOGCAT;
0003 CONST TIGER=-2816;ADRU=-2805;ADRV=-2803;
000C I6=16;I8=18;
000C TYPE POINTS=ARRAY(.1..2.) OF REAL;
0012 VAR I,J,U,V,Z,PWIDE,PHIGH ,H0,K0,STOPDOG,STOPCAT: INTEGER;
003E     WIDTH,HEIGHT: INTEGER;
0046     H1,K1,X1,Y1,X2,Y2,K,DOGVELOCITY,CATVELOCITY: REAL;
006A     DOG,CAT,TREE: POINTS;
0076     ANSWER: CHAR;
007A
007A PROC INIT;
0083 CONST ADRH0=-2809;ADRK0=-2807;ADRPHIGH=-2813;ADRPWIDE=-2811;
0084 BEGIN
0089     PWIDE:=14; PHIGH:=9; H0:=1; K0:=1;
00A9     POKE(ADRPHIGH,PHIGH); POKE(ADRPHIGH+1,0);
00BC     POKE(ADRPWIDE,PWIDE); POKE(ADRPWIDE+1,0);
00CF     POKE(ADRH0,H0); POKE(ADRH0+1,0);
00E2     POKE(ADRK0,K0); POKE(ADRK0+1,0)
00F5 END; (*INIT*)
00F6
00F6 FUNC MIN(X,Y: INTEGER) : INTEGER;
0102 BEGIN
0108     IF X<Y THEN MIN:=X ELSE MIN:=Y
012C END; (*MIN*)
012F
012F FUNC MAX(X,Y: INTEGER) : INTEGER;
013B BEGIN
0141     IF X<Y THEN MAX:=Y ELSE MAX:=X
0165 END; (*MAX*)
0168
0168 PROC FILL(X,Y: INTEGER) ;
0174 VAR A1,A2,V: INTEGER;

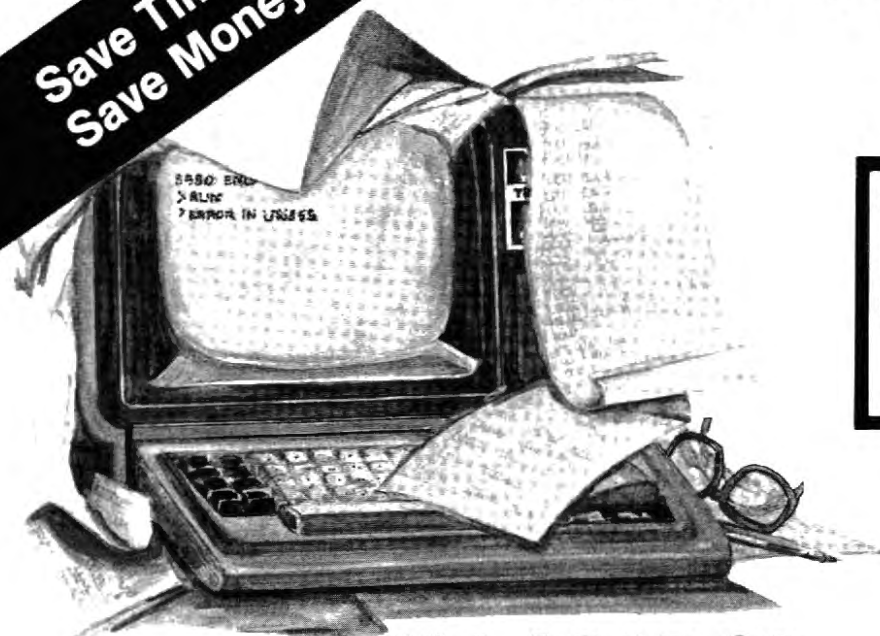
```

Listing 11 continues

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```

0181 BEGIN
0186 A1:=MAX(MIN(X,Y),0)+1;
01A3 A2:=MIN(MAX(X,Y),HEIGHT)-1;
01C4 V:=A1;
01CE WHILE V<=A2 DO
01DD BEGIN
01DD POKE(ADRV,V); POKE(ADRV+1,0);
01F0 V:=V+2;
01FF Z:=CALL(TIGER,2)
0209 END
020B END;(*FILL*)
020F
020F PROC LINE;
0213 VAR A1,A2,U,V,OLDV,I:INTEGER;
022C M,B:REAL;
0234 BEGIN
0239 IF (X1<>X2) THEN
0248 BEGIN
0248 A1:=MIN(ROUND(I6*(X1+H0)),ROUND(I6*(X2+H0)));
0277 A2:=MAX(ROUND(I6*(X1+H0)),ROUND(I6*(X2+H0)));
02A6 M:=(Y1-Y2)/(X1-X2);
02C5 B:=(X1*Y2-X2*Y1)/(X1-X2);
02F2 FOR U:=A1 TO A2 DO
030A BEGIN
030A V:=ROUND(I8*(K0+M*(U/I6-H0)+B));
033C IF (V>=0) AND (V<=HEIGHT) THEN
0354 BEGIN
0354 IF V=HEIGHT THEN V:=HEIGHT-1;
0372 POKE(ADRU,U); POKE(ADRU+1,0);
0385 POKE(ADRV,V); POKE(ADRV+1,0);
0398 Z:=CALL(TIGER,2)
03A2 END;
03A4 IF(U =A1) THEN OLDDV:=V;
03BD IF(ABS(V-OLDDV)>2) THEN FILL(V,OLDDV);
03E0 OLDDV:=V
03E8 END
03EA END
03ED ELSE
03F0 BEGIN
03F0 U:=ROUND(I6*(X1+H0));
0408 IF U=WIDTH THEN U:=U-2;
0426 POKE(ADRU,U); POKE(ADRU+1,0);
0439 FILL(ROUND(I8*(Y1+K0)), ROUND(I8*(Y2+K0)))
0462 END
0462 END;(*LINE*)
0463
0463 PROC MOVE(K:REAL;VAR X,Y:POINTS);
0473 VAR M,P,Q,DISTANCE:REAL;
0484 BEGIN
0489 P:=Y(.1.)-X(.1.); Q:=Y(.2.)-X(.2.);
04CB DISTANCE:=SQRT(SQR(P)+SQR(Q));
04E2 IF (DISTANCE <= K) THEN
04F1 BEGIN
04F1 X1:=Y(.1.); Y1:=Y(.2.);
0515 END
0515 ELSE
0518 BEGIN

```

```

0518      M:=K/DISTANCE;
0529      X1:=X(.1.) + M*P; Y1:=X(.2.) + M*Q;
0569      END;
0569      X2:=X(.1.); Y2:=X(.2.);
058D      LINE;
0590      X(.1.):=X1; X(.2.):=Y1
05B2 END; (*MOVE*)
05B5
05B5 BEGIN
05B5      INIT;
05B8      WIDTH:=I6*PWIDE; HEIGHT:=I8*PHIGH;
05D6      Z:=CALL(TIGER,0);
05E0      WRITELN('DO YOU WANT AXES DRAWN (Y OR N)');
060C      REPEAT ANSWER:=INKEY UNTIL ANSWER<>CHR(0);
0620      IF ANSWER = 'Y' THEN Z:=CALL(TIGER,1);
0639      DOG(.1.):=13; DOG(.2.):=0;
0659      CAT(.1.):=0; CAT(.2.):=0;
0677      TREE(.1.):=0; TREE(.2.):=8;
0697      DOGVELOCITY:=2.0;
06A1      CATVELOCITY:=1.5;
06AB      STOPDOG:=0; STOPCAT:=0;
06B7      REPEAT
06B7          IF ((CAT(.1.)=TREE(.1.)) AND (CAT(.2.)=TREE(.2.)))
06F0              THEN STOPCAT:=1
06F9              ELSE MOVE(DOGVELOCITY,DOG,CAT);
070C              IF (STOPCAT=1) OR ((DOG(.1.)=CAT(.1.)) AND (DOG(.2.)=CAT(.2.)))
074F                  THEN STOPDOG:=1
0759                  ELSE MOVE(CATVELOCITY,CAT,TREE);
076C      UNTIL (STOPDOG=1) OR (STOPCAT=1);
0784      Z:=CALL(TIGER,3);
0790      WRITELN(LP);
0797      IF (STOPCAT<>1) THEN
07A4          WRITELN(LP,'DOG GOT CAT AT (' ,DOG(.1.):3,',',',',
07D3              DOG(.2.):3,',')');
07EB      ELSE WRITELN(LP,'CAT GOT TO THE TREE');
0815      WRITELN(LP,'VELOCITY OF DOG: ',DOGVELOCITY,
0833          ' VELOCITY OF CAT: ',CATVELOCITY);
085A      WRITELN(LP,'ORIGIN AT (' ,H0,',',',',K0,')');
088C      WRITELN(LP,'PHIGH: ',PHIGH,', PWIDE: ',PWIDE)
08B9 END.

```

Procedure Line is designed to draw a sequence of connected line segments. That is, given a sequence of points P1, P2, P3, ... Line draws the line segments P1 to P2, P2 to P3, and so forth. The procedure begins by asking for the first two points, and the line segment joining these two points is inserted into the page. After the line segment is drawn, the user is asked for the next point in the sequence. If the point entered is the same as the last point entered, the procedure ends; otherwise the While loop continues and the next line segment is drawn.

Vertical lines and nonvertical lines must be done in different cases, just as

in the Basic programs in Part I. The variable INCREMENT is assigned a value of one or two, according to whether or not the line segment is vertical or not vertical, respectively. INCREMENT is used to space the dots of the graph, and without this change in INCREMENT, vertical lines are darker when graphed. In addition, it saves time by reducing the number of computations and POKES to be performed.

When control returns to the body of the program, the user has the option of beginning a new line-segment sequence. Depending upon the answer, the program either ends or uses the Line procedure again. Figure 18

was drawn using Liner.

Change the Scale of a Graph

There comes a time in the graphing of functions when the implicit restriction on the domains and ranges of functions to be graphed must be overcome. For example, if we want to graph the national debt over the past 50 years, obviously the graph must be scaled to fit within the dimensions of the maximum size page permitted. The program Scaler (Program Listing 10) is an example of graphing a function for x's in the range from -20 to 20 and y's ranging from -400 to 400, within the dimensions of a 2-by-2 page. In the previous

```

0000 PROGRAM BUGS;
0003 CONST TIGER=-2816;ADRU=-2805;ADRV=-2803;
000C I6=16;I8=18;
000C TYPE POINTS=ARRAY(.1..2.) OF REAL;
0012 VAR I,J,U,V,Z,WIDTH,HEIGHT,H0,K0:INTEGER;
0036     H1,K1,X1,Y1,X2,Y2,K:REAL;
0052     A,B,C,D,OLDA:POINTS;
0066     ANSWER:CHAR;
006A
006A PROC INIT(VAR PWIDE,PHIGH,H0,K0:INTEGER);
0083 CONST ADRH0=-2809;ADRK0=-2807;ADRPHIGH=-2813;ADRPWIDE=-2811;
0084 BEGIN
0089     PWIDE:=14; PHIGH:=14; H0:=7; K0:=7;
00A9     POKE(ADRPHIGH,PHIGH); POKE(ADRPHIGH+1,0);
00BC     POKE(ADRPWIDE,PWIDE); POKE(ADRPWIDE+1,0);
00CF     POKE(ADRH0,H0); POKE(ADRH0+1,0);
00E2     POKE(ADRK0,K0); POKE(ADRK0+1,0)
00F5 END;(*INIT*)
00F6
00F6 FUNC MIN(X,Y:INTEGER):INTEGER;
0102 BEGIN
0108     IF X<Y THEN MIN:=X ELSE MIN:=Y
012C END;(*MIN*)
012F
012F FUNC MAX(X,Y:INTEGER):INTEGER;
013B BEGIN
0141     IF X<Y THEN MAX:=Y ELSE MAX:=X
0165 END;(*MAX*)
0168
0168 PROC FILL(X,Y:INTEGER);
0174 VAR A1,A2,V:INTEGER;
0181     BEGIN
0186         A1:=MAX(MIN(X,Y),0)+1;
01A3         A2:=MIN(MAX(X,Y),HEIGHT)-1;
01C4         V:=A1;
01CE         WHILE V<=A2 DO
01DD             BEGIN
01DD                 POKE(ADRV,V); POKE(ADRV+1,0);
01F0                 V:=V+2;
01FF                 Z:=CALL(TIGER,2)
0209             END
020B         END;(*FILL*)
020F
020F PROC LINE;
0213 VAR A1,A2,U,V,OLDV,I:INTEGER;
022C     M,B:REAL;
0234 BEGIN
0239     IF (X1<>X2) THEN
0248         BEGIN
0248             A1:=MIN(ROUND(I6*(X1+H0)),ROUND(I6*(X2+H0)));
0277             A2:=MAX(ROUND(I6*(X1+H0)),ROUND(I6*(X2+H0)));
02A6             M:=(Y1-Y2)/(X1-X2);
02C5             B:=(X1*Y2-X2*Y1)/(X1-X2);
02F2             FOR U:=A1 TO A2 DO
030A                 BEGIN
030A                     V:=ROUND(I8*(K0+M*(U/I6-H0)+B));

```

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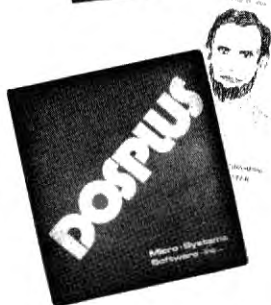
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```

033C      IF (V>=0) AND (V<=HEIGHT) THEN
0354      BEGIN
0354          IF V=HEIGHT THEN V:=HEIGHT-1;
0372          POKE(ADRU,U); POKE(ADRU+1,0);
0385          POKE(ADRV,V); POKE(ADRV+1,0);
0398          Z:=CALL(TIGER,2)
03A2      END;
03A4      IF(U =A1) THEN OLDV:=V;
03BD      IF(ABS(V-OLDV)>2) THEN FILL(V,OLDV);
03E0      OLDV:=V
03E8      END
03EA      END
03ED      ELSE
03F0      BEGIN
03F0          U:=ROUND(I6*(X1+H0));
0408          IF U=WIDTH THEN U:=U-2;
0426          POKE(ADRU,U); POKE(ADRU+1,0);
0439          FILL(ROUND(I8*(Y1+K0)), ROUND(I8*(Y2+K0)))
0462      END
0462  END; (*LINE*)
0463
0463  PROC MOVE(VAR X,Y:POINTS);
046F  VAR M,P,Q:REAL;
047C  BEGIN
0481      P:=Y(.1.)-X(.1.); Q:=Y(.2.)-X(.2.);
04C3      M:=K/SQRT(SQR(P)+SQR(Q));
04E1      X1:=X(.1.)+M*P; Y1:=X(.2.)+M*Q;
0521      X2:=X(.1.); Y2:=X(.2.);
0545      LINE;
0548      X(.1.):=X1; X(.2.):=Y1
056A  END; (*MOVE*)
056D
056D  PROC SQUARE;
0571  BEGIN
0577  X1:=6;Y1:=6; X2:=-6;Y2:=6;LINE; X2:=6; Y2:=-6; LINE;
05B7  X1:=-6;Y1:=-6;LINE; X2:=-6;Y2:=6;LINE
05E7  END; (*SQUARE*)
05E8
05E8  BEGIN
05E8      INIT(WIDTH,HEIGHT,H0,K0);
05F7      WIDTH:=I6*WIDTH; HEIGHT:=I8*HEIGHT;
0615      Z:=CALL(TIGER,0);
061F      WRITELN('DO YOU WANT AXES DRAWN (Y OR N)');
064B      REPEAT ANSWER:=INKEY UNTIL ANSWER<>CHR(0);
065F      IF ANSWER = 'Y' THEN Z:=CALL(TIGER,1);
0678      SQUARE;
067B      K:=1.0;
0685      A(.1.):=6 ;A(.2.):=6;
06A7      B(.1.):=-6 ;B(.2.):=6;
06CB      C(.1.):=-6; C(.2.):=-6;
06F1      D(.1.):=6; D(.2.):=-6;
0715      OLDA(.1.):=A(.1.); OLDA(.2.):=A(.2.);
0749      FOR I:=0 TO 40 DO
075B      BEGIN
075B          MOVE(A,B); MOVE(B,C); MOVE(C,D);MOVE(D,OLDA);
077F          OLDA(.1.):=A(.1.); OLDA(.2.):=A(.2.)
07B1      END;

```



```

07B6     Z:=CALL(TIGER,3)
07C0     END.

```

Program Listing 13

```

0000 PROGRAM SOLUTION;
0003 CONST TIGER=-2816;ADRU=-2805;ADRV=-2803;
000C I6=16;I8=18;
000C VAR I,J,U,V,Z,WIDTH,HEIGHT,H0,K0:INTEGER;
0030     X1,Y1,X2,Y2,R,ALPHA,BETA:REAL;
004C     ANSWER:CHAR;
0050
0050 PROC INIT(VAR PWIDE,PHIGH,H0,K0:INTEGER);
0069 CONST ADRH0=-2809;ADRK0=-2807;ADRPHIGH=-2813;ADRPWIDE=-2811;
006A BEGIN
006F     PWIDE:=14; PHIGH:=14; H0:=7; K0:=7;
008F     POKE(ADRPHIGH,PHIGH); POKE(ADRPHIGH+1,0);
00A2     POKE(ADRPWIDE,PWIDE); POKE(ADRPWIDE+1,0);
00B5     POKE(ADRH0,H0); POKE(ADRH0+1,0);
00C8     POKE(ADRK0,K0); POKE(ADRK0+1,0)
00DB END;(*INIT*)
00DC
00DC FUNC MIN(X,Y:INTEGER):INTEGER;
00E8 BEGIN
00EE     IF X<Y THEN MIN:=X ELSE MIN:=Y
0112 END;(*MIN*)
0115
0115 FUNC MAX(X,Y:INTEGER):INTEGER;
0121 BEGIN
0127     IF X<Y THEN MAX:=Y ELSE MAX:=X
014B END;(*MAX*)
014E
014E PROC FILL(X,Y:INTEGER);
015A VAR A1,A2,V:INTEGER;
0167     BEGIN
016C         A1:=MAX(MIN(X,Y),0)+1;
0189         A2:=MIN(MAX(X,Y),HEIGHT)-1;
01AA         V:=A1;
01B4         WHILE V<=A2 DO
01C3             BEGIN
01C3                 POKE(ADRV,V); POKE(ADRV+1,0);
01D6                 V:=V+2;
01E5                 Z:=CALL(TIGER,2)
01EF             END
01F1         END;(*FILL*)
01F5
01F5 PROC LINE;
01F9 VAR A1,A2,U,V,OLDV,I:INTEGER;
0212     M,B:REAL;
021A BEGIN
021F     IF (X1<>X2) THEN
022E         BEGIN
022E             A1:=MIN(ROUND(I6*(X1+H0)),ROUND(I6*(X2+H0)));
025D             A2:=MAX(ROUND(I6*(X1+H0)),ROUND(I6*(X2+H0)));
028C             M:=(Y1-Y2)/(X1-X2);

```

Listing 13 continues

```

02AB      B:=(X1*Y2-X2*Y1)/(X1-X2);
02D8      FOR U:=A1 TO A2 DO
02F0          BEGIN
02F0              V:=ROUND(I8*(K0+M*(U/I6-H0)+B));
0322              IF (V>=0) AND (V<=HEIGHT) THEN
033A                  BEGIN
033A                      IF V=HEIGHT THEN V:=HEIGHT-1;
0358                      POKE(ADRU,U); POKE(ADRU+1,0);
036B                      POKE(ADRV,V); POKE(ADRV+1,0);
037E                      Z:=CALL(TIGER,2)
0388                  END;
038A                      IF (U =A1) THEN OLDV:=V;
03A3                      IF (ABS(V-OLDV)>2) THEN FILL(V,OLDV);
03C6                      OLDV:=V
03CE                  END
03D0      END
03D3      ELSE
03D6          BEGIN
03D6              U:=ROUND(I6*(X1+H0));
03EE              IF U=WIDTH THEN U:=U-2;
040C              POKE(ADRU,U); POKE(ADRU+1,0);
041F              FILL(ROUND(I8*(Y1+K0)), ROUND(I8*(Y2+K0)))
0448          END
0448      END;(*LINE*)
0449
0449      PROC SQUARE;
044D      BEGIN
0453      X1:=6;Y1:=6; X2:=-6;Y2:=6;LINE; X2:=6; Y2:=-6; LINE;
0493      X1:=-6;Y1:=-6;LINE; X2:=-6;Y2:=6;LINE
04C3      END;(*SQUARE*)
04C4
04C4      BEGIN
04C4          INIT(WIDTH,HEIGHT,H0,K0);
04D3          WIDTH:=I6*WIDTH; HEIGHT:=I8*HEIGHT;
04F1          Z:=CALL(TIGER,0);
04FB          WRITELN('DO YOU WANT AXES DRAWN (Y OR N)');
0527          REPEAT ANSWER:=INKEY UNTIL ANSWER<>CHR(0);
053B          IF ANSWER = 'Y' THEN Z:=CALL(TIGER,1);
0554          SQUARE;
0557          POKE(ADRU+1,0);POKE(ADRV+1,0);
056B          ALPHA:=PI/4;
057E          BETA:=6*SQRT(2);
058E          WHILE ALPHA<3*PI/2 DO
05AB              BEGIN
05AB                  R:=BETA*EXP(PI/4-ALPHA);
05D0                  U:=ROUND(I6*(R*COS(ALPHA) + H0));
05F3                  V:=ROUND(I8*(R*SIN(ALPHA) + K0));
0616                  IF (V>=0) AND (V<=HEIGHT) AND (U>=0) AND (U<=WIDTH) THEN
0644                      BEGIN
0644                          POKE(ADRU,U);
064D                          POKE(ADRV,V);
0656                          Z:=CALL(TIGER,2)
0660                      END;
0662                      ALPHA:=ALPHA+0.01
066F                  END;
0676                  Z:=CALL(TIGER,3)
0680      END.

```

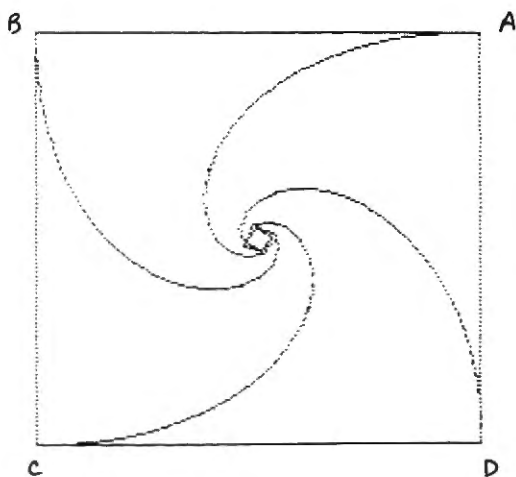


Figure 24

examples, one-quarter inch on the graph has represented one unit on the coordinate axes. Now we need one-quarter inch in the x direction to be five x units, and one-quarter inch in the y direction to be 100 y units.

In Scaler, the function to be graphed is $F(x) = x^3 + 4x^2 - 60x$. (See Fig. 18.) This function crosses the x axis at $x = -10, 0$, and 6 , and has a relative minimum point at $(10/3, -118.5)$ and relative maximum point at $(-6, 280)$. By graphing this function for x's in the range from -20 to 20 and for y's in the range from -400 to 400 , we get a graph that shows its critical points. In this example, the relationship between the u-v coordinate system and the scaled x-y system is given by:

$$u = 16(1 + H0) \text{ for } x = 5, v = 18(1 + K0) \text{ for } y = 100$$

$$u = 16(2 + H0) \text{ for } x = 10, v = 18(2 + K0) \text{ for } y = 200$$

and so forth. Thus the relations $u = 16(x/5 + H0)$ and $v = 18(y/100 + K0)$, or $x = 5(u/16 - H0)$ and $y = 100(v/18 - K0)$ will give the desired scaling. Substituting these values for x and y into $y = f(x)$, we get $100(v/18 - K0) = f(5(u/16 - H0))$, which simplifies to $v = 18[K0 + (1/100)f(5(u/16 - H0))]$.

In the general case, if S is the number of x units represented by one-quarter inch and Y is the number of y units represented by one-quarter inch on the graph, then the changes of coordinates between the u-v and x-y coordinate systems are $u = 16(x/S + H0)$ and $v = 18(y/T + K0)$ and $x = S(u/16 - H0)$ and $y = T(v/18 - K0)$.

So, to graph the function $y = f(x)$ using the new scale, substituting the above equations for x and y we get $T(v/18 - K0) = f(S(u/16 - H0))$, which simplifies to $v = 18[K0 + (1/T)f(S(u/16 - H0))]$.

As before, we use $v = \text{ROUND}(v)$. In Scaler the function F is defined in

lines 024A-0276 and the value of v is computed in line 0389. The resulting graph in Fig. 18 has marks on the x axis representing five units and on the y axis representing 100 units. In Basic, after defining the function, the equation $v = \text{INT}(v + .5)$ accomplishes the same scaling from a Basic program.

Curves of Pursuit

Curves of pursuit are one of the most interesting and challenging types of differential equations. In this class of equations, an object A is chasing an object B—a dog chasing a cat, a hawk chasing a pigeon, or a submarine chasing a submarine. The goal of object B is to evade object A, through outrunning B or by changing its direction or its velocity.

The key to obtaining a graphic approximation of the solution is the ability to program the concept of "move object A towards object B a specified distance D." The process of sketching a graph for an equation of this type is straightforward, but often tedious. However, finding the solution of the differential equation can also be difficult. A favorite question of a teacher of mathematics posed to students is, "Is your answer reasonable?" Comparing the graph of the solution to a graph done with "finite steps" is an easy test for correctness.

In the following, I give two examples of graphic approximations of the solutions of differential equations. To tempt those readers not interested in differential equations, there is bound to be an interesting game built on the concept of moving A toward B a distance of D.

The first example I call Dogcat (Program Listing 11). In this example, suppose a cat is sitting at a point in the x-y plane. Let that point be the origin, and

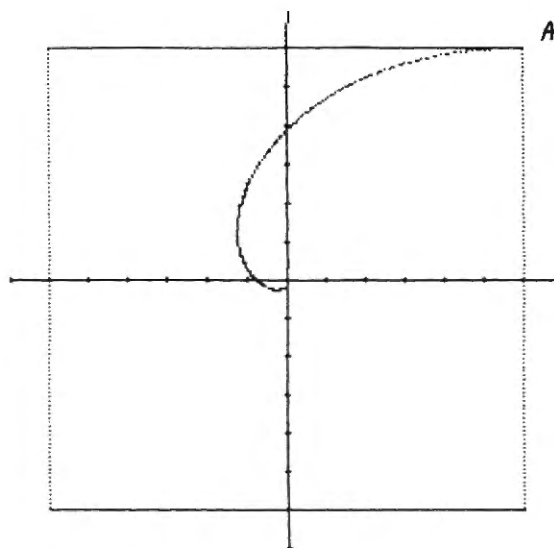


Figure 25

suppose further that to the north of the cat there is a tree, and to the east of the cat there is a dog. When the dog sees the cat, he begins to chase it; the dog always moves toward the cat a distance determined by its velocity. At the same time the cat begins to run toward the tree. If the velocities of the dog and cat are known, together with the original distances between the dog and the cat and the tree, then it is possible to determine whether or not the cat safely reaches the tree.

In Dogcat the Line procedure has been changed slightly. The interactive portion has been removed and the new version plots a line segment joining two points $(X1, Y1)$ to $(X2, Y2)$.

The Move procedure, called by $\text{MOVE}(K, X, Y)$, moves the point X toward the point Y a distance of K units. The distance D between the two points $X = (X1, X2)$ and $Y = (Y1, Y2)$ is computed in line 52A. Recall that the distance between the two points is given by the distance formula

$$D = \sqrt{(Y1 - X1)^2 + (Y2 - X2)^2}$$

If the distance is less than or equal to K (the distance to be moved), then the point X is moved to the point Y. Otherwise, the point X is moved K units toward the point Y along the line joining these two points. The parametric equations for the line joining these two points are

$$x = (1 - M)X1 + M \cdot Y1$$

$$y = (1 - M)X2 + M \cdot Y2$$

In this form, $M = 0$ gives the point $(X1, X2)$, $M = 1$ gives the point $(Y1, Y2)$, and as M varies from 0 to 1, the point

on the line goes from the point X to the point Y. To move a distance K along this line from X, you must find the coordinates (x,y) for which the distance between this point and X is K. Using the distance formula again and solving for M gives

$$M = \frac{K}{\sqrt{(Y1 - X1)^2 + (Y2 - X2)^2}}$$

In the main body of the program (614H-814H), the initialization is done and lines 6A4H and 6C4H fix the original positions of the dog and cat. In this case, the distance between the dog and cat is 13 units and between the cat and the tree is eight units. Lines 702H and 70BH define the velocities of the dog and cat. The moving of the dog toward the cat and cat toward the tree is accomplished in the Repeat statement (lines 71BH-7CCH), which continues until the dog reaches the cat or the cat reaches the tree. The graphs resulting from two sets of velocities are shown in Figs. 19 and 20. The first shows the path of the dog in an example in which the cat reaches the tree and the second shows the path when the cat does not reach the safety of the tree.

The final example is a well-known

problem. In fact, its graph was the cover of *Scientific American* a few years ago. In this problem, you have a square with its center at the origin and sides parallel to the coordinate axes. At each corner of the square there is a bug. Each bug moves counterclockwise towards the bug "in front of it;" i.e., A moves toward B, B toward C, C toward D, and D toward A. It is also assumed that the distance between each bug is 2a units, and the bugs move at the same speed.

Bugs (Program Listing 12) uses the same procedures and functions as Dogcat. A Square procedure has been added that draws the initial square. The sequence of moving each bug toward the one in front of it would theoretically take place simultaneously; however, that cannot be the case in a program. In order to model the simultaneous movement, you must remember to send bug D toward the point where bug A was at the previous instant. This is done using a point denoted OLDA, representing the previous position of A. The bug at D moves toward OLDA. Figures 21, 22, and 23 show the resulting paths for the point A for values of K equal to 2, 1, and 5.

The solution of the differential equation for the path of A is given by

$$r = \sqrt{2a} e^{\left(\frac{\pi}{4} - \theta\right)}$$

in polar equations, where the original position of bug A is the point (a,a). Program Listing 13 graphs the solution to this problem and the graph is shown in Fig. 24. This program is the Pascal equivalent of POLAR/BAS. (See Part I.) Comparing the graphs of the real solution to the graphs for the various values of K, you can see the following: First, as K gets smaller, the approximations to the graph of the solution get better. Second, the value K = .5 gives a good approximation to the graph of the solution.

This article gives a set of programs that will produce the graph of many functions. However, no set of programs can be complete enough to fill every need. I hope I have provided enough insight into the programs so that they can be adapted to other situations. ■

Barbara Clinger is a professor of mathematics at Wheaton College, Norton, MA 02766.



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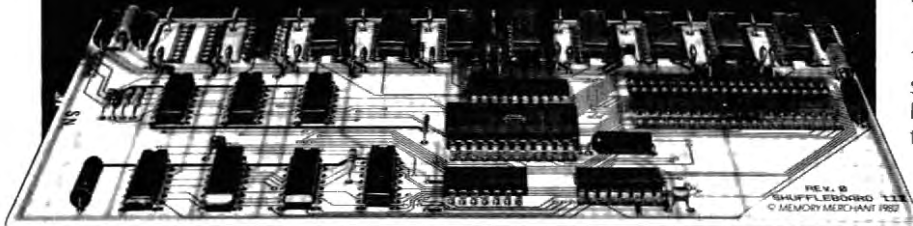
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Cobol on Your 80

by Sam Perry

Learning a new computer language can be a long tedious process, but this article leads you painlessly into the confusing world of Cobol.

Learning Cobol on the TRS-80 is much like trying to find your way through a Scott Adams adventure—everything you need is there; the problem is finding the information and then deciding what to do with it.

This article will detail the fundamentals of Cobol programming. In addition to reviewing the techniques for using Radio Shack's Cobol editor, compiler and runtime package, we will explore the basic elements of Cobol from the divisions of the Cobol program to setting up and processing sequential files.

Introduction to Cobol

Cobol (Common Business-Oriented Language) is the most widely-used business-programming language today. As much as 80 percent of all new business application programs are written in Cobol.

Although there are a number of reasons for Cobol's popularity, the two most commonly cited are the language's machine independence and self documentation.

In short, machine independence means that a Cobol program written for one computer can be easily con-

verted to run on another. This machine independence is the result of the specifications for the language that have been laid down by the American National Standards Institute (ANSI or ANS). This means once you learn Cobol on the TRS-80, you are qualified to program in Cobol on any machine from micro to mainframe.

The self-documenting nature of the language simplifies updating and debugging, thus reducing programming costs.

Cobol's most serious drawback is its inability to handle complex mathematical computations; but then again, the language was not designed for that purpose.

Choosing a Suitable Text

Before undertaking the challenge of learning Cobol, you should acquire a suitable text. Radio Shack's Cobol editor, compiler and runtime programs make up an impressive package, but the reference manual is a weak link in the system. It is useless as an instructional text and of little value as a reference guide. Confusing and ambiguous statements such as "This variation of the Perform statement is used to augment

the values referenced by one or more identifiers or index-names in an orderly fashion during the execution of a Perform statement" are common.

The book you select should be specifically for the ANSI '74 or ANS '74 version of Cobol. (ANSI meets every six years or so to decide on changes that should be made in Cobol. The version of Cobol offered by Radio Shack adheres to the 1974 standards.)

Do not let titles such as "Structured Cobol" confuse you—Cobol is Cobol. ("Structured" simply means the author will also present structured programming techniques.) I suggest any introductory book on the subject by Shelly and Cashman or Stern and Stern.

Basic Cobol Terminology

A program is merely a set of instructions given to the computer by a programmer. These instructions are coded in a computer language.

Why not give the computer instructions in English? The answer is simple. Since a computer cannot make judgments, the instructions we give it must be totally clear and singular in meaning. English is inherently ambiguous. For example, the phrase "take a seat" is clearly subject to two or more interpretations. Instructions written in a computer language have only one possible meaning.

Programs written in computer languages are referred to as "software," and the physical computer equipment is termed "hardware."

Cobol is a compiled language, while

Basic is interpreted. After keying in a Basic program you need merely type Run to execute the instructions found in the program lines. With Basic, the computer interprets and performs each instruction as it is encountered. (This is similar to a human interpreter translating line by line as a foreigner speaks.) In Cobol, the entire program is translated (or compiled) before any of it is executed. (This is similar to the interpreter translating an entire speech before delivering the message.)

The actual Cobol program lines that you type in are known as the source code. After typing in this source code it must be compiled into a form called object code. This object code is the translated version of the Cobol program. It is the version that can be executed.

Once the object code is created you can run it as often as you like without recompiling the source code.

Finally, as the source code is being compiled, the compiler lists all syntax errors in your program (lines that break the rules of the language). These errors include misspellings, illegal use of data items or variables, and improper punctuation.

While the compiler will locate and flag syntax errors, it cannot detect errors in program logic—when you tell the computer to do something other than what you intended. For example, if you tell the computer to subtract two numbers when you meant to add them, your program has a logic error.

Included in Radio Shack's Cobol package are three major programs: editor, compiler, and runtime.

To create, compile, and run a Cobol program you must understand the interrelationships between these programs, and how each is properly executed.

Following the instructions below, key in, compile and execute the Cobol program in Listing 1. You can use your right arrow on the Model III and the tab key on the Model II to tab over to the next margin as you enter the code. You should be in the TRSDOS Ready state with a copy of your Cobol disk in drive 0. When executed, this program will allow you to key in a line and specify the position on the screen where you would like to see it printed.

Step 1—The Program Editor (CEDIT)

First, you must key in the source code. To do this you need to access the program editor—simply type CEDIT and press enter while in TRSDOS. After the program editor loads you are ready to begin keying in the source code.

Although the TRS-80 Cobol refer-

ence manual outlines a variety of options available for the editor, there are only six essential commands:

- I Insert
- R Retype
- D Delete
- W Write to the disk
- L Load from the disk
- Q Quit the editor

To type in a Cobol program you must get into the editor's insert mode. To do this simply press the letter I. Line 000100 will appear and you are ready to begin typing the first line. While entering lines, be sure to pay strict attention to spacing because, unlike Basic, it must be precise. Refer to the margin requirements in Fig. 1 for spacing details.

After each line press enter and the next line number will appear automatically. When you complete the last line, press enter and then break to exit the insert mode.

Before writing the source code to the disk, proofread the program lines. You

can view the lines by pressing the up and down arrows.

Should you find an error in a program line, the simplest way to make a correction is to retype the line. To do this simply type the letter R followed by the number of the line you wish to change. For example, when you enter R 120 the number 00120 will appear and you can retype the line.

To delete lines, simply press the letter D followed by the number of the line you wish to delete from the program. The editor automatically renumbers program lines after one is deleted on the Model III.

When you are satisfied that the source code is entered correctly, store it on the disk by typing the letter W followed by the name of your program. (Note that the name must not be longer than eight characters and should not have an extension. Also, the name must begin with a letter and consist of only letters and digits—no blanks or special characters.)

Now, to return to TRSDOS, press

Margin Requirements Chart

Columns	Use	Explanation
1-6	Sequence numbers	Used for reference to lines for purpose of insertion, change and deletion.
7	Continuation or remark	(-) means continuation of data name or literal started on a previous line. (*) means that the line serves only as a comment or remark.
8-11	Margin A	Division, Section and Paragraph names must begin in this margin.
12-72	Margin B	Most Cobol entries, particularly in the procedure division, must begin in this margin.

Coding Rules

- 1) Division and Section names:
 - a) Must begin in Margin A
 - b) Must end with a period
 - c) Must appear on a line alone
- 2) Paragraph Names:
 - a) Must begin in Margin A
 - b) Must end with a period
 - c) May appear on a line alone or with other entries
 - d) Must always be followed by at least one space
- 3) Statements:
 - a) Must begin in Margin B
 - b) Must end with a period
 - c) May appear on a line alone or with other entries
 - d) Must always be followed by at least one space

Figure 1

the letter Q.

Step 2—Compiling the Program (RSCOBOL)

When the source code is safely stored on the disk, it is time to compile the program into object code. From TRSDOS, simply enter RSCOBOL filename.

Two options in RSCOBOL allow you to see the source code as it is being compiled. They are T, which displays the code on the terminal (screen), and P, which copies the code on the printer.

```
RSCOBOL PROGRAMI T
RSCOBOL PROGRAMI P
RSCOBOL PROGRAMI T P
```

As the program is compiled, if any errors are found, you must return to the editor (with CEDIT) and reload the source code (with L filename). Then make any corrections with the R and D commands. Rewrite the program to the disk with the W command and then end the session with Q. You are then ready to recompile the corrected program.

Step 3—Running the Program (RUNCOBOL)

When an error-free version of the

program is compiled, the object code can be executed. Do this in TRSDOS by typing RUNCOBOL filename.

After you have successfully keyed in, compiled and executed the program in Listing 1, you can check your disk directory by entering DIR. You will see

“Every Cobol program must have four divisions: Identification, Environment, Data, and Procedure.”

your program listed twice—as filename/CBL and filename/COB.

When you write your source code to the disk from the editor, the extension /CBL is appended to the filename you supply. Then, when the program is compiled, the object code is written to the disk with the extension /COB. You need to use extensions with the pro-

grams only when referring to the file in a TRSDOS command such as Copy, Kill or List.

The Cobol Program

Every Cobol program must have four divisions: Identification, Environment, Data, and Procedure. These divisions are broken down into sections, which are subdivided into paragraphs, which are composed of statements. See Fig. 1 for a summary of the margin requirements and coding rules necessary for these entries.

The Identification division serves to identify the program. Program-ID is the only required entry in this division. Other entries serve merely as documentation. Note that the program ID you assign need not be the same as the name you use to write the source code to the disk, although this is generally a good practice.

In the Environment division, the computer the program is to be compiled and run on must be listed. Although the actual computer name is merely for documentation, the entries must be made. In this division you must also assign the files you plan to use to devices. For example, you might

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assign an output file to the printer or a sequential file to a disk.

The Data division is where all data items (variables) used in the program must be defined. Unlike Basic, you cannot simply pick a variable out of thin air; it must be defined in this division before it can be used in the program.

Another purpose of the Data division is to allow you to describe the fields within the files you intend to use. For example, if you plan to store names and addresses on the disk, you would have to define the fields (i.e. name, street, city, state, zip code, phone number) in the record. If you plan to use no files or variables in your program, which would rarely if ever be the case, you still must list the division's name in your program.

Finally, the Procedure division is the portion of the program where the actual instructions are entered. This is where you tell the computer what it is that you want done. This division most closely resembles the Basic program.

Program Listing 2 will print the message "SHORTEST COBOL PROGRAM" on the screen. This is probably about as short a program as can be written in Cobol—all divisions are present even though there are no en-

tries for the Data division.

Two frequently-used Cobol statements are Display and Accept. The text you select may not go into any detail on either statement, because these instructions are used primarily for displaying information on the screen and accepting it from the keyboard. Until recently, most Cobol programming was done by punching program lines into computer cards. There was no interaction between the programmer and the computer or the user and the computer. With the advent of the computer terminal and microcomputer, a truly interactive Cobol program can now be written.

Printing Messages on the Screen

A variety of items can be printed on the screen: numeric and nonnumeric literals, figurative constants, and the contents of data items.

A numeric literal is simply a value such as 10, 3, or -15. It can also be called a constant since its value never changes in the course of a program.

In contrast, a nonnumeric literal is any string of characters enclosed in quotes. Examples of nonnumeric literals are "Hello", "919 872-1955", and "a*b?/d@\$". These items can in-

clude any printable character on the keyboard.

Figurative constants are Cobol words that represent the value they describe. Examples include zeros and spaces.

Finally, data names are programmer-defined terms used to represent data. In Basic they are called variables.

Since we haven't discussed the Data division and the definition of data items, this explanation of Display will be restricted to printing literals.

To print messages on the screen, refer to the RSCOBOL section of the Cobol reference manual under the Display statement. Display is the equivalent to Print in Basic. You should note the options Erase, Line, and Position are similar to Basic's CLS, and PRINT@ respectively. To print the word "HELLO" on line 10 beginning five spaces over on a clear screen you would use the following line in the Procedure division:

```
DISPLAY "HELLO" LINE 10  
POSITION 5 ERASE.
```

Look at Listings 1 and 2—all Cobol statements found in the Procedure division must be located in paragraphs.

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A paragraph must begin with a programmer-created name that describes what the paragraph will instruct the computer to do. This is a form of self-documentation.

Note that paragraph names begin in margin A (columns 8-11) and end with a period. Statements in the paragraph must begin in margin B (columns 12-72) and also conclude with a period. As you can see from the sample listings, a statement can occupy two or more lines. It is concluded by a period.

Accepting Input from the Keyboard

Basic's powerful Input statement allows you to key in a response to a prompt. Cobol's Accept statement performs this same function.

The format for the Accept statement is as follows:

```
ACCEPT data-item.
```

When executed, the computer waits for you to type in some information. The response is then assigned to the data-item just as it is assigned to a variable in Basic.

A number of options can be used with Accept: Line, Position, Prompt, Tab, and Convert. An Accept state-

ment asking for a person's name might look like this (note that the Display statement is necessary to print the prompt on the screen):

```
DISPLAY "ENTER YOUR NAME:"
      LINE 5 POSITION 10.
ACCEPT NAME-ITEM LINE 5 POSITION
      27 PROMPT TAB.
```

The Display statement places the prompt Enter Your Name: on line 5 of the screen starting at tab position 10. Accept then allows you to key in the name starting on line 5 at position 27 (which is at the end of the line displayed). The option Prompt causes the computer to draw a solid line where your entry will be typed. Tab tells the computer to wait until you press Enter.

You must use the Convert option when accepting numeric data that contains a decimal point. For example:

```
DISPLAY "ENTER THE AMOUNT" LINE
      12 POSITION 5.
ACCEPT AMOUNT-PAID LINE 12
      POSITION 22 PROMPT
      TAB CONVERT.
```

Before a data item (such as name-item or amount-paid) can be used in an Accept statement, it must be defined in

the Data division. With your textbook, begin work on defining data items (or variables) in the Data division.

The Four Divisions

Each Cobol program consists of four divisions: Identification, Environment, Data and Procedure. While each division can contain numerous entries, we will concentrate on the most frequently used.

Figure 2 is a skeleton of the most commonly required entries. Consult this "cheat sheet" and the program listings provided as you read the following sections. (Key in capitalized items exactly as they appear, and supply all lowercase entries.)

Identification Division

Undoubtedly, the simplest division to code is the Identification division. As you can see in lines 100-150 of Fig. 2, the Identification division contains only five paragraphs. The only required entry is Program-ID. All other entries serve merely for documentation, but you should routinely include them.

The program name, which follows Program-ID, identifies the program to the computer. It should consist of no

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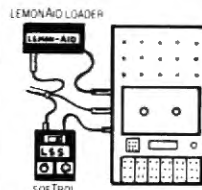
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more than eight characters and must begin with a letter. The name can be made up of only letters and digits—no spaces or hyphens are allowed. The following are valid program names: PROGRAM1, TEST and A123. Remember that this program name does not have to be the same as the name you use when writing the source code to the disk from CEDIT.

You can make all other entries in this division using any characters on the keyboard, including spaces. For example, you could enter the date as August 28, 1982 or as 8/28/82. These are the only programmer-supplied entries in which you can use blanks.

Earlier versions of Cobol allowed a Remarks entry in this division. With the ANSI '74 version, you can place remarks anywhere in the program simply by entering an asterick in column 7 of the program line, followed by a comment or remark. Remarks are used primarily for additional notes within the source code of the program. They are for the programmer's benefit and are ignored when the program is compiled.

Environment Division

Entries in the Environment division cover the computer equipment, or hardware, used to compile and execute the program. Consequently, this division is the most machine-dependent portion of the program—entries depend entirely on the computer equipment you are using. Lines 170-230 of Fig. 2 outline the division.

Although the Environment division can contain three sections, the two most commonly used are the Configuration and Input-Output sections. In the Configuration section, there are two required paragraphs: Source-Computer and Object-Computer. These paragraphs name the system on which the program is keyed in and executed, respectively. These can be, and generally are, the same.

Note that these and all other programmer-created names (other than those found in the Identification division) must conform to the rules in Fig. 3. It is important to remember that programmer-supplied names cannot contain any blanks. The hyphen is generally used in lieu of the blank.

Unlike the Configuration section, the Input-Output section is necessary only if your program will input or output information to devices such as a printer, disk drive, tape unit or card reader. Input is the movement of information into the computer by means of

the keyboard, disk drives or other input device. Output, in contrast, is the flow of information from the computer to devices such as the printer or disk drives. An example of input would be reading names and addresses from a disk, while output could in-

*“Output is the
flow of information
from the computer
to devices such as
the printer or disk drives.”*

volve printing mailing labels.

With the TRS-80, you need only be concerned with the printer and disk drives when considering input and output.

Before any device can be used for input or output, it must be assigned a filename. This is accomplished in the

File-Control paragraph with a Select clause. As is illustrated in line 230 of Fig. 2, the Cobol word Select is followed by a file name that the programmer creates; then the words ASSIGN TO are followed by the specifications of the device that the program will address. We will cover the specifications for the TRS-80 printer and disk drives later.

Data Division

The material covered in the Data division may appear difficult and perhaps abstract, but it will all come together when we get into the Procedure division. If you find this section difficult, read your textbook and then move on to the next division with confidence that the material covered here will soon become clear.

You must describe all data items (variables) and files used in the program in the Data division. As you can see in Fig. 2, this division is made up of two sections: File and Working-Storage.

A file is an overall classification of

```

00100 IDENTIFICATION DIVISION.
00110 PROGRAM-ID.          LISTING1.
00120 AUTHOR.             your name here.
00130 INSTALLATION.      your location.
00140 DATE-WRITTEN.      today's date here.
00150 SECURITY.          UNCLASSIFIED.
00160
00170 ENVIRONMENT DIVISION.
00180 CONFIGURATION SECTION.
00190 SOURCE-COMPUTER.   MODELIII-48K.
00200 OBJECT-COMPUTER.  MODELIII-48K.
00210
00220 DATA DIVISION.
00230 WORKING-STORAGE SECTION.
00240 01 STORAGE-AREAS.
00250    02 LINE-TYPED-IN      PICTURE X(50).
00260    02 POSITION-SELECTED   PICTURE 99.
00270    02 WAIT-CHARACTER    PICTURE X.
00280
00290 PROCEDURE DIVISION.
00300 PROGRAM-TITLE.
00310   DISPLAY "P R O J E C T 1"
00320   LINE 1 POSITION 23 ERASE.
00330 ACCEPT-LINE-ROUTINE.
00340   DISPLAY "TYPE IN A LINE AND PRESS <ENTER>."
00350   LINE 5 POSITION 10.
00360   ACCEPT LINE-TYPED-IN
00370   LINE 7 POSITION 10 TAB.
00380 ACCEPT-LINE-POSITION.
00390   DISPLAY "SELECT LINE NUMBER (1-15)"
00400   LINE 9 POSITION 10.
00410   ACCEPT POSITION-SELECTED
00420   LINE 9 POSITION 36 TAB.
00430 PRINT-MESSAGE-ON-LINE-SELECTED.
00440   DISPLAY LINE-TYPED-IN
00450   LINE POSITION-SELECTED POSITION 10 ERASE.
00460 ENTER-TO-CONTINUE.
00470   DISPLAY "PRESS <ENTER> TO CONTINUE OR <BREAK> TO STOP"
00480   LINE 16 POSITION 10.
00490   ACCEPT WAIT-CHARACTER
00500   LINE 16 POSITION 55.
00510 START-ROUTINE-OVER.
00520   GO TO PROGRAM-TITLE.
00530 END-PROGRAM.
00540   STOP RUN.
00550   END PROGRAM.

```

Program Listing 1. Screen printing program

data pertaining to a specific category. For example, a name and address file would contain names and addresses, similar to an address book.

A record is a single unit within a file, such as an individual's name, address, and phone number.

Fields within a record refer to the specific categories within the record. In the address book example, the fields would be name, street, city, state, zip code and phone number.

In Cobol two types of fields are used—group items and elementary items. A group item is a field that is further subdivided. For example, in

our address book we could have three main fields: name, address and phone. Since address is broken down into street, city, state and zip code, it is a group item. Items which are not further subdivided, such as name, street or phone, are termed elementary items.

If the program is to address any files, either printer or disk, the files must be described in a FD (File Description) entry. Note that the letters FD must begin in margin A while the file name must be entered in margin B. Also, note that the file name appearing in the FD is the same as the name first defined in the Select clause of the En-

vironment division. There must be one FD for each file established in the Select clauses.

Four clauses generally appear in the FD entry. (Refer to lines 280-310 of Fig. 2.) While the order in which the four clauses appear makes no difference, Block Contains integer Records is presented first. This clause specifies how records are stored and retrieved. Consult your Cobol text for details on blocking factors. On the TRS-80 a blocking factor of one should be used (i.e., Record Contains 1 Records). Despite the fact that one is singular, the word Records must be used.

The Record Contains integer Characters clause specifies the size of the data record being described. Later the record will be described; at that time its length will be determined. An example is Record Contains 120 Characters.

Although four clauses should be included in the FD entry, only one is actually required—Label Records are Standard/Omitted. This clause is used to specify whether header and trailer labels are used on tape and disk. Check your text for specific details but simply remember to always use the word Standard when describing a disk file and Omitted for a printer file. (Use Label Records are Standard for a disk file and Label Records are Omitted for a printer file.)

The final clause of the FD entry is Data Record is record-name. In this clause it is up to the programmer to give a name to the records within the file described. Remember that the file was named in a Select clause of the Environment division and now the record within that file must be given a name. An example is Data Record is Disk-Record.

Only one period is found in the FD—it follows the final clause, thus ending the sentence.

You may notice that some texts include commas between clauses in the FD and throughout the program. The comma is optional—use it anywhere to aid readability, or omit it altogether.

Following each FD entry must come a record description. Refer to lines 320-380 of Fig. 2. The record description begins with the number 01 in margin A followed by the record-name, which is coded in margin B. Actual fields within the record are defined and described in this portion of the program.

The relationship of the fields is specified by level numbers between 01 and 49. See Fig. 4 for a description of a name/address record using level numbers. In the example, note that the

```

00100 IDENTIFICATION DIVISION.
00110 PROGRAM-ID.          program-name.
00120 AUTHOR.              programmer's name.
00130 INSTALLATION.       computer location.
00140 DATE-WRITTEN.       today's date.
00150 SECURITY.            level of security.
00160
00170 ENVIRONMENT DIVISION.
00180 CONFIGURATION SECTION.
00190 SOURCE-COMPUTER.    computer-specifications.
00200 OBJECT-COMPUTER.    computer-specifications.
00210 INPUT-OUTPUT SECTION.
00220 FILE-CONTROL.
00230     SELECT file-name ASSIGN TO device-specifications.
00240
00250 DATA DIVISION.
00260 FILE SECTION.
00270 FD   file-name
00280     BLOCK CONTAINS integer RECORDS
00290     RECORD CONTAINS integer CHARACTERS
00300     LABEL RECORDS ARE [STANDARD or OMITTED]
00310     DATA RECORD is record-name.
00320 01   record-name.
00330     02 group-item.
00340         03 elementary-item  PICTURE type(length).
00350         03 elementary-item  PICTURE type(length).
00360     02 elementary-item  PICTURE type(length).
00370     02 elementary-item  PICTURE type(length).
00380     02 FILLER           PICTURE X(length).
00390 WORKING-STORAGE SECTION.
00400 01   group-item.
00410     02 elementary-item  PICTURE type(length).
00420     02 elementary-item  PICTURE type(length) VALUE "a value".
00430     02 elementary-item  PICTURE type(length) VALUE figurative const.
00440     02 elementary-item  PICTURE type(length) value numeric literal.
00450 77   independent-data-item PICTURE type(length).
00460
00470 PROCEDURE DIVISION.
00480 paragraph-name.
00490     COBOL statement.
00500     COBOL statement.
00510     COBOL statement.
00520 paragraph-name.
00530     COBOL statement.
00540     COBOL statement.
00550 TERMINATE-PROGRAM.
00560     STOP RUN.
00570     END PROGRAM.

```

Figure 2. Cheat Sheet

higher level numbers indicate that the fields are subsets of the items with lower level numbers. Fields with identical level numbers are independent of each other.

Remember that group items are subdivided. An example of a group item is Address. Elementary items are those fields which are not further subdivided. In the example, the elementary fields are Name, Street, City, State, Zip Code and Phone. It is up to the programmer to decide which fields are needed in a record description. Several additional examples of record descriptions will be provided in future listings.

As can be seen in Fig. 4, each elementary item has an associated Picture clause. This clause defines the length of the field and the type of data it can contain.

In the Picture clause the letter A signifies that the data in the field is alphabetic. Such a field can contain only letters and blanks.

The letter X defines an alphanumeric field, one containing any character on the keyboard including letters, digits, blanks and special characters.

Finally, 9 defines a field as numeric. Such a field can contain only digits, a sign and a decimal point. This is the only type data that can be used in mathematical operations.

The length of the data field can be specified in one of two ways. To signify an alphanumeric field three characters in length, the Picture could be XXX or X(3). To maintain consistency, the second format is generally recommended.

Looking at Fig. 4, the Name field is alphanumeric and 20 characters long. The Street and City fields are also alphanumeric and 20 characters long. A two-character alphanumeric field is set aside for State, while a five-character alphanumeric field is defined for Zip Code.

Many people question the use of alphanumeric for Zip Code. They argue that the zip code is a number and should be defined as numeric. While Zip Code can be correctly defined as numeric, you should generally define a field as numeric only if the program performs mathematical calculations using the value. There is no need to add, subtract, multiply or divide a zip code, therefore there is no reason for defining it as numeric. The same logic applies to the Phone field, which is also defined as alphanumeric.

You can determine the overall record

length by totaling the length of each field in Fig. 4. This total (80) appears in the Record Contains integer Characters clause of the Data division's FD entry. In this case the clause would be Record Contains 80 Characters.

In line 380 of Fig. 2, the Cobol word Filler is found. This reserved word (a word that has a predefined meaning)

*“You should define
a field as
numeric only if
the program performs
mathematical calculations
using the values.”*

can be used to define any field that will not be addressed by name in the Procedure division. It can be used only in the Data division, and must be defined as alphanumeric. The sample listings here and later will clarify the use of Filler.

In the Working-Storage section you must define all data items (variables) to be used for purposes other than input or output to files. Lines 390-450 of Fig. 2 provide a skeleton of what this section might look like. It is difficult to know which items you will need in this section until you begin preparing the

Procedure division.

In general, here is where counters and accumulators are initialized, page headings are assigned to data items and general-purpose data items are named and described.

This section differs from the file section in that an initial value can be assigned to each data item. This value is an alphabetic or alphanumeric value enclosed in quotes and called a nonnumeric literal. (Note that some texts show the nonnumeric literal enclosed in single quotes. On the TRS-80 it is necessary to always use double quotes.) The value can also be a numeric value, which is called a numeric literal, or a figurative constant, such as zeros or spaces.

In the Working-Storage section, group items and elementary items are established using the level numbers 01-49. Level 77 can be used in this section to define an independent item—one having no relationship to any group item. Generally all data items in this section can be included as subordinate to a group item even if the group item has a name such as General-Purpose-Items or Work-Areas.

Procedure Division

In this final division of the Cobol program, you give the computer a set of instructions to carry out. These instructions are included in paragraphs, subdivided into sentences and statements.

Each instruction or set of related instructions must begin with a paragraph

- 1) Name can be from 1 to 30 characters in length.
- 2) Allowable characters include:
 - a) letters
 - b) numbers
 - c) hyphens
- 3) No embedded blanks are allowed or other punctuation.
- 4) At least one character must be a letter.
- 5) Name cannot begin or end with a hyphen.
- 6) No two hyphens can be used together.
- 7) Names must be unique.
- 8) Names cannot be reserved words.
- 9) Names should be meaningful.

Figure 3. Rules for forming programmer-supplied names

00300	01	DISK-RECORD.	
00310	02	NAME	PICTURE X(20).
00320	02	ADDRESS.	
00330	03	STREET	PICTURE X(20).
00340	03	CITY	PICTURE X(20).
00350	03	STATE	PICTURE X(2).
00360	03	ZIP-CODE	PICTURE X(5).
00370	02	PHONE	PICTURE X(13).

Figure 4. Lengths of each field

name conforming to the rules for programmer-supplied names shown in Fig. 3. A paragraph name should describe the purpose or function of the statements enclosed in the paragraph. The more descriptive, the better. Valid paragraph names include Display-Heading-on-Screen, or Calculate-Payroll-Deductions.

In theory, a paragraph should perform only one function. If this is the case, anytime a particular function needs to be performed, control can be sent to the paragraph needed.

The Procedure division is much like a Basic program. As a matter of fact, many Cobol statements are very similar to those found in Basic. Figure 5 provides a chart of similar Cobol and Basic statements.

There is no set of rules for coding the Procedure division. No two programs will have exactly the same Procedure division, although they may have similar routines.

One routine which must appear in each Procedure division is the paragraph to end the program. In Fig. 2, this paragraph is named Terminate-Program, although you could name it anything you like. The Cobol statement Stop Run makes program execution cease. The optional instruction End Program tells the compiler that it has reached the end of the source-code listing.

To further illustrate the statements and techniques required in the Procedure division (and throughout the Cobol program), let's examine a sample program that asks the user to enter his name and address and then sends this information to the printer.

Program Listing 3 contains the source code of the Cobol program. Before output can be sent to the printer, a number of entries must be made throughout the program. Here we will trace the entries necessary to create a printer file, describe a print record and output to the printer.

The first reference to the print file occurs in a Select clause of the Environment division as is shown in line 230. For the TRS-80, the line Select file

name Assign to Print, "Printer" must be used. It is up to you to supply the file name. (Programmers often use the name PRNT as their printer file name.)

Another reference to the printer file must be made in an FD entry of the File section of the Data division, as shown in lines 270-310. As you recall, any programmer-supplied name can be used for the data record name. In line 310 we chose the name Print-Line since each record will represent one line on the printer.

Following the FD comes the record description. When setting up a printer file, this entry can be quite simple. As shown in line 320, the record can be simply a line 132 alphanumeric characters long. It is not necessary to define any fields in the Print-Line—data can simply be moved into this Print-Line and output to the printer.

On some printers it is necessary to define the record as containing 133 characters, with the first representing a carriage return. This should not be done on the TRS-80, though—define your Print-Line as having 132 characters.

The next reference to the printer file is made in the Procedure division. Here you must follow four steps to enable the program to output to the printer.

First, you must open the file. The Open statement allows the program to gain access to the file. (It is similar to opening a file cabinet drawer before having access to the files inside.)

The format for the Open statement is shown in line 410. Note that the word Open is followed by Output. This sets the printer file up as an output file. The final word in the Open statement is the name of the file you wish to open—PRNT, in this case.

After opening the file you must move the information you want printed to the Print-Line. This is done through the Move statement. In line 560 the name you typed, which has been stored in a data item, is moved to the Print-Line.

Once the information to be printed has been moved to the Print-Line, it can be output to the printer with the Write statement. In line 570 the Write

statement sends the contents of the Print-Line to the printer.

The final statement required is Close. This statement instructs the computer to make the file no longer available for access. Close the file only after you have output all that is necessary. The format for closing a printer file is shown in line 630—Close PRNT.

As I pointed out earlier, the Open statement is used to gain access to the file named. It can refer to either a printer or disk file.

The Move statement is used to copy the contents of one data item (the sending field) into another (the receiving field). The contents of the sending field are unchanged after the move, while the original contents of the receiving field are destroyed and replaced by those from the sending field. We will discuss additional details on the Move statement in the section on editing data items.

After data to be sent to the output file has been moved to an output record such as the Print-Line, it can be sent out to the file with the Write statement.

The Write statement instructs the computer to output the contents of the record specified to the file with which it is associated. In Listing 3, the record Print-Line is associated with the printer file named PRNT. When Write Print-Line is executed, the contents of the record Print-Line are output to the PRNT file.

Finally, the Close statement is used to terminate access to a particular file. All files must be closed before the program is ended.

Line by Line

Line 100—this division name is always the first line in the program.

Line 110—Program-ID is the only required entry in the Identification division. The name following must be eight characters or less and contain only letters and numbers.

Lines 120-150—these lines provide details for documentation purposes. These entries can contain any character on the keyboard, including blanks.

Line 160—here we left a blank line between divisions to aid readability of the program.

Line 170—the second division name appears here.

Line 180—this is always the first section in the Environment division.

Lines 190-200—these two paragraphs name the equipment on which the program will be written and executed. Usually both entries are identical.

Line 210—the second section in this

Program Listing 2. Shortest Cobol program

```
00100 IDENTIFICATION DIVISION.  
00110 PROGRAM-ID. LISTING2.  
00120  
00130 ENVIRONMENT DIVISION.  
00140 CONFIGURATION SECTION.  
00150 SOURCE-COMPUTER. MODELII-64K.  
00160 OBJECT-COMPUTER. MODELII-64K.  
00170
```

Listing 2 continues

Listing 2 continued

```

00180 DATA DIVISION.
00190
00200 PROCEDURE DIVISION.
00210 DISPLAY-PARAGRAPH.
00220 DISPLAY "SHORTEST COBOL PROGRAM" ERASE.
00230 TERMINATE-PROGRAM.
00240 STOP RUN.
00250 END PROGRAM.

```

```

00100 IDENTIFICATION DIVISION.
00110 PROGRAM-ID. PROJECT2.
00120 AUTHOR. student's name.
00130 INSTALLATION. JTC.
00140 DATE-WRITTEN. 04/21/82.
00150 SECURITY. UNCLASSIFIED.
00160
00170 ENVIRONMENT DIVISION.
00180 CONFIGURATION SECTION.
00190 SOURCE-COMPUTER. MODELII-64K.
00200 OBJECT-COMPUTER. MODELII-64K.
00210 INPUT-OUTPUT SECTION.
00220 FILE-CONTROL.
00230 SELECT PRNT ASSIGN TO PRINT, "PRINTER".
00240
00250 DATA DIVISION.
00260 FILE SECTION.
00270 FD PRNT
00280 BLOCK CONTAINS 1 RECORDS
00290 RECORD CONTAINS 132 CHARACTERS
00300 LABEL RECORDS ARE OMITTED
00310 DATA RECORD IS PRINT-LINE.
00320 01 PRINT-LINE PICTURE X(132).
00330 WORKING-STORAGE SECTION.
00340 01 ADDRESS-IN-FIELDS.
00350 03 NAME-IN PICTURE X(30).
00360 03 STREET-IN PICTURE X(30).
00370 03 CITY-STATE-IN PICTURE X(30).
00380
00390 PROCEDURE DIVISION.
00400 OPEN-FILE-TO-PRINTER.
00410 OPEN OUTPUT PRNT.
00420 DISPLAY-AND-ACCEPT-DATA.
00430 DISPLAY "ENTER NAME;"
00440 LINE 3 POSITION 10 ERASE.
00450 ACCEPT NAME-IN
00460 LINE 3 POSITION 22 PROMPT "." TAB.
00470 DISPLAY "ENTER STREET;"
00480 LINE 5 POSITION 8.
00490 ACCEPT STREET-IN
00500 LINE 5 POSITION 22 PROMPT "." TAB.
00510 DISPLAY "ENTER CITY & STATE;"
00520 LINE 7 POSITION 2.
00530 ACCEPT CITY-STATE-IN
00540 LINE 7 POSITION 22 PROMPT "." TAB.
00550 MOVE-AND-PRINT-DATA.
00560 MOVE NAME-IN TO PRINT-LINE.
00570 WRITE PRINT-LINE.
00580 MOVE STREET-IN TO PRINT-LINE.
00590 WRITE PRINT-LINE.
00600 MOVE CITY-STATE-IN TO PRINT-LINE.
00610 WRITE PRINT-LINE.
00620 CLOSE-PRINTER-FILE.
00630 CLOSE PRNT.
00640 TERMINATE-PROGRAM.
00650 STOP RUN.
00660 END PROGRAM.

```

Program Listing 3. A name printing program

Program Listing 4. Storing names in a sequential file

```

00100 IDENTIFICATION DIVISION.
00110 PROGRAM-ID. SEQOUT.
00120 AUTHOR. SAM PERRY.
00130 INSTALLATION. JTC.
00140 DATE-WRITTEN. APRIL 4, 1982.
00150 SECURITY. UNCLASSIFIED.
00160
00170 ENVIRONMENT DIVISION.
00180 CONFIGURATION SECTION.
00190 SOURCE-COMPUTER. MODELIII-48K.

```

Listing 4 continues

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Listing 4 continued

```

00200 OBJECT-COMPUTER.           MODELIII-48K.
00210 INPUT-OUTPUT SECTION.
00220 FILE-CONTROL.
00230     SELECT NAME-FILE
00240     ASSIGN TO OUTPUT "NAMEFILE/SEQ".
00250
00260 DATA DIVISION.
00270 FILE SECTION.
00280 FD NAME-FILE
00290     BLOCK CONTAINS 1 RECORDS
00300     RECORD CONTAINS 30 CHARACTERS
00310     LABEL RECORDS ARE STANDARD
00320     DATA RECORD IS NAME-RECORD.
00330 01 NAME-RECORD.
00340     02 NAME-FIELD           PICTURE X(30).
00350
00360 PROCEDURE DIVISION.
00370 OPEN-SEQUENTIAL-DISK-FILE.
00380 OPEN OUTPUT NAME-FILE.
00390 DISPLAY-PROMPT.
00400 DISPLAY "ENTER 'END' AS LAST NAME"
00410 LINE 2 POSITION 20 ERASE.
00420 DISPLAY "ENTER NAME"
00430 LINE 6 POSITION 14.
00440 ACCEPT-NAME.
00450 ACCEPT NAME-FIELD
00460 LINE 6 POSITION 28 PROMPT "." TAB.
00470 IF NAME-FIELD = "END"
00480     GO TO CLOSE-DISK-FILE.
00490 WRITE-TO-DISK.
00500 WRITE NAME-RECORD.
00510 LOOP-ROUTINE.
00520 GO TO ACCEPT-NAME.
00530 CLOSE-DISK-FILE.
00540 CLOSE NAME-FILE.
00550 TERMINATE-PROGRAM.
00560 STOP RUN.
00570 END PROGRAM.

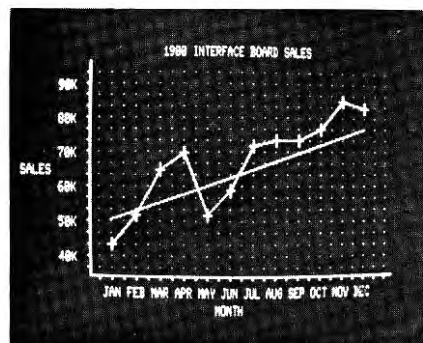
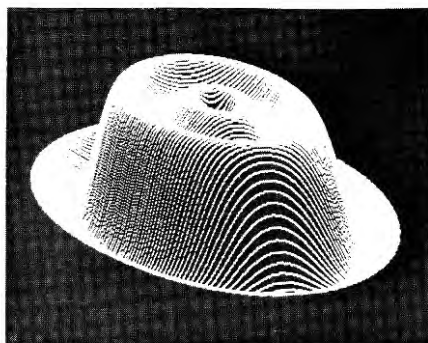
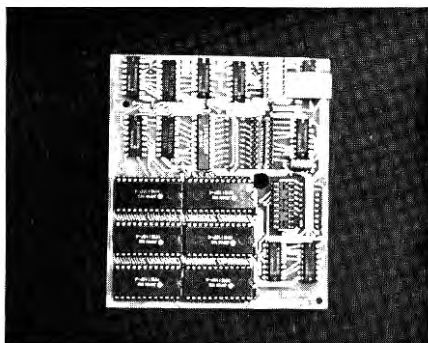
```

```

00100 IDENTIFICATION DIVISION.
00110 PROGRAM-ID.                 SEQIN.
00120 AUTHOR.                     SAM PERRY.
00130 INSTALLATION.              JTC.
00140 DATE-WRITTEN.              APRIL 5, 1982.
00150 SECURITY.                  UNCLASSIFIED.
00160
00170 ENVIRONMENT DIVISION.
00180 CONFIGURATION SECTION.
00190 SOURCE-COMPUTER.           MODELIII-48K.
00200 OBJECT-COMPUTER.           MODELIII-48K.
00210 INPUT-OUTPUT SECTION.
00220 FILE-CONTROL.
00230     SELECT NAME-FILE
00240     ASSIGN TO INPUT "NAMEFILE/SEQ".
00250
00260 DATA DIVISION.
00270 FILE SECTION.
00280 FD NAME-FILE
00290     BLOCK CONTAINS 1 RECORDS
00300     RECORD CONTAINS 30 CHARACTERS
00310     LABEL RECORDS ARE STANDARD
00320     DATA RECORD IS NAME-RECORD.
00330 01 NAME-RECORD.
00340     02 NAME-FIELD           PICTURE X(30).
00350
00360 PROCEDURE DIVISION.
00370 OPEN-SEQUENTIAL-DISK-FILE.
00380 OPEN INPUT NAME-FILE.
00390 DISPLAY-HEADING.
00400 DISPLAY "READING IN NAMES"
00410 LINE 2 POSITION 24 ERASE.
00420 READ-FROM-DISK.
00430 READ NAME-FILE
00440     AT END GO TO CLOSE-DISK-FILE.
00450 PRINT-NAME-ON-SCREEN.
00460 DISPLAY NAME-RECORD.
00470 LOOP-ROUTINE.
00480 GO TO READ-FROM-DISK.
00490 CLOSE-DISK-FILE.
00500 CLOSE NAME-FILE.
00510 TERMINATE-PROGRAM.
00520 STOP RUN.
00530 END PROGRAM.

```

Program Listing 5. Record Retrieval

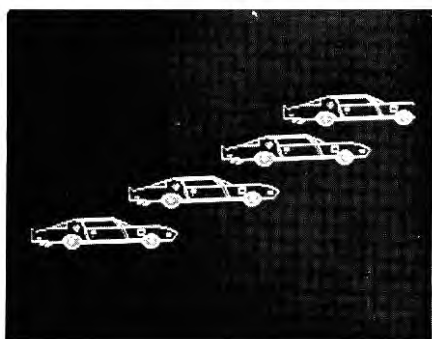


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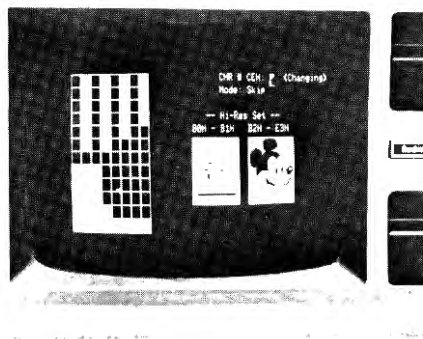
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division, required only if disk or printer files are to be used.

Line 220—this paragraph name is always required after the entry in line 210.

Line 230—here the Select clause allows you to create a file name and assign it to a device (printer or disk drive). In this case, a printer file is established.

Line 240—blank to aid readability.

Line 250—the third division name appears here.

Line 260—if any files are named in Select clauses they must be described here in the File section.

Line 270—FD (File Description) entry begins with FD followed by the file name created in the Select clause.

Line 280—this line defines the blocking factor. On the TRS-80, always use one.

Line 290—specifies the number of characters in the record.

Line 300—Omitted must always be used with printer files while Standard must be used with disk files.

Line 310—in this line the record in the file is named. This is a programmer-supplied name.

Line 320—following the FD must come the record description, which begins with 01 followed by the record name just defined. While the record is often subdivided into fields, it is not necessary to do so with a printer record. This record is simply defined as having 132 characters, which is the length of the line on most printers.

Line 330—here the name of the second section in the division appears.

Line 340—this programmer-supplied group item name describes the data items which follow.

Line 350—this data item will hold the name that the user types in. Remember that data items named here in the Working-Storage section are not part of input or output. Although this item is used to allow the user to key in a name and is later moved to the Print-Line for output, it is not actually part of the input or output record. Print-Line is the only record used in this program.

Lines 360-370—these two fields will hold the user's street, city and state address.

Line 380—blank to aid readability.

Line 390—the fourth division name appears here.

Line 400—this is a paragraph name.

Line 410—the Cobol statement Open is used to gain access to the printer file.

Line 420—this paragraph name describes the function of the following statements.

Line 430-440—these two lines make up a Display statement. While the entire

statement could have been placed on one line, it is more readable like this—the period in line 440 marks the end of the statement. The Display instruction tells the computer to place on the screen the item following the word Display. The line clause specifies the line number on the screen where the message should be placed. The Position clause tells the computer how far to tab over before displaying the message. Finally, Erase clears the screen before printing the message.

Lines 450-460—these two lines make up an Accept statement. Again, the period in line 460 marks the end of the statement. The Accept statement tells the computer to pause while the user types in a response (in this case, to the message printed by lines 430-440). This response is then placed in the data item specified after the word Accept (Name-In, in this case). Line tells the computer the screen line number where the keyed-in response is to be displayed. Position specifies how far to tab before displaying the response. Prompt “.” tells the computer to prompt the user by placing a string of periods on the screen where the response is to be typed. Any character can be used inside the quotes. If no quotes or characters are used, Prompt displays a solid line.

Lines 470-480—see lines 430-440.

Lines 490-500—see lines 450-460.

Lines 510-520—see lines 430-440.

Lines 530-540—see lines 450-460.

Line 550—this paragraph name describes the function of the statements included in it.

Line 560—the Move instruction copies the contents of the first item (sending field) into the second item (the receiving field). In this case the contents of Name-In are moved into the Print-Line. Remember that Name-In contains the name the user enters. This Move step is necessary before the record Print-Line can be written to the printer.

Line 570—Write moves the contents of the record specified out to the file. In this case the contents of Print-Line are moved out to the printer and thus printed.

Line 580—once again, Move is used to move the contents of the first data item to the second. Here the contents of Street-In are moved to the Print-Line. This destroys the previous contents of Print-Line and replaces them with the new item.

Line 590—again, the contents of the Print-Line are sent to the printer.

Lines 600-610—this is the same as lines 560-570 and lines 580-590, except this time the contents of the data item

City-State-In are moved to the Print-Line and sent out to the printer.

Line 620—here the paragraph name specifies what the instructions following will do.

Line 630—the Close statement closes the file specified. This must be done before the program is terminated. If we wanted to print other information we would not have closed the file yet.

Line 640—here the final paragraph name specifies the actions to be taken.

Line 650—Stop Run causes the program to stop running. The execution is complete.

Line 660—this line tells the compiler that this is the end of the program.

Now is the time to write your first Cobol program. Using the material presented so far, and relying heavily on Fig. 2, code a simple program. If your system includes a printer, create a printer file and output to it. Perhaps write a simple program that asks the user a series of questions and prints the responses on the printer. If you get error messages, consult your Cobol manual.

Probably the most common use of the computer in the business environment is for storage and retrieval of information. The computer has a distinct advantage over the file cabinet—it can be programmed to store and recall information, and also process the records and present them in a report format.

Sequential Files

A disk file is much like a folder kept in a file cabinet—it contains records pertaining to some particular category. For example, a sales file may contain information on the performance of a company's sales force.

File, record, and field are the three key terms used when referring to disk files.

A sequential file is one of three common Cobol types. It is perhaps the simplest and, therefore, generally the first learned.

The term “sequential” actually refers to the access mode used for storing and retrieving records from the disk. Records are stored and recalled in the order in which they are entered.

As you can see, there are disadvantages in this method of disk access. For example, if you want to retrieve the 900th record, you have to read the preceding 899. This can be time-consuming, even for a computer.

Probably the best way to visualize the notion of sequential access is to think of a music album stored on tape. When listening to the album on a tape player,

to hear the last song, you must play through all the songs preceding it. This is unlike a record album, where you can lift the needle and place it on the last track. This second type of access is termed direct, relative, or random.

If you wish to hear the entire album, there is no disadvantage in sequential access. In the same sense, if you plan to process all of the records in your disk file, there is no disadvantage in sequential access. Sequential files are only a disadvantage when you must retrieve an individual record—then they can be inefficient.

Creating a Sequential File

A number of entries are required in a Cobol program to create a sequential disk file. These entries are similar to those used to set up a printer file because a printer file is actually a sequential file.

Program Listing 4 stores names on the disk in a sequential file. The program is written in the traditional approach, as opposed to the structured approach, which we will discuss later.

The first reference to the sequential disk file is found in a Select clause of the Environment division's File-Control section, as is shown in lines 230-240.

Following the Cobol word Select comes a file name created by the programmer. After the Assign To portion of the clause must come the word Output, Input or Input-Output. The word Output tells the computer that the file will be used in this particular program only for output—records will be written to the file but not retrieved from it. Input means that this program will only input, or read, records from the file. Input-Output signifies that the file will be used for both input and output in this program.

The final entry in the Assign To clause is the actual name that the file will be stored under on the disk. This does not have to be the same as the file name listed after the word Select, which is the name used inside the program to refer to the file.

In the example we selected the disk file name NAMEFILE/SEQ. This is part of the device specifications and must adhere to TRSDOS filespecs requirements. In brief, a TRSDOS file name can consist of eight characters or less followed by a slash and up to three more characters. The name must begin with a letter, but can also contain numbers. No blanks or other characters are allowed in the name. We chose NAMEFILE/SEQ because NAMEFILE refers to the contents of the

file, while SEQ reminds us that the file is sequential. In this case the full device-specifications entry is Output "NAME-FILE/SEQ".

The next reference to the disk file comes in the Data division in a FD entry. Lines 280-320 present a typical disk-file FD entry. Note the entry Label Records Are Standard—remember that Standard is required with disk files while Omitted is used with printer files. We chose the name Name-Record in this case to represent a disk record, since the file will be made up of names.

Lines 330-340 make up the record description, which here is simply a record containing one field. The Picture clause shows that Name-Field will contain 30 alphanumeric characters.

Finally, the disk file is referenced in the Procedure division. There it is treated like a printer file—we use the statements Open, Move, Write and Close to gain access to the file and output records to it.

Just as in a printer file, the disk file must be opened before it can be accessed. It can be opened as an Output file, Input file or I-O (Input-Output) file. Do not forget that the Select clause specified how the file could be used.

With Open Output Name-File, the disk file is opened for output only. When the file is opened as an Output file, you can use it only to receive records output from the computer.

The first record output from the disk file in the Output mode will be placed in the first position in the file. If the file did not exist on the disk before the Open Output statement, then it is created. If the file did already exist on the disk, it is opened and its previous contents are lost. An existing file, whose contents should not be destroyed, must be opened with either Input or I-O. We'll discuss these modes later.

Two statements you can use for placing a value into a data item are Move and Accept. When we set up a printer file (see Listing 3) data was accepted and then moved to the printer record. Now we'll show how the move can sometimes be avoided and information accepted directly into a field of the record.

In lines 450-460 we used the data item Name-Field in an Accept statement. When the user types in the name, it is placed immediately in the record field. Line 500 shows that the record can then be written directly to the disk.

Often it is necessary to define data items in the Working-Storage section that will be used to accept input from the keyboard. The information ac-

cepted by these data items can then be moved into the appropriate fields. In this example we have simply taken a short cut.

When no other records are to be added to the file, it must be closed as is shown in line 540.

In the Procedure division of Listing 4 you'll find two new statements: If and Go To.

Before exploring these Cobol instructions, let's look at the overall purpose of the program in Listing 4 and the steps required to achieve this goal.

Figure 6 is a flowchart of the program. A flowchart is a graphic representation of the steps in a computer program. The flowchart is made up of symbols, lines and arrows. The symbols represent the type of operation while the lines and arrows show the flow of execution.

An oval symbol represents the beginning or end of a program. The rectangle signifies a process such as Open, Close or Move, while the trapezoid means an input or output operation such as Read, Write, Display or Accept. Finally, a diamond represents a decision to be made with statements such as If ... Else and Go To ... Depending.

The Program

First, the disk file is opened. Then, a prompt to the user to enter a name is displayed on the screen.

Next, through the Accept statement, the user is allowed to type in the name he wishes stored on the disk.

The decision block shows that if the name End is entered the program is to be terminated; if it is not End, the name entered is to be stored on the disk.

After the record is written to the disk, control of the program returns to the paragraph in which the user is asked to enter a name. Here the user can enter another name or the word End.

You should be able to find the paragraphs in Listing 4 corresponding to each symbol on the flowchart.

The Cobol statements If and Go To appear in lines 470-480. Line 470, which says, If Name-Field = "END", simply means that if the value accepted for Name-Field is the word End, then do whatever comes next (before the period). If Name-Field does equal End then the instruction on line 480 is to be executed. If it does not equal End then the remainder of the sentence (up to the period) is to be ignored and the following sentence executed. The instruction in line 480 is indented two spaces merely to aid readability—this indicates that it is to be executed only when

the If condition is true.

In summary, the Cobol word If is always followed by a condition. If that condition is true then the remainder of the If sentence is executed. When the condition is not true, the remainder of the sentence is ignored and the program continues with the next sentence. Any number of instructions can follow the condition in the If statement, not just one as is the case in this program.

When the condition in line 470 is true, the instruction in 480 is executed. In line 480 the instruction Go To Close-Disk-File tells the computer to jump to the paragraph named Close-Disk-File. The statement Go To means just what it says—go to the paragraph named and do not do anything else on the way. Control is transferred directly to the paragraph named. The instructions found there are executed and the program continues from that point.

In Listing 4 we used the Go To statement again in the Loop-Routine to transfer control back to the Accept-Name paragraph.

You should generally avoid the Go To statement whenever possible because it completely transfers control to another part of the program. The unrestricted use of Go To can lead to a program that is difficult to debug or even read. See the section on structured programming for more details.

Sequential Input

Now that we've covered the techniques for setting up a sequential output disk file and storing information on the disk, let's focus on the details needed to input, or to read the records back from, the disk file.

Program Listing 5 reads the records created by the program in Listing 1 and displays them on the screen.

To treat the file as an input file, you must change only one entry before the Procedure division. Line 240 in Listing 5 tells the computer that the file will be used for input only in this program.

Before the file can be accessed, it must be opened as shown in line 380. Note that the file is opened as an Input file.

After the file is opened, this program displays a message on the screen to let the user know that records are to be read from the disk.

Just as the Write statement is used to output to a file, the Read statement retrieves a record from the disk (see line 430). Since the access mode is sequential, the records are read in the order they were stored—first in, first out (FIFO).

It is important to note that the disk

file name is used with the Read instruction while the record name is used with Write. That is to say, you write a record but read a file.

Also, note that the Read statement contains an At End clause (see line 440). (Remember that a sentence does not end until the period. Lines 430-440 make up one instruction.)

Always use the At End clause with the Read statement to tell the computer what is to be done after the last record in the file has been read. This clause is similar to the If statement in that it is only executed when the condition is true.

The Read statement's At End clause is activated when the computer tries to read a record after all have been read. The instructions following the At End are then, and only then, executed.

As can be seen in lines 430-440, when the computer tries to read beyond the last record in the file, control is transferred to the Close-Disk-File paragraph and the program is terminated.

After the record is read, line 460 displays the contents of the Name-Field on the screen. Note that the Display statement can be used without the Line and Position clauses—without them, the item is simply displayed on the next available line on the screen.

Line 480 sends control of the program back to the Read statement, where another record is retrieved from the disk file. This loop continues until the At End condition is met.

Structured Programming Techniques

The programs in Listing 4 and Listing 5 were written in the traditional approach—execution flows from top to bottom with little concern for structure.

In an effort to bring about a more standardized method of programming, structured programming was developed.

Structured programming is a technique in which a program is written in modules. Each module performs a single function. Whenever a particular function needs to be executed, the paragraph containing that module is executed. Control then returns to a main-logic paragraph which directs the program sequencing (see Listing 6).

Line 480 executes the Display-Prompt paragraph, and then control returns to line 490.

In 490 a more sophisticated and powerful Perform instruction is employed—Perform ... Until. Here the statement instructs the computer to execute the Read-From-Disk-And-Display paragraph until the EOF-Flag equals one.

When the Perform ... Until state-

ment is used, the paragraph named is executed and then the condition is tested. If it is not true, the paragraph is again executed and tested. This continues until the condition is true, at which time control moves on to the sentence after the Perform instruction.

In the case of line 490, the paragraph Read-From-Disk-And-Display will continue to be executed until the EOF-Flag equals 1. Remember that it was initially set to zero in line 420.

The Read-From-Disk-And-Display paragraph first displays the contents of the Name-Field last read from the disk. In line 570 it then attempts to read the next record. If a valid record is retrieved from the disk, line 490 causes the paragraph to be executed again. If the end of file is reached and the At End condition is true, the value 1 is moved into the data item EOF-Flag. Then, when line 490 tests the value of the EOF-Flag it finds it equal to one and moves on to line 500.

In the Read-From-Disk-And-Display paragraph, it is essential that the Display statement precede the Read statement. This is because the condition in line 490 is tested only after the entire paragraph has been executed. Therefore it is important that the final instruction in the paragraph be to place the one in the EOF-Flag data item—this prevents displaying the last record twice. That is why the first Read must be executed in the Mail-Logic paragraph.

The purposes behind structured programming are many. Its primary goal is to make it easier for one programmer to read or modify another's work. Also, debugging a program is easier since individual modules can be tested apart from the entire program. Finally, a team of programmers can work on a single program, with each writing individual modules that will later be merged.

An example of a structured program is in Listing 6. This program performs exactly the same task as the one in Listing 5, but the program is controlled by a single paragraph—Main-Logic.

A comparison of the two listings reveals several changes. Lines 110-150 of Listing 6 contain remarks, signified by the asterisk in column 7 of each line.

The next change is lines 400-420 of Listing 6—a Working-Storage section is present. In this section, a data item named EOF-Flag is created for use in the Procedure division. Note that the item is given an initial value of zero.

The Procedure division of Listing 6 is controlled by a Main-Logic paragraph that directs the flow of the pro-

gram. A line-by-line analysis of this paragraph will clarify techniques of structured programming, as well as introduce a new Cobol statement.

Line 460 simply opens the disk file for input.

In line 470 the first record from the disk file is read. Note the At End clause is present in case the file contains no records. Although this is highly unlikely, a good program should be prepared to handle any plausible situation.

The Perform statement is introduced in line 480. This statement is similar to the Go To instruction—it sends control of the program to the paragraph named. However, after the named paragraph is executed, control returns to the instruction following the Perform statement. This instruction allows the Main-Logic paragraph to execute modules throughout the program and still maintain control.

Printing the Report

With the few Cobol statements we have covered, it is possible to store data on the disk, retrieve it, and output it to the printer in a report format. While we'll cover additional details for printing reports later, let's consider a few fundamentals. All references apply to Listing 7.

First, we need a program that creates both disk and printer files. To do this we will merely combine the entries covered in the sections on printer and disk files.

Note the two Select clauses in lines 290-300 as well as the two FDs in lines 340-460. These are just like those presented in the sections on disk and printer files.

The technique of defining page headings in the Working-Storage section is introduced in lines 480-540. This technique allows you to create page and column headings here and print them later simply by moving the item into the Print-Line and then writing it to the printer.

A closer look at Page-Heading, created in lines 480-510, shows how the heading is to be printed. Line 490 defines the first 10 columns of the heading as spaces. Following these 10 spaces comes the actual title defined in line 500. This title is 21 characters long and has the value "NAME REPORT." Finally, 101 spaces follow the title, using the entire 132 characters of the Print-Line.

It is always a good habit to define headings as 132 characters long. When the heading is moved into the Print-Line, it will clear out any other characters that may have been stored in the line.

ACCEPT	INPUT
ADD	+
AND	AND
CLOSE	CLOSE
COMPUTE	LET
DISPLAY	PRINT
DIVIDE	/
GO TO	GOTO
GO TO / DEPENDING	ON / GOTO
IF / ELSE	IF / THEN / ELSE
MOVE	LET or LSET & RSET
MULTIPLY	*
OCCURS	DIM
OPEN	OPEN
OR	OR
PERFORM	GOSUB
PERFORM / VARYING / FROM / BY / UNTIL	FOR / NEXT / STEP
READ	GET
STOP RUN	END
SUBTRACT	-
WRITE	PUT

Figure 5. Partial listing of Cobol vs. Basic statements

```

00100 IDENTIFICATION DIVISION.
00110 *****
00120*   * * *   S E Q U I N 1   * * *   *
00130*   READ RECORDS FROM THE DISK   *
00140*   Using Structured Approach     *
00150*****
00160 PROGRAM-ID.           SEQIN1.
00170 AUTHOR.              SAM PERRY.
00180 INSTALLATION.       JTC.
00190 DATE-WRITTEN.      APRIL 5, 1982.
00200 SECURITY.           UNCLASSIFIED.
00210
00220 ENVIRONMENT DIVISION.
00230 CONFIGURATION SECTION.
00240 SOURCE-COMPUTER.    MODELIII-48K.
00250 OBJECT-COMPUTER.   MODELIII-48K.
00260 INPUT-OUTPUT SECTION.
00270 FILE-CONTROL.
00280   SELECT NAME-FILE
00290   ASSIGN TO INPUT "NAMEFILE/SEQ".
00300
00310 DATA DIVISION.
00320 FILE SECTION.
00330 FD NAME-FILE
00340   BLOCK CONTAINS 1 RECORDS
00350   RECORD CONTAINS 30 CHARACTERS
00360   LABEL RECORDS ARE STANDARD
00370   DATA RECORD IS NAME-RECORD.
00380 01 NAME-RECORD.
00390   02 NAME-FIELD      PICTURE X(30).
00400 WORKING-STORAGE SECTION.
00410 01 WORK-AREAS.
00420   02 EOF-FLAG      PICTURE 9(1) VALUE 0.
00430
00440 PROCEDURE DIVISION.
00450 MAIN-LOGIC.
00460   OPEN INPUT NAME-FILE.
00470   READ NAME-FILE AT END MOVE 1 TO EOF-FLAG.
00480   PERFORM DISPLAY-PROMPT.
00490   PERFORM READ-FROM-DISK-AND-DISPLAY UNTIL EOF-FLAG = 1.
00500   CLOSE NAME-FILE.
00510   STOP RUN.
00520 DISPLAY-PROMPT.
00530   DISPLAY "READING IN NAMES"
00540   LINE 2 POSITION 24 ERASE.
00550 READ-FROM-DISK-AND-DISPLAY.
00560   DISPLAY NAME-RECORD.
00570   READ NAME-FILE AT END MOVE 1 TO EOF-FLAG.

```

Program Listing 6. An example of a structured program

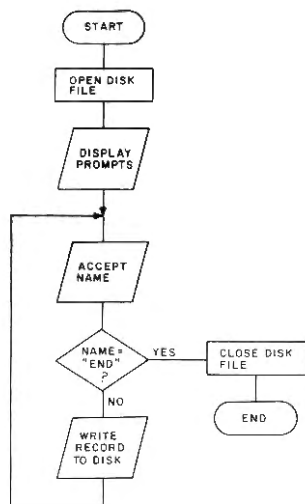


Figure 6. Flowchart of Program Listing 4

Remember, when programming on computers other than the TRS-80, you may have to define the Print-Line as having 133 characters. When this is the case, always define the first character as a space to allow for the carriage-return character.

In the description of the headings, note the use of the Cobol word Filler in

place of field names. Filler is to be used in the Data division to define any field that will not be addressed by name in the Procedure division. The headings will only be referred to by their 01 group name—field names are unnecessary. See lines 610-640 for clarification.

The Procedure division begins by opening the disk and printer files. Although both files can be opened with a single Open instruction, it is more readable to use two instructions on separate lines. Note that the disk file is opened as an Input file, while the printer file is opened for Output.

Headings are output to the printer in lines 600-640. Line 640 includes a variation on the Write statement. Write to the printer can be used with an After Advancing or Before Advancing (integer) Lines clause. This clause is used to advance the printer the specified number of lines either before or after the contents of the Print-Line are printed.

In line 720, the After Advancing 2 Lines clause is used to double-space between names.

According to the ANSI '74 stan-

dards the integer in the After Advancing clause can be any number from 1 to 100. On the TRS-80 you can use values higher than 100.

Finally, note the Move instruction used in line 690. This statement moves spaces into the Print-Line to clear it before use. Since the Name-Field accounts for only the left 30 columns of the Print-Line, there is a chance that the right 102 columns could contain characters from a previous Move.

Some Homework

Write a program to store and retrieve names and addresses on a disk. The information should then be printed in mailing-label format.

Numeric Data

Up to this point, we've said little about numeric data. All our Move and Accept statements have used alphanumeric data items to manipulate nonnumeric literals. Here, we'll consider the special rules that apply to numeric items.

First, let's examine the procedure for defining numeric data items in the Data division. As you may recall, numeric data items are accompanied by a Picture clause consisting of 9s. A Picture of 9(3) represents a data item that can contain a value consisting of three digits, such as 312 or 999. Such a field can also contain values less than 100, such as 23 or 76 but these values are actually stored as 023 and 076.

To define a numeric data item that contains decimal places, use the character V where the decimal point should appear. For example, Picture 999V99 represents a numeric item with three places on the left of the decimal and two on the right. You could also write this clause as Picture 9(3)V9(2).

When using numeric data items containing a decimal, remember that the decimal is not actually stored as part of the value. For example, the value 321.28 would be stored in memory and on the disk as 32128. Therefore, the Picture clause 9(3)V9(2) would have a field length of five. The decimal point is only implied, and is not actually stored in the data item.

A numeric-data item containing a decimal place can be assigned a value in the Working-Storage section, using the following format: Picture 9(3)V9(2) Value 123.45. Be sure to include the decimal point in the Value clause.

This method of storing a decimal value without the decimal point was designed to conserve memory and disk space. This convention requires additional programming effort, however.

Program Listing 7

```

00100 IDENTIFICATION DIVISION.
00110 *****
00120 * * * R E P O R T 1 * * * *
00130 * READ RECORDS FROM THE DISK *
00140 * AND PRINT A SIMPLE REPORT *
00150 * Using Traditional Approach *
00160 *****
00170 PROGRAM-ID. REPORT1.
00180 AUTHOR. SAM PERRY.
00190 INSTALLATION. JTC.
00200 DATE-WRITTEN. APRIL 5, 1982.
00210 SECURITY. UNCLASSIFIED.
00220
00230 ENVIRONMENT DIVISION.
00240 CONFIGURATION SECTION.
00250 SOURCE-COMPUTER. MODELIII-48K.
00260 OBJECT-COMPUTER. MODELIII-48K.
00270 INPUT-OUTPUT SECTION.
00280 FILE-CONTROL.
00290 SELECT NAME-FILE ASSIGN TO INPUT "NAMEFILE/SEQ".
00300 SELECT PRNT ASSIGN TO PRINT, "PRINTER".
00310
00320 DATA DIVISION.
00330 FILE SECTION.
00340 FD NAME-FILE
00350 BLOCK CONTAINS 1 RECORDS
00360 RECORD CONTAINS 30 CHARACTERS
00370 LABEL RECORDS ARE STANDARD
00380 DATA RECORD IS NAME-RECORD.
00390 01 NAME-RECORD.
00400 02 NAME-FIELD PICTURE X(30).
00410 FD PRNT
00420 BLOCK CONTAINS 1 RECORDS
00430 RECORD CONTAINS 132 CHARACTERS
00440 LABEL RECORDS ARE STANDARD
00450 DATA RECORD IS PRINT-LINE.
00460 01 PRINT-LINE PICTURE X(132).
00470 WORKING-STORAGE SECTION.
00480 01 PAGE-HEADER.
00490 02 FILLER PICTURE X(10) VALUE SPACES.
00500 02 FILLER PICTURE X(21) VALUE "N A M E R E P O R T".
00510 02 FILLER PICTURE X(101) VALUE SPACES.
00520 01 SUB-HEADER.
00530 02 FILLER PICTURE X(6) VALUE "NAMES:".
  
```

Listing 7 continues

Keep it Clean.

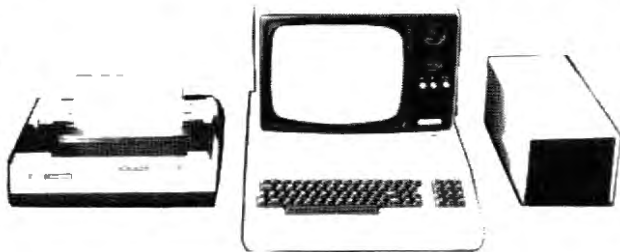
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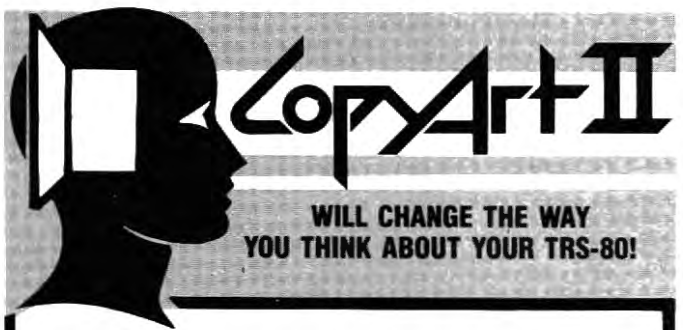
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8. *GRAPHIC CHARACTERS. CopyArt has a built in graphics character generator. Used for typesetting large letters from 3 to 25 times normal size! Yes, you can even print characters down the page as well as across. Black on white or white on black.
9. JUSTIFICATION is fully supported. *Proportional spaced justify is supported.
10. *SUPER or SUB-SCRIPT.
11. UNDERLINING.
12. BOLDFACTING.
13. *CHANGE CHARACTER SIZE or PITCH within your document. Character size changes for dot matrix printers with capability. Pitch change for daisy wheel printers with capability.
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 *Indicates printer must have capability to do function.

For example, when you print or display a numeric-data item, the decimal point will not be included. You must edit all numeric data before output to the screen or printer—we'll discuss editing later.

If a numeric-data item contains a negative value, then the Picture clause describing the item must be signed—it must contain the character S. Picture S9(3) describes a numeric-data item that can contain a positive or negative three-digit number.

When calculating the length of a signed field, you should count the S character. In the example above, the field length is four. (When punching computer cards, an additional column is not needed to record the sign, but on the TRS-80 the space is required for the plus or minus sign.)

Accepting numeric data from the keyboard presents a special set of problems.

First, when accepting numeric data from the keyboard, a Convert clause must be used in the Accept statement. The Convert clause is used to align the decimal point typed in by the user with the V in the numeric data item's Picture. A sample Accept statement is as follows: Accept Number-1 Line 10 Position 10 Prompt Convert-1 Tab. (Remember that the order of the clauses in the Accept statement makes no difference.)

Forgetting to use the Convert clause when accepting numeric data can cause unpredictable results.

(While Convert is not a standard ANSI Cobol word, it is also used on systems other than the TRS-80.)

An Accept statement using a data item with a Picture of 9(3)V9(2) will allow you to enter only five characters, including the decimal point. Therefore, even though the data item is designed to hold three digits to the left of the decimal place and two to the right, a value this large cannot be keyed in. Perhaps the simplest solution to this problem is to define a Picture larger than that actually needed.

The best way to understand all of the details involved in accepting numeric data is to write a sample program which tests various combinations of Picture clauses.

Editing Numeric Data

Before numeric data can be output to the screen or printer, it must be edited. Editing allows you to define exactly how the values will be displayed—you can suppress leading zeros, insert dollar signs, and add commas. A numeric value that is stored on the disk as 123456789 can be printed as \$1,234,567.89—clearly a far more meaningful value.

Numeric values are edited by moving them from a numeric-data item into an edit-data item. All edit-data items are defined in the Working-Storage Section.

Examples of editing operations are

shown in Program Listing 8. Note that the numeric data item is moved into the edit data item and then the edit data item is printed or displayed.

Figure 7 contains a summary of the edit symbols, along with the results of some sample editing.

The edit character Z suppresses leading zeros. A value of 000123 can be printed as 123 with this character in the edit Picture.

Generally, it is not a good idea to fill the entire edit Picture with Zs—a value of zero would be displayed as a blank. Include at least one 9 in the Picture clause (use Picture ZZZ.99 rather than Picture ZZZ.ZZ).

The decimal point is used in the edit Picture to tell the computer where to align the implied decimal point of the numeric-data item with the actual decimal point of the edit-data item. For example, a numeric-data item with a Picture of 999V9 and a value of 1234 can be moved into an edit-data item with a Picture of ZZZZ.99. The edited result is the value 123.40—the decimal points align themselves.

The dollar-sign edit character is used to place a \$ before a number. If you use more than one \$, they act as zero-suppression characters. For example, when the value 1234 is moved into the edit field \$\$\$\$99, the result is \$12.34. If the same value is moved into the field \$ZZZZ.99, the result is \$ 12.34.

The comma-edit character is used to insert a comma in the appropriate location of a value. For example, the value 123456 can be moved into an edit-data item with a Picture 999,999. When the edit item is sent to the screen or printer, the value 123,456 is displayed.

Asterisks can be used in the edit Picture to replace leading zeros to be replaced by asterisks. This is done primarily when printing paychecks.

A leading or trailing plus or minus sign can be added to a value by including - or + in the edit Picture. If a minus sign is included, it is printed only when the value is negative. If the value is positive, no sign is printed. When the plus sign is used in the edit Picture, + is printed with the value when it is positive or unsigned and - when it is negative.

The symbols CR (credit) and DB (debit) can be printed with a negative value simply by ending the edit Picture with these letters. Note that these symbols are printed only with negative values.

Although there are additional edit symbols, the final one we'll consider is B for blank. Placing a B in the edit field in-

Symbol	Meaning
Z	Substitute blanks for leading zeroes
.	Insert decimal point
,	Insert comma
+	Insert + sign if value is positive and - sign if value is negative
-	Insert - sign if value is negative
\$	Insert \$ sign as first character
CR	Append CR to value if item is negative
DB	Append DB to value if item is negative
*	Insert asterisk in place of leading zero
B	Insert a blank in this position

Sending Field		Receiving Field	
Picture	Contents	Edit Picture	Edited Results
9(3)V9(2)	12345	\$ 999.99	\$ 123.45
9(3)V9(2)	00123	\$ ZZZ.99	\$ 1.23
9(3)V9(2)	00123	\$ \$\$\$9.99	\$1.23
9(5)V9(2)	0000123	\$**,***.99	\$****1.23
S9(6)	- 123456	+ ZZZ,ZZZ	- 123,456
9(9)	246871977	999B999B9999	246 87 1977
S9(3)	- 123	ZZZ -	123 -
S99V99	- 1234	\$ ZZ.99CR	\$ 12.34CR
99V99	0000	\$ ZZ.99	\$.00

Figure 7. A summary of Edit symbols


```

00540      02 FILLER      PICTURE X(126) VALUE SPACES.
00550
00560 PROCEDURE DIVISION.
00570 OPEN-DISK-PRINTER-FILE.
00580 OPEN INPUT NAME-FILE.
00590 OPEN OUTPUT PRNT.
00600 PRINT-HEADINGS.
00610 MOVE PAGE-HEADER TO PRINT-LINE.
00620 WRITE PRINT-LINE.
00630 MOVE SUB-HEADER TO PRINT-LINE
00640 WRITE PRINT-LINE AFTER ADVANCING 2 LINES.
00650 READ-RECORD-FROM-FILE.
00660 READ NAME-FILE
00670 AT END GO TO TERMINATE-PROGRAM.
00680 MOVE-DATA-TO-PRINT-LINE.
00690 MOVE SPACES TO PRINT-LINE.
00700 MOVE NAME-FIELD TO PRINT-LINE.
00710 WRITE-REPORT-ITEM.
00720 WRITE PRINT-LINE AFTER ADVANCING 2 LINES.
00730 LOOP-ROUTINE.
00740 GO TO READ-RECORD-FROM-FILE.
00750 TERMINATE-PROGRAM.
00760 STOP RUN.
00770 END PROGRAM.
    
```

Add

Format 1 Add item-1 To item-2.
 or Add item-1 item 2 To item-3.

Example Add AMT-1 AMT-2 To AMT-3.

Before	2	4	6
After	2	4	12

Format 2 Add item-1 To item-2 Giving item-3.
 or Add item-1 item 2 To item-2 Giving item-3.

Example Add AMT-1 To AMT-2 Giving AMT-3.

Before	2	8	6
After	2	8	10

Subtract

Format 1 Subtract item-1 From item-2.
 or Subtract item-1 item-2 From item-3.

Example Subtract AMT-1 AMT-2 From AMT-3.

Before	6	3	20
After	6	3	11

Format 2 Subtract item-1 From item-2 Giving item-3.

Example Subtract 3 From 7 Giving Result-1.

Before	3	7	12
After	3	7	4

Multiply

Format 1 Multiply item-1 By item-2.

Example Multiply Amount-1 By Amount-2.

Before	3	5
After	3	15

Format 2 Multiply item-1 By item-2 Giving item-3.

Example Multiply AMT-1 By AMT-2 Giving AMT-3.

Before	6	5	10
After	6	5	30

Divide

Format 1 Divide item-1 Into item-2.

Example Divide AMT-1 Into AMT-2.

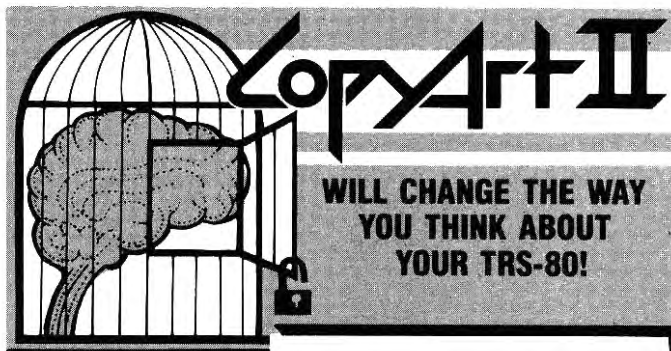
Before	2	6
After	2	3

Format 2 Divide item-1 {By/Into} item-2 Giving item-3.

Example Divide AMT-1 Into AMT-2 Giving AMT-3.

Before	2	6	18
After	2	6	3

Figure 8. General formats for the Add instruction



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19. CENTERING.
20. HEADERS and FOOTERS. You can even put graphics within headers for super page layouts.
21. PAGE NUMBERING. Page numbers can appear at the top or bottom of the page.
22. DOS COMMANDS from within the editor. Kill files, check free space or get directories easily.
23. CUSTOMIZED PRINTER driver. Since your printer has features that other printers don't, CopyArt II will be supplied with the printer driver of your choice below. Each printer driver is custom made to provide you with commands for each of your printer's fine capabilities. If you have more than one printer, order other printer drivers for only \$19.95 each. Printer drivers are available for:
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 - Epson MX-80, MX-80/FT, MX-100 with or without grafrax.
 - Okidata Microline 80, 82a, 83a and 84
 - NEC 8023
 - Smith Corona Daisy Wheel TP-1
 - Brother Daisy Wheel
 - C-itho Starwriters and Prowriters all.
 - PMC P-inter
 - Centronics 737, 739
 - Diablo 620
- OTHERS COMING SOON. Call if you don't see your printer!
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25. MAILIST/MAILMERGE INCLUDED. CopyArt II comes with a mailist program that stores over 2,000 names on a MOD III diskette. These names can be sorted by any field and have a special field for your code. You can make PERSONALIZED FORM LETTERS that will take the following codes from the mailist and insert them in your text. FIELDS INCLUDE: Mr. or Ms., Last name, First name, Business name, City, State, up to 9 digit ZIP code and your own special 2 character code. ANY OF THESE fields can be inserted within your form letter wherever you want. You can print form letters or mailing labels to all the people on your list or to specific codes only. CopyArt makes it easy.

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 *Indicates printer must have capability to do function.

serts a blank in the location it occupies. For example, a social-security number stored as the value 123456789 could be moved into an edit data item with the Picture 999B99B9999. When the edit item is output to the printer or screen it would look like this: 123 45 6789.

Arithmetic Operations

The arithmetic operations available in Cobol include Add, Subtract, Multiply, Divide, and Compute.

The Add instruction is used to perform addition on numeric-data items. There are two general formats for the Add instruction (see Fig. 8).

The first format allows you to sum data items. All data items in the instruction are first summed, and then the result is moved into the data item following the word To. The only item in the operation whose value is changed is the final data item. This is the case with all operations involving Add, Subtract, Multiply and Divide.

In the second format the clause Giving is included in the instruction. When Giving is used in any arithmetic operation, the data item following the word receives the result of the operation. The example in Fig. 8 under the second format of the Add statement shows that the items to the left of the word Giving are summed and the result placed in the final data item.

Since the data item following Giving

does not actually participate in the operation, and only acts as a receiving field, it can be an edit-data item. All other items must be either numeric-data items or numeric literals. This is the case in all arithmetic statements.

Subtract is used to perform subtraction on numeric items. As with the Add statement, there are two formats for Subtract. Figure 8 shows that the first format simply sums all of the data items and numeric literals before the word From and then subtracts this amount from the data item following From.

In format 2, the Giving clause is added. In this case, the subtraction is performed and the result moved into the data item following the word Giving. As with the Add statement and all other arithmetic statements, the data item following Giving does not participate in the operation; it acts only as a receiving field.

This is a good place to point out two general rules about the Cobol arithmetic statements Add, Subtract, Multiply and Divide.

First, only the value of the final data item is ever changed. If this final data item follows the word Giving, it does not participate in the actual arithmetic operation but acts only as a receiving field. When the Giving clause is not included, the final data item participates in the operation and then acts as the receiving field for the result.

Second, a data item following the word Giving can be a numeric or edit-data item, while all others must be either numeric-data items or numeric literals.

The Multiply statement is limited because only two values can be multiplied in a single instruction. Nonetheless, there are two formats for the statement (see Fig. 8).

In the first format, the two values are multiplied and the result is placed in the final data item. The second format is used to multiply the two items to the left of the word Giving and then place the result in the final data item.

With Divide, as with the other arithmetic statements, there are two general formats. The first format shown in Fig. 8 divides the value represented by item-1 into the value represented by item-2. The result is then stored in item-2.

The second format causes the two data items to the left of the word Giving to be divided; the result is placed in the final data item. Note that when using this second format, item-1 can be divided by or into item-2. For example, if 2 is divided into 6 the quotient is 3. If 2 is divided by 6 the quotient is .333.

The final, and most powerful, of the Cobol arithmetic statements is the Compute instruction. Figure 9 is a list of the arithmetic symbols used with Compute as well as some examples using the statement.

With the Compute statement, the data item to the left of the equals sign always acts as the receiving field. It does not take part in the computation. For example, Compute Sum = 2 + 2, would make Sum equal to 4. The computation to the right of the equal sign is completed and the result is moved into the data item to the left of the sign.

When using the Compute instruction to perform complex calculations, remember the mathematical hierarchy of operations as is shown in Fig. 9. For example, Compute Average = 10 + 20 + 30 / 3, does not calculate the average. As can be seen in the hierarchy of operations, multiplication and division are performed before addition and subtraction. In this example the data item Average would equal 40. To actually calculate the average, you must use parentheses to instruct the computer to perform the addition before the division: Compute (10 + 20 + 30) / 3.

Two additional options can be used with all arithmetic statements. They are Rounded and On Size Error.

You can use the Rounded option to round a number off to a specified decimal place. For example, the statement Subtract Discount From Amount

Program Listing 8. Examples of editing operations

```

000100 IDENTIFICATION DIVISION.
000110*****
000120* COBOL 1 -- BUDGET PROJECT *
000130*      Module 1 -- Store Data *
000140*      Using Traditional Approach *
000150*****
000160 PROGRAM-ID.                WORK6.
000170 AUTHOR.                    student's name.
000180 INSTALLATION.             JTC.
000190 DATE-WRITTEN.             MAY 1982
000200 SECURITY.                  UNCLASSIFIED.
000210
000220 ENVIRONMENT DIVISION.
000230 CONFIGURATION SECTION.
000240 SOURCE-COMPUTER.            MODELIII-48K.
000250 OBJECT-COMPUTER.          MODELIII-48K.
000260 INPUT-OUTPUT SECTION.
000270 FILE-CONTROL.
000280     SELECT BUDGET-FILE ASSIGN TO OUTPUT "BUDGET/SEQ".
000290
000300 DATA DIVISION.
000310 FILE SECTION.
000320 FD BUDGET-FILE
000330     BLOCK CONTAINS 1 RECORDS
000340     RECORD CONTAINS 44 CHARACTERS
000350     LABEL RECORDS ARE STANDARD
000360     DATA RECORD IS BUDGET-RECORD.
000370 01 BUDGET-RECORD.
000380     02 EMPLOYEE-NUMBER        PICTURE X(5).
000390     02 EMPLOYEE-NAME          PICTURE X(25).
000400     02 BUDGET-AMOUNT           PICTURE 9(5)V99.
000410     02 CURRENT-EXPENSE        PICTURE 9(5)V99.
000420 WORKING-STORAGE SECTION.
000430 77 RESPONSE                   PICTURE X.
000440
000450 PROCEDURE DIVISION.
000460 OPEN-OUTPUT-DISK-FILE.
000470 OPEN OUTPUT BUDGET-FILE.

```

Listing 8 continues

Listing 8 continued

```

000480 DISPLAY-PROMPTS.
000490 DISPLAY "INPUT BUDGET DATA"
000500 LINE 1 POSITION 15 ERASE.
000510 DISPLAY "EMPLOYEE NUMBER:"
000520 LINE 5 POSITION 8.
000530 DISPLAY "EMPLOYEE NAME:"
000540 LINE 7 POSITION 10.
000550 DISPLAY "AMOUNT BUDGETED:"
000560 LINE 9 POSITION 8.
000570 DISPLAY "CURRENT EXPENSE:"
000580 LINE 11 POSITION 8.
000590 ACCEPT-BUDGET-DATA.
000600 ACCEPT EMPLOYEE-NUMBER
000610 LINE 5 POSITION 25 PROMPT "." TAB.
000620 ACCEPT EMPLOYEE-NAME
000630 LINE 7 POSITION 25 PROMPT "." TAB.
000640 ACCEPT BUDGET-AMOUNT
000650 LINE 9 POSITION 25 PROMPT "." CONVERT TAB.
000660 ACCEPT CURRENT-EXPENSE
000670 LINE 11 POSITION 25 PROMPT "." CONVERT TAB.
000680 WRITE-DATA-TO-DISK.
000690 WRITE BUDGET-RECORD.
000700 ASK-IF-MORE-DATA.
000710 DISPLAY "MORE DATA TO ENTER (Y/N) ?"
000720 LINE 15 POSITION 10.
000730 ACCEPT RESPONSE
000740 LINE 15 POSITION 38 TAB.
000750 IF RESPONSE EQUAL "Y"
000760 GO TO DISPLAY-PROMPTS.
000770 TERMINATE PROGRAM.
000780 CLOSE BUDGET-FILE.
000790 STOP RUN.
000800 END PROGRAM.

```

Compute

Symbols Used With Compute

+	=	Add
-	=	Subtract
*	=	Multiply
/	=	Divide
**	=	Exponentiate (Not supported on TRS-80)

Hierarchy of Operations

1. () Items in parentheses are evaluated first
2. ** Exponentiations are performed next
3. */ Multiplication and division occur next
4. + - Finally, addition and subtraction

Examples using Compute

Compute Amount-1 = 35.

This statement moves the value 35 into the data item Amount-1.

Compute Tax = .05 * Amount.

Amount is multiplied by .05 with the product being moved into the data item Tax.

Compute Total = AMT-1 + AMT-2 + AMT-3.

Here AMT-1, AMT-2 and AMT-3 are totaled. The sum is moved into Total.

Compute Average = (AMT-1 + AMT-2 + AMT-3) / 3.

The three amounts are added first and then the sum is divided by three. This amount is then moved into Average.

Figure 9. Arithmetic symbols used with Compute

Program Listing 9.

```

000100 IDENTIFICATION DIVISION.
000110 *****
000120* COBOL I -- BUDGET PROJECT *
000130* Module II -- Print Report From Data *
000140* Traditional Method *
000150*****
000160 PROGRAM-ID. WORK5.
000170 AUTHOR. student's name.
000180 INSTALLATION. JTC.

```

Listing 9 continues



26. SIMPLE CURSOR commands. Simply use the arrow keys to move your cursor around the text. The screen will scroll both vertically and horizontally. Shift arrows take you to the beginning or end instantly.

27. SCREEN DUMP. Prints whatever is on the screen to the printer.

28. COMPLETE MARGINS CONTROL. You tell CopyArt II what margins you desire. You can even change margins within the same text. You may also have parts of your text with 2 columns, some with one etc. It's super easy to use.

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31. SPECIAL SCRIPSIT FILE LOADER. Allows you to load your old Scripsit files without having to save them in ASCII. Copyart will also load Pencil files and other normal ASCII files.

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TRS-80 and Scripsit are TM of Radio Shack a Tandy corp.
*Indicates printer must have capability to do function.

```

000190 DATE-WRITTEN.          MAY 1982
000200 SECURITY.             UNCLASSIFIED.
000210
000220 ENVIRONMENT DIVISION.
000230 CONFIGURATION SECTION.
000240 SOURCE-COMPUTER.        MODEL III-48K.
000250 OBJECT-COMPUTER.      MODEL III-48K.
000260 INPUT-OUTPUT SECTION.
000270 FILE-CONTROL.
000280 SELECT BUDGET-FILE ASSIGN TO INPUT "BUDGET/SEQ".
000290 SELECT PRNT ASSIGN TO PRINT "PRINTER".
000300
000310 DATA DIVISION.
000320 FILE SECTION.
000330 FD BUDGET-FILE
000340 BLOCK CONTAINS 1 RECORDS
000350 RECORD CONTAINS 44 CHARACTERS
000360 LABEL RECORDS ARE STANDARD
000370 DATA RECORD IS BUDGET-RECORD.
000380 01 BUDGET-RECORD.
000390 02 EMPLOYEE-NUMBER        PICTURE X(5).
000400 02 EMPLOYEE-NAME          PICTURE X(25).
000410 02 BUDGET-AMOUNT         PICTURE 9(5)V99.
000420 02 CURRENT-EXPENSE       PICTURE 9(5)V99.
000430 FD PRNT
000440 BLOCK CONTAINS 1 RECORDS
000450 RECORD CONTAINS 132 CHARACTERS
000460 LABEL RECORDS ARE OMITTED
000470 DATA RECORD IS PRINT-LINE.
000480 01 PRINT-LINE            PICTURE X(132).
000490 WORKING-STORAGE SECTION.
000500 01 HEADERS.
000510 02 HEADER-1.
000520 03 FILLER                  PICTURE X(35) VALUE SPACES.
000530 03 LITERAL1               PICTURE X(13) VALUE "BUDGET REPORT".
000540 03 FILLER                  PICTURE X(84) VALUE SPACES.
000550 02 HEADER-2.
000560 03 FILLER                  PICTURE X(5) VALUE SPACES.
000570 03 LITERAL2               PICTURE X(10) VALUE "EMP #".
000580 03 LITERAL3               PICTURE X(30) VALUE "EMPLOYEE NAME".
000590 03 LITERAL4               PICTURE X(12) VALUE "BUDGET AMT".
000600 03 LITERAL5               PICTURE X(16) VALUE "CURRENT EXP".
000610 03 LITERAL6             PICTURE X(59) VALUE "BALANCE".
000620 02 DETAIL-LINE-1.
000630 03 FILLER                  PICTURE X(5) VALUE SPACES.
000640 03 EMPLOYEE-NUMBER-OUT    PICTURE X(5).
000650 03 FILLER                  PICTURE X(5) VALUE SPACES.
000660 03 EMPLOYEE-NAME-OUT     PICTURE X(25).
000670 03 FILLER                  PICTURE X(5) VALUE SPACES.
000680 03 BUDGET-AMOUNT-OUT     PICTURE Z(4)9.99
000690 03 FILLER                  PICTURE X(5) VALUE SPACES.
000700 03 CURRENT-EXPENSE-OUT  PICTURE Z(4)9.99
000710 03 FILLER                  PICTURE X(5) VALUE SPACES.
000720 03 BALANCE-OUT         PICTURE Z(6)9.99CR.
000730 03 FILLER                  PICTURE X(49) VALUE SPACES.
000740 02 DETAIL-LINE-2.
000750 03 FILLER                  PICTURE X(64).
000760 03 LITERAL-7            PICTURE X(7) VALUE "TOTAL".
000770 03 TOTAL-OUT           PICTURE Z(6)9.99CR.
000780 03 FILLER                  PICTURE X(49) VALUE SPACES.
000790 01 WORK-AREAS.
000800 02 TOTAL-COUNTER          PICTURE S9(7)V99 VALUE ZERO.
000810 02 BALANCE                PICTURE S9(7)V99 VALUE ZERO.
000820
000830 PROCEDURE DIVISION.
000840 OPEN-DISK-PRINT-FILE.
000850 OPEN INPUT BUDGET-FILE.
000860 OPEN OUTPUT PRNT.
000870 PRINT-HEADINGS.
000880 MOVE HEADER-1 TO PRINT-LINE.
000890 WRITE PRINT-LINE BEFORE ADVANCING 3 LINES.
000900 MOVE HEADER-2 TO PRINT-LINE.
000910 WRITE PRINT-LINE BEFORE ADVANCING 2 LINES.
000920 READ-RECORD-FROM-FILE.
000930 READ BUDGET-FILE
000940 AT END GO TO MOVE-TOTAL-TO-PRINT-LINE.
000950 MOVE-DATA-TO-PRINT-LINE.
000960 MOVE EMPLOYEE-NUMBER TO EMPLOYEE-NUMBER-OUT.
000970 MOVE EMPLOYEE-NAME TO EMPLOYEE-NAME-OUT.
000980 MOVE BUDGET-AMOUNT TO BUDGET-AMOUNT-OUT.
000990 MOVE CURRENT-EXPENSE TO CURRENT-EXPENSE-OUT.
001000 CALCULATE-BALANCE.
001010 SUBTRACT CURRENT-EXPENSE FROM BUDGET-AMOUNT GIVING BALANCE.
001020 MOVE-BALANCE-TO-PRINT-LINE.
001030 MOVE BALANCE TO BALANCE-OUT.
001040 ADD-BALANCE-TO-TOTAL.
001050 ADD BALANCE TO TOTAL-COUNTER.
001060 WRITE-REPORT-ITEM.
001070 WRITE PRINT-LINE FROM DETAIL-LINE-1.
001080 LOOP-ROUTINE.
001090 GO TO READ-RECORD-FROM-FILE.
001100 MOVE-TOTAL-TO-PRINT-LINE.
001110 MOVE TOTAL-COUNTER TO TOTAL-OUT.
001120 PRINT-FINAL-TOTAL.
001130 WRITE PRINT-LINE FROM DETAIL-LINE-2
001140 AFTER ADVANCING 2 LINES.
001150 TERMINATE-PROGRAM.
001160 CLOSE BUDGET-FILE PRNT.
001170 STOP RUN.
001180 END PROGRAM.

```

Giving Total Rounded would subtract Discount from Amount, move the difference to the receiving field Total and round the total to fit in the Picture of the receiving field. If the difference was 12.75 and the Picture for Total 9(2), then the value 13 would be stored in Total. Note that all rounding is done at the .5 level.

You can use the On Size Error option to take special action if the receiving field in an arithmetic operation is not large enough. If this option is not used, the value will simply be truncated and no error message will appear. For example, if you try to move the value 324 into a data item with a Picture of 9(2), the value 24 will be moved into the item and 3 will simply be lost.

Size errors occur under two conditions—when the receiving field is too small to hold the value being moved into it, and when division by zero is attempted. Note the following example: Multiply Amount-1 By Amount-2 Giving Amount-3 On Size Error Perform Error-Routine. This statement instructs the computer to multiply Amount-1 by Amount-2 and move the result into Amount-3. If the data item Amount-3 is not large enough to contain the result, the On Size Error clause is activated, and, in this case, the paragraph named Error-Routine is executed.

Logical Operators

Through the use of the logical operators And and Or, you can test compound conditions. At times it is necessary to perform a particular function only when two or more specific conditions exist. For example, if it is over 85 degrees and the swimming pool is full of water, then go for a swim. This compound condition states that you will only swim if both conditions are true, signified by the word And.

In Cobol the And operator can be used in statements such as If Amount Is Less Than 100 And Budget Is Equal To 75 Display "Adequate Funds". Only when the two conditions are true will the Display statement be executed.

The word Or is used in Cobol in precisely the same way it is used in English. The sentence, "If you have a ticket or \$5 then you can get into the movie," means that if you have either the ticket or the money then you can enter. It is necessary to meet only one condition in an Or statement.

A Cobol example of Or is If Name-1 Is Equal To "Mary" Or Name-1 Is Equal To "Sue" Display Phone-Number. If Name-1 contains either name then the contents of the data item

Phone Number will be printed on the screen.

In the examples using And and Or, I used the relational operator Is Equal To. Actually, I could have chosen a number of operators—see Fig. 10.

Final Programming Project

Let's have a final program so we can review the instructions and concepts covered here. The assignment actually consists of two programs—one that accepts data from the keyboard and stores it on the disk, and another that reads in the data and prints a report.

Before the data can be accepted and written to the disk, the file specifications must be made clear. Each record will consist of 44 characters. There will be four fields containing an employee's number, name, budget amount and current expense. The field lengths are as follows: employee number = 5 characters; name = 25 characters; budget amount = 7 characters; and current expense = 7 characters.

The first program should create the disk file, which will be called Budget-File in the program and BUDGET/SEQ on the disk.

The program should prompt the user to enter the employee number, name, budget amount, and current expense. This data should then be written to the disk and the user asked if he wishes to enter another person's record. If so, ask for the data again and store it on the disk; if not, close the file and end the first program.

Using sample programs, you should find this first program a fairly simple exercise. Although the program is presented in Listing 9, try to write your own version first.

Once the first program is completed, key in the data presented in Fig. 11. Obviously, you will only enter the four field items for each employee. Your second program will calculate the balance.

The second program requires that the data stored on the disk be retrieved and a report printed.

This report should present the employee's number, name, budget amount, current expense and balance. The balance for each employee is calculated by subtracting the current expense from the budget amount—simply use the Cobol Subtract statement. Finally, the report should contain the grand total of each employee's balance. To do this, a running total must be maintained as each record is processed.

The report format is shown in Fig. 11. Note the use of a title and column

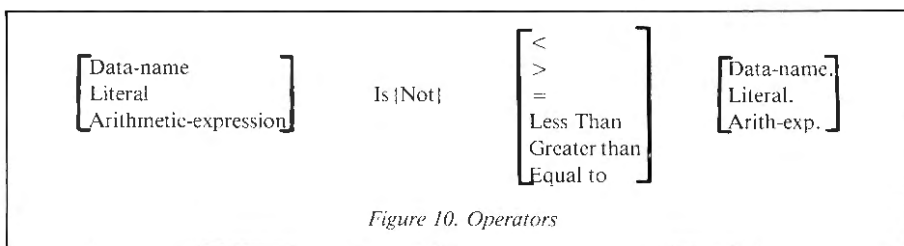


Figure 10. Operators

BUDGET REPORT				
EMP #	EMPLOYEE NAME	BUDGET AMT	CURRENT EXP	BALANCE
10001	THOMAS, ROY	500.00	250.00	250.00
10002	BOWIE, WENDELL	300.00	450.00	150.00CR
10003	LIPPARD, CINDY	300.00	150.00	150.00
			TOTAL	250.00

Figure 11. Data and Report format

headings, as well as the final total located at the bottom. Also, the CR (credit) option has been used in the edit data items. Remember that this causes negative values to be accompanied by the letters CR.

This second program is more complex than the first, but try to write your own before studying the program shown in Listing 9.

Common Cobol Programming Errors

Probably the most common Cobol error is improper spelling and punctuation while keying in the source code. Periods are often omitted and key words misspelled. The simple solution to this is to carefully proofread your program. Those mistakes that you do not find will be flagged by the compiler.

Don't substitute the letter O for the number zero. Note that the zero has a slash through it. Typists must also remember that, to the computer, the letter l is not the same as the number one.

When describing numeric Picture clauses, it is a common mistake to use the . instead of the V. Remember that the decimal point must be represented by a V in the Picture clause of numeric-data items.

Probably one of the most difficult errors to locate occurs when a program line extends beyond column 72. As the program is compiled an error message will be generated but upon proofreading the line no error can be found. Remember that the compiler ignores columns 73 through 80 and does not see any instructions located there. To correct this error, use two program lines for a single instruction.

Despite your efforts, nearly every program that you write will initially

contain syntax errors. Your job will be to locate and correct them.

The compiler flags the errors that it finds while compiling the source code and will display them on the screen or printer at your request. Sending error messages to the printer is best—those on the screen quickly scroll past, making it difficult to read them.

Although I have not found a way to make the Model III pause while compiling, the Model II pauses if you depress the space bar. By pausing, you are given time to read the messages on the screen. Press the enter key to resume compiling.

If you have a printer, compile with the full listing going to the printer (use RSCOBOL file name P).

Figure 12 provides a sample of a printout from the compiler, complete with errors.

The compiler flags the location of an error with a dollar sign. It then places another dollar sign where the compilation process resumes. In other words, it jumps over the error and begins compiling again.

Each \$ is later followed by a message. The messages are numbered and refer to either the first or second dollar sign. Look at program line number 350 in Fig. 12. Below it are two messages numbered 1 and 2. The first refers to the first \$ in line 350, while the second refers to the next \$ in the line.

An examination of the two messages shows that a syntax error has been found by the compiler at the start of line 350. What is the error?

Actually, there is no error in line 350. The error occurred in line 340, where a period was omitted. The compiler did not discover the error until it

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Listen. We're going to let you in on an industry secret: It's not hard to make a good spelling checker.

You see, although spelling checking is new for microcomputers, it's been around on big computers for *years*. And when you get past all the talk, most spelling checkers work the same way. They compare what you've written with a dictionary—and report the errors.

So is there *any* difference? You bet: the dictionary, and the price.

Who Checks The Checker?

The hardest part of a spelling checker to make is the dictionary. It's hard to pick the right words—and spell every one of them perfectly. That's why some popular spelling checkers don't even contain real dictionaries. They use formulas called "hash tables." Which make a hash out of your spelling some of the time.

Other spelling checkers "borrow" their words from printed dictionaries—or copy them from old word lists. Or give a programmer who can't spell "programmer" a chance to write his first dictionary. And as though all this wasn't bad enough, a lot of these

companies want to charge you \$100, or \$200 or even \$300!

Random House to the Rescue

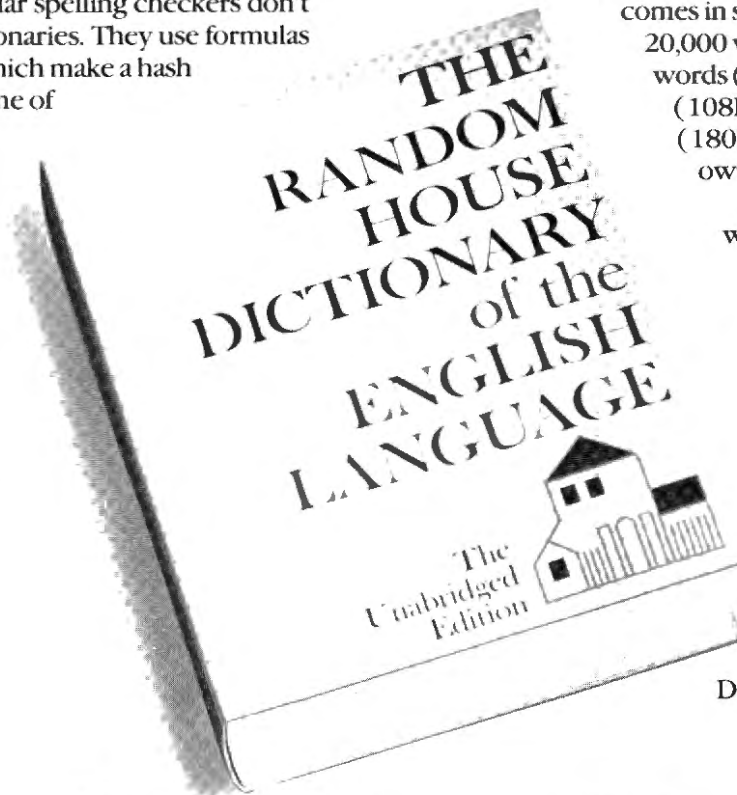
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Disk Tiny Pascal

by David M. Silver

Did you have to abandon all your cassette-based Tiny Pascal programs when you upgraded to a disk system? David's got the answer.

Do you want to modify Radio Shack's cassette-based Tiny Pascal for disk? This article carries on from where "Modify Tiny Pascal for Disk" left off (*80 Micro*, July 81).

These machine-language programs will allow you to save and load source and compiled p-code programs using the disk. The cassette routines are still present so you can store all your old cassette programs on disk.

An additional routine prints source programs, and a command returns control to DOS. You can even prepare source programs with word processors such as Scripsit or Electric Pencil.

Tape to Disk

The original 32K program loads into addresses 4D90H-73EFH. Upon execution, a block move transfers 900H bytes from 4D90H down to 4090H. According to the Tiny Pascal manual, addresses from 4060H up-

ward are used, although I found no references to addresses below 4090H. However, DOS uses memory up to 51FFH. In order to use the DOS routines for disk I/O, the Tiny Pascal program must be relocated above the DOS area. We will shift Tiny Pascal by 1200H bytes, so it occupies memory from 5290H upward.

There are many ways to save the cassette program on disk. NEWDOS users can use the LMOFFSET program. The new load point address should be 4D90H plus 1200H or 5F90H. Suppress the appendage, and call the disk program PASCAL/CMD.

Other programs, such as RSM-2D, perform the same function.

A short machine-language program (see Listing 1) can also perform the job. Using Debug, type the hex code into 9000H-900DH. Then reset the computer while holding the break key down. Answer the memory-size prompt with enter. Enter System, followed by PAS32K, and load the 32K Tiny Pascal from cassette. At the next prompt type /36864. (This is the address of the block-move routine that is still in memory.)

The routine moves the program to an area of memory above DOS and then reboots the computer, this time with disks. Now enter the following command:

```
DUMP PASCAL/CMD (START = X'5F90',
END = X'85EF')
```

Tiny Pascal is now on disk, but not in an executable form. Addresses in the program still refer to the original program locations. We must change these references. (At this stage, make a backup of this disk file in case you make errors in the following steps.)

Completing Relocation

Moving the program code in memory was relatively simple. In the second stage we must offset all references to addresses 4090H-73EFH by 1200H by adding 12H to the most significant byte of these address references. Table 1 lists all the addresses of bytes that must be altered, as well as the old and new contents of each byte. Change these by using Debug.

I found other changes necessary. Because the system often rebooted or hung up, I disabled the interrupts.

The break key was no longer functional because Level II ROM jumps to 400CH when the break key is pressed. A jump vector is placed here in DOS, whereas for Level II operation, there is just a return opcode. (I found that this was the only Level II environment expected by Tiny Pascal.) I used a return opcode (C9H) to replace the jump opcode (C3H) at 400CH.

Cassettes created by Tiny Pascal include the address of the data to be loaded as part of each data block. The address bytes are also used in the checksum calculation. This meant that cassettes from the original Tiny Pascal would load into the original, lower area of memory and bomb the system. Since we always load data starting

The Key Box

**Model I
32K RAM
Tiny Pascal
One Disk Drive**

from a known location (8900H for disk Tiny Pascal), the address information is unnecessary. I modified the cassette routines to accept cassettes created by both the original cassette version of Tiny Pascal and the disk version described in this article. (I doubt that you'll want to save programs on cassette anyway.) The new cassette routines will also read cassettes created with the 16K version of Tiny Pascal.

Table 1 also lists the changes necessary to solve these problems. Use Debug and work methodically to avoid errors. If you change the wrong byte by mistake, the back-up copy of PASCAL/CMD may rescue you. Note that some locations are shown with xx as the original contents. These are in buffer areas in the original Tiny Pascal, and the contents may vary from copy to copy.

Exit from Debug and enter the following command:

```
DUMP PASCAL/CMD (START = X'5F8A',
END = X'85EF',TRA = X'5F8A')
```

Now test all your work to this stage; the program should perform identically to the original cassette version. If you have problems, check all your modifications with Table 1. Ensure that you have made the correct changes for the memory size of your system.

Determining the Bytes to be Changed

The Tiny Pascal manual gives a memory map of the system. From this I determined that the bulk of the changes would be made to the interpreter, I/O and runtime routines, and the entry-points table. The routines are written in machine language and the entry-points table refers to machine addresses. The remainder of the package is p-code for the editor and compiler. P-code is relocatable; modifications are only required if the p-code refers to an absolute memory address. In this case, a few references are made to the system control block in the editor and compiler p-code.

Using a disassembler and the memory map provided, I disassembled the original code from 4090H-498FH. (The code is placed there by the initial block move from 4D90H.) This is the only machine-language (not p-code) part of the system. The result was a heap of about 25 pages of Assembly code! All references to addresses in the range 4090H-73EFH would have to be changed for relocation.

The most common instructions to be changed were jumps and calls, and loads to and from absolute addresses. Relative jumps do not have to be altered. No indexed addressing is used in

the program, so all the references to addresses were listed by the disassembler. An exception was the most significant byte of the address of the entry points table. This was used as data in one instruction and had to be altered. I also noted references to the location of the text buffer, editor p-code, compiler p-code, and run-time stack, as well as the memory size of the system.

Another problem is distinguishing between data and program code. This is partly a matter of experience. Strange hex code is worth converting to ASCII: The resulting data is often a message. The area of strange code could also be used as a buffer.

The source listing of the compiler indicated the references to the system control block in the compiler p-code. Since the address of the control block was defined as a constant in the listing, I expected to find the same value in the p-code. Similarly, expressions that used this constant would also need to have their corresponding p-code altered. I searched the p-code areas for references in the range 4180H-419BH, and noted the addresses.

Adding the Extensions to Tiny Pascal

The new commands with the extensions to Tiny Pascal are shown in Table 2. I used the original cassette

Table 1

(Note that all address and byte values are in hex)

Change bytes at these addresses from 40 to 52: (relocation)

```
5F95 663C 663P 6645 6648 666E 6699 66D2 6729 6738
673E 6784 678D 67BF 67CD 67FE 6804 6808 6822 6833
683A 6862 6882
```

Change bytes at these addresses from 41 to 53: (relocation)

```
60A2 60A5 60A8 60B4 60E4 60F7 60FD 6107 611C 611F
6123 6142 6177 6238 626C 627F 6284 6287 628A 6376
656E 6669 6680 66B3 6686 6689 668C 6690 6694 669F
66A9 66BE 66C1 66C4 66CD 66D8 66DB 66DE 66F0 66F4
66FD 6701 6714 671C 6722 672F 6748 6756 6759 6799
67C7 67CA 6E35 6E3C 6E50 7086 71C8 71D0 71DB 71E4
75E5 859A
```

Change bytes at these addresses from 42 to 54: (relocation)

```
6001 6003 6005 6007 6009 600B 600D 600F 6011 6017
6019 601B 601D 601F 602B 602D 6101 6135 6146 6166
6170 617C 6182 61A3 61A6 61BC 61BF 61D2 61D6 61D9
61EE 61F1 6211 623C 6346 634C 637D 63A2 655F
```

Change bytes at these addresses from 43 to 55: (relocation)

```
6013 6015 6021 6023 6025 6027 6029 605B 605D 605F
6217 6275 6293 629D 62AF 62CB 62CE 62E3 6311 6326
6388 6524 6535 6558 6562
```

Change bytes at these addresses from 44 to 56: (relocation)

```
602F 6031 6033 6035 6037 6039 6061 60FA 617F 6260
6268 62DB 62E0 62E6 6304 630C 6314 632A 6380 6390
639A 63A5 63A8 63AB 63B2 63B6 63CF 63D9 63DD 63E1
63E4 63EC 63EF 63F2 6410 6416 643C 644D 6456 645C
6471 64A5 64B0 64C4 64D5 64D8 64EB 6538 65B5 65FB
6600 660B 660F 661A 661E
```

Change bytes at these addresses from 45 to 57: (relocation)

```
603B 603D 603F 6041 6043 6045 6047 6049 604B 604D
604F 6051 6053 6055 6057 631A 63E8 6431 6451 646A
647E 6496 649C 64A2 64C9 64CC 64DF 65BC
```

Change bytes at these addresses from 46 to 58: (relocation)

```
6059 6063 6065 6067 6069 606B 606D 606F 6071 6073
6075 60E8 6149 61AA 61C3 61DD 61F5 621B 6225 6228
6298 62AC 62D7 632F 6337 650D 6511 6517 651F 6543
```

Table 1 continues

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Table 1 continued

654A 658E 65A3 65C3

Change bytes at these addresses from 47 to 59: (relocation)
5F9D 6077 6095 60B7 665B 66F7 6704 6735 6744 679C

Change bytes at these addresses from 48 to 5A: (relocation)
6642 664B 664E 6660 6665 6671 6675 667C 669C 66A3
66A6 66B5 66C9 66E1 66EA 66ED 66FA 6707 6710 673B
6741 6791 679F 67A9 67B0 67B8 67C2 6825

Change bytes at these addresses from 49 to 5B: (relocation)
608F 6732 6828

Change at 5F8A to 5F8F: (enable Break key & disable
from xx xx xx xx xx xx interrupts)
to 3E C9 32 0C 40 F3

Change bytes at these addresses

from 4D to 5F: 5F92 (relocation of initial block move)

from F0 to 00: 6080 608C (relocation of source buffer)

from 73 to 89: 6081 608D " " " "

from 56 to 68: 6089 (relocation of editor p-code)

from 5F to 71: 608B (relocation of compiler p-code)

from BF to FF: (for 48k systems only) 6091 6093 (memory
size)

from 0C to 23: 676D 6773 (space for DOS DCB + 3)

from F2 to 56: 6750 677E (relocation of command buffer)

from 40 to 88: 6751 677F (" " " ")

from 12 to F2: 67CF (remainder of the changes are

from 02 to 52: 67D0 patches for the cassette loader)

from 22 to CD: 6802

from 98 to F9: 6803

from 35 to CC: 680D

from 02 to 53: 680E

from 77 to 00: 680F

from 2B to 1B: 682F

from EB to 00: 6830

Change at 5FF2 to 5FFD

from xx xx xx xx xx xx xx xx xx xx xx xx

to CD 12 02 11 00 89 C9 ED 53 98 52 C9

Change at 60CC to 60D1:

from xx xx xx xx xx xx

to CD 35 02 12 13 C9

Change bytes at these addresses

from 4C to 47: 6658 (change 'L' to 'G' for cassette load)

from 57 to 53: 665D (change 'W' to 'S' for cassette save)

from 95 to F0: 6664 (patch extension to monitor)

from 5A to 85: 6665 (" " " ")

Table 3

commands for the equivalent disk operations because I still tended to type LS when I wanted to load a source file from disk. Since I expected to use the cassette routines rarely after the initial rush to store cassette programs on disk, changing the names of the cassette commands caused no inconvenience.

To access these extensions to Tiny Pascal, the monitor must recognize the new commands and jump to the required routine. Program Listing 2 is the Assembly code for the extended monitor and routines. The comments

with the program describe its operation.

For the disk operations, the return opcode at 400CH is replaced by a jump; this is restored upon completion of disk I/O to reenable the break key. I have used the standard DOS Open and INIT calls, as well as the write-byte-to-disk (Call 1BH) and read-byte-from-disk (Call 13H) routines.

Because p-code can contain bytes of any value, an EOF byte cannot be defined. Thus, my routines store the byte count of the p-code program as the first two bytes of the file, followed by

the p-code. The byte count information is then used by the loader to determine the number of bytes to read.

Add the hex code to PASCAL/CMD by using Debug or creating the file using EDTASM. First, load the PASCAL/CMD file you created previously. Then enter Debug and type the hex code into locations 85F0H-8755H, or load the assembled EDTASM object code. Finally, patch these new routines into PASCAL/CMD and change the names of the cassette commands. Table 3 lists the addresses of the four bytes to be changed, along with the old and new values.

Then enter the following command:

```
DUMP PASCAL/CMD (START = X'5F8A',
END = X'8755',TRA = X'5F8A')
```

You should now have a fully operational disk version of Tiny Pascal. The disk I/O routines incorporate error-checking and display the conventional DOS error messages. Note that there must be only one space between a disk command (such as LS) and the file name. You can stop the print routine at any time by pressing the break key. This allows you to escape if you accidentally try to print a long file or if you don't have a printer connected. That's right—no more computer hangups!

I have tried this Tiny Pascal with TRSDOS 2.3, NEWDOS 2.1, and NEWDOS80. When a disk error occurs in TRSDOS, the message displayed is followed by meaningless graphics that scroll the message off the screen. However, control still returns to the monitor. I don't know why this occurs since I used a documented TRSDOS call.

Finally, the routine that loads source code from disk is compatible with word processors such as Scripsit and Electric Pencil. The routine accepts the ASCII characters between 20H and 7FH, carriage return (0DH), and the Tiny Pascal editor tab character (09H). Any other hex code is interpreted as the EOF byte. Scripsit users should save the files with the ASCII option. Deleting to the end of text after the last character is also a sensible precaution to avoid garbage after the last valid character (which should be an end-of-line marker). Also, the only control character used should be the end-of-line marker—include no formatting instructions!

Disk Tiny Pascal is quite a powerful package for applications requiring only integer arithmetic. Now all you disk users can publish programs written in Tiny Pascal! ■

Command	Function
SS filespec	Save source program on cassette (same as old WS)
SP filespec	Save P-code on cassette (same as old WP)
GS filespec	Get source program from cassette (same as old LS)
GP filespec	Get p-code from cassette (same as old LP)
WS filespec	Save source program on disk
WP filespec	Save p-code on disk
LS filespec	Load source program from disk
LP filespec	Load p-code from disk
P	Print source program
X	Return to DOS

Table 2

```

00100 ;
00110 ;
00120 ;
00130 ;
00140 ;
00150 ;***** PROGRAM TO MOVE TINY PASCAL *****
00160 ;
00170 ; WRITTEN BY D.M. SILVER 12TH NOV. 1981
00180 ; 15 HOWARD ST. KEW 3101. VIC. AUSTRALIA
00190 ;
9000      00200      ORG      9000H
9000 21EF73 00210 MOVE    LD      HL,73EFH      ;END OF TINY PASCAL
9003 11EF85 00220      LD      DE,85EFH      ;DESTINATION
9006 016026 00230      LD      BC,2660H     ;BYTE COUNT
9009 EDB8    00240      LDDR     ;MOVE IT
900B C30000 00250      JP      0          ;REBOOT SYSTEM
9000      00260      END      MOVE
00000 TOTAL ERRORS
```

Program Listing 1

```

00100 ;
00110 ;
00120 ;
00130 ;
00140 ;
00150 ;***** EXTENSIONS FOR DISK TINY PASCAL *****
00160 ;
00170 ; WRITTEN BY D.M. SILVER 12TH NOV. 1981
00180 ; 15 HOWARD ST. KEW 3101. VIC. AUSTRALIA
00190 ;
00200 ;***** CONTINUATION OF MONITOR *****
00210 ;
85F0      00220      ORG      85F0H
85F0 FE58 00230 MONCTD CP      'X'      ;TEST FOR RETURN TO DOS COMMAND
85F2 CA4E87 00240      JP      Z,EXIT
85F5 FE50 00250      CP      'P'      ;TEST FOR PRINT COMMAND
```

Listing 2 continued

```

85F7 CA1787 00260 JP Z,PRINT
85FA FE4C 00270 CP 'L' ;TEST FOR DISK LOAD COMMAND
85FC C20F86 00280 JP NZ,TESTW
85FF CD825A 00290 CALL 5A82H ;GET CHARACTER FOLLOWING 'L'
8602 FE53 00300 CP 'S' ;TEST FOR LOAD SOURCE COMMAND
8604 CA9786 00310 JP Z,LS
8607 FE50 00320 CP 'P' ;TEST FOR LOAD P-CODE COMMAND
8609 CAC686 00330 JP Z,LP
860C C3955A 00340 JP 5A95H ;BAD COMMAND, RETURN TO MONITOR
860F FE57 00350 TESTW CP 'W' ;TEST FOR WRITE TO DISK COMMAND
8611 C2955A 00360 JP NZ,5A95H ;BAD COMMAND, RETURN TO MONITOR
8614 CD825A 00370 CALL 5A82H ;GET CHARACTER FOLLOWING 'W'
8617 FE53 00380 CP 'S' ;TEST FOR WRITE SOURCE CODE
8619 CA2486 00390 JP Z,WS
861C FE50 00400 CP 'P' ;TEST FOR WRITE P-CODE COMMAND
861E CA5A86 00410 JP Z,WP
8621 C3955A 00420 JP 5A95H ;BAD COMMAND, RETURN TO MONITOR
00430
00440
00450 ;***** WRITE SOURCE CODE TO DISK *****
00460
8624 3A8353 00470 WS LD A,(5383H) ;TEST FOR VALID SOURCE
8627 B7 00480 OR A
8628 CA365A 00490 JP Z,5A36H
862B CD0987 00500 CALL SETUP ;SET UP DOS CALL AND VECTOR
862E CD2044 00510 CALL 4420H ;CALL DOS INIT & TEST FOR ERROR
8631 C2FB86 00520 JP NZ,ERROR
8634 2A8053 00530 LD HL,(5380H) ;LOAD POINTER TO SOURCE CODE
8637 7E 00540 LOOP1 LD A,(HL) ;GET TEXT BYTE FROM BUFFER
8638 FEFF 00550 CP 0FFH ;TEST FOR END-OF-FILE
863A 2809 00560 JR Z,EOF1
863C CD1B00 00570 CALL 1BH ;WRITE BYTE TO DISK
863F C2FB86 00580 JP NZ,ERROR
8642 23 00590 INC HL ;UPDATE POINTER TO SOURCE CODE
8643 18F2 00600 JR LOOP1 ;LOOP FOR NEXT BYTE
8645 CD1B00 00610 EOF1 CALL 1BH ;WRITE EOF BYTE (FF) TO DISK
8648 C2FB86 00620 JP NZ,ERROR
00630
864B CD2844 00640 FINISH CALL 4428H ;CLOSE FILE
864E C2FB86 00650 JP NZ,ERROR
8651 F3 00660 DI ;DISABLE INTERRUPTS
8652 3EC9 00670 LD A,0C9H ;RESTORE BREAK KEY OPERATION
8654 320C40 00680 LD (400CH),A
8657 C34359 00690 JP 5943H ;RETURN TO MONITOR
00700
00710
00720 ;***** WRITE P-CODE TO DISK *****
00730
865A 3A8753 00740 WP LD A,(5387H) ;TEST FOR VALID P-CODE
865D B7 00750 OR A
865E CA275A 00760 JP Z,5A27H
8661 CD0987 00770 CALL SETUP ;SET UP DOS DCB AND VECTOR
8664 CD2044 00780 CALL 4420H ;CALL DOS INIT
8667 C2FB86 00790 JP NZ,ERROR
866A 2A8653 00800 LD HL,(5386H) ;CALCULATE LENGTH OF P-CODE
866D ED4B8453 00810 LD BC,(5384H)
8671 AF 00820 XOR A
8672 ED42 00830 SBC HL,BC
8674 23 00840 INC HL
8675 4D 00850 LD C,L ;STORE BYTE COUNT IN BC REG
8676 44 00860 LD B,H
8677 79 00870 LD A,C
8678 CD1B00 00880 CALL 1BH ;WRITE BYTE COUNT LSB TO DISK
867B C2FB86 00890 JP NZ,ERROR
867E 78 00900 LD A,B
867F CD1B00 00910 CALL 1BH ;WRITE BYTE COUNT MSB TO DISK
8682 C2FB86 00920 JP NZ,ERROR
8685 2A8453 00930 LD HL,(5384H) ;LOAD POINTER TO P-CODE
8688 7E 00940 LOOP2 LD A,(HL) ;GET BYTE OF P-CODE
8689 CD1B00 00950 CALL 1BH ;WRITE BYTE TO DISK
868C C2FB86 00960 JP NZ,ERROR
868F 23 00970 INC HL ;UPDATE POINTER TO P-CODE
8690 0B 00980 DEC BC ;UPDATE BYTE COUNT
8691 79 00990 LD A,C
8692 B0 01000 OR B
8693 20F3 01010 JR NZ,LOOP2 ;LOOP IF MORE BYTES TO WRITE
8695 18B4 01020 JR FINISH ;CLOSE FILE, ETC.
01030
01040
01050 ;***** LOAD SOURCE CODE FROM DISK *****
01060
8697 CD0987 01070 LS CALL SETUP ;SET UP DOS DCB AND VECTOR
869A CD2444 01080 CALL 4424H ;CALL DOS OPEN
869D C2FB86 01090 JP NZ,ERROR
86A0 2A8053 01100 LD HL,(5380H) ;LOAD POINTER TO SOURCE CODE
86A3 CD1300 01110 LOOP3 CALL 13H ;READ BYTE FROM DISK
86A6 C2FB86 01120 JP NZ,ERROR
86A9 FE0D 01130 CP 0DH ;TEST FOR VALID CHAR - MUST BE
86AB 280E 01140 JR Z,OK ;09H, 0DH, OR BETWEEN 20H & 7FH
86AD FE09 01150 CP 09H ;INCLUSIVE
86AF 280A 01160 JR Z,OK
86B1 FE20 01170 CP 20H
86B3 FABF86 01180 JP M,EOF2 ;IF NOT VALID CHAR, MUST BE EOF
86B6 FE7F 01190 CP 7FH
86B8 F2BF86 01200 JP P,EOF2
86BB 77 01210 OK LD (HL),A ;STORE BYTE IN TEXT BUFFER

```

```

86BC 23      01220      INC      HL          ;UPDATE POINTER TO SOURCE CODE
86BD 18E4    01230      JR        LOOP3     ;LOOP FOR NEXT CHARACTER
86BF 36FF    01240      LD        (HL),0FFH ;STORE EOF BYTE IN TEXT BUFFER
86C1 228253  01250      LD        (5382H),HL ;STORE END OF SOURCE ADDRESS
86C4 1885    01260      JR        FINISH    ;CLOSE FILE, ETC.
                01270
                01280
                01290 ;***** LOAD P-CODE FROM DISK *****
                01300
86C6 CD0987  01310      LP        CALL      SETUP ;SET UP DOS DCB AND VECTOR
86C9 CD2444  01320      CALL     4424H      ;CALL DOS OPEN
86CC C2FB86  01330      JP        NZ,ERROR
86CF 2A8053  01340      LD        HL,(5380H) ;LOAD POINTER TO P-CODE
86D2 228453  01350      LD        (5384H),HL ;STORE START OF P-CODE ADDRESS
86D5 CD1300  01360      CALL     13H        ;READ LSB OF BYTE COUNT FROM DISK

86D8 C2FB86  01370      JP        NZ,ERROR
86DB 4F      01380      LD        C,A
86DC CD1300  01390      CALL     13H        ;READ MSB OF BYTE COUNT FROM DISK

86DF C2FB86  01400      JP        NZ,ERROR
86E2 47      01410      LD        B,A        ;BYTE COUNT IS IN BC REG
86E3 CD1300  01420      LOOP4    CALL     13H      ;READ BYTE OF P-CODE FROM DISK
86E6 C2FB86  01430      JP        NZ,ERROR
86E9 77      01440      LD        (HL),A     ;STORE P-CODE IN BUFFER
86EA 23      01450      INC      HL          ;UPDATE POINTER TO P-CODE
86EB 0B      01460      DEC      BC          ;DECREMENT BYTE COUNT
86EC 79      01470      LD        A,C
86ED B0      01480      OR        B
86EE 20F3    01490      JR        NZ,LOOP4   ;LOOP IF MORE BYTES TO BE READ
86F0 2B      01500      DEC      HL
86F1 228653  01510      LD        (5386H),HL ;STORE END OF P-CODE ADDRESS
86F4 AF      01520      XOR      A
86F5 328353  01530      LD        (5383H),A  ;ZERO END OF SOURCE ADDRESS
86F8 C34B86  01540      JP        FINISH    ;CLOSE FILE, ETC.
                01550
                01560
                01570 ;***** DISK ERROR ROUTINE *****
                01580
86FB F680    01590      ERROR    OR        80H  ;SET UP DOS ERROR CODE
86FD CD0944  01600      CALL     4409H      ;DISPLAY DOS ERROR MESSAGE
8700 3EC9    01610      LD        A,0C9H    ;RESTORE BREAK KEY OPERATION
8702 320C40  01620      LD        (400CH),A
8705 F3      01630      DI
8706 C34359  01640      JP        5943H     ;RETURN TO MONITOR
                01650
                01660
                01670 ;***** SET UP DCB FOR DOS CALL *****
                01680
8709 115988  01690      SETUP    LD        DE,DCB+3 ;ADDRESS OF FILE NAME
870C 215687  01700      LD        HL,BUFFER ;ADDRESS OF BUFFER FOR DISK I/O
870F 0600    01710      LD        B,0        ;LRL=256 BYTES
8711 3EC3    01720      LD        A,0C3H    ;SET UP DOS VECTOR
8713 320C40  01730      LD        (400CH),A
8716 C9      01740      RET
                01750
                01760
                01770 ;***** PRINT ROUTINE *****
                01780
8717 3A8353  01790      PRINT    LD        A,(5383H) ;TEST FOR VALID SOURCE FILE
871A B7      01800      OR        A
871B CA365A  01810      JP        Z,5A36H
871E 2A8053  01820      LD        HL,(5380H) ;LOAD POINTER FOR SOURCE CODE
8721 7E      01830      PLOOP    LD        A,(HL)    ;GET BYTE OF TEXT
8722 FEFF    01840      CP        0FFH      ;TEST FOR END OF FILE
8724 CA4359  01850      JP        Z,5943H   ;RETURN TO MONITOR WHEN FINISHED
8727 FE09    01860      CP        9          ;TEST FOR TAB CHARACTER
8729 200C    01870      JR        NZ,F1
872B 3E20    01880      LD        A,20H     ;IF TAB, SUBSTITUTE WITH 3 SPACES
872D CD3D87  01890      CALL     PCHAR      ;PRINT SPACE
8730 3E20    01900      LD        A,20H
8732 CD3D87  01910      CALL     PCHAR      ;PRINT SPACE
8735 3E20    01920      LD        A,20H
8737 CD3D87  01930      P1       CALL     PCHAR      ;PRINT CHARACTER
873A 23      01940      INC      HL          ;UPDATE POINTER TO SOURCE CODE
873B 18E4    01950      JR        PLOOP     ;LOOP TO PRINT NEXT CHARACTER
873D 32E837  01960      PCHAR    LD        (37E8H),A ;PRINT CHARACTER
8740 CDC453  01970      WAIT    CALL     53C4H    ;CALL INKEY ROUTINE
8743 CA4359  01980      JP        Z,5943H   ;IF BREAK KEY, RETURN TO MONITOR
8746 3AE837  01990      LD        A,(37E8H) ;GET PRINTER STATUS
8749 CB7F    02000      BIT     7,A
874B 20F3    02010      JR        NZ,WAIT   ;LOOP WHILE BUSY
874D C9      02020      RET
                02030
                02040
                02050 ;***** RETURN TO DOS *****
                02060
874E 3EC3    02070      EXIT    LD        A,0C3H ;RESTORE DOS VECTOR
8750 320C40  02080      LD        (400CH),A
8753 C32D40  02090      JP        402DH     ;JUMP TO DOS
                02100
                02110
                02120 ;***** BUFFER AREAS *****
                02130
0100 02140      BUFFER  DEFS    256    ;BUFFER FOR DOS I/O
0023 02150      DCB     DEFS    35    ;COMMAND BUFFER AND DOS DCB
0000 02160      END
00000 TOTAL ERRORS

```

Charter subscribers to *80 Micro* remember the dark days...long hours spent typing in a program only to have it crash with a typing error. Since April 1981, Load 80 has been making such aggravation a thing of the past.

An ad in the April 1981 magazine introduced Load 80 as "a monthly dump of the major program listings in *80 Micro* computing on cassette."

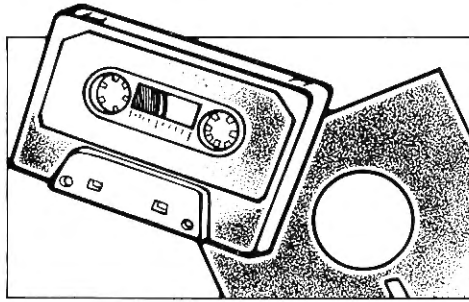
This column began in August 1981 as technical advice to Load 80 users, and in March 1982 Load 80 expanded to include disks. Originally conceived for the Model I/III only, Load 80 begins coverage of the Color Computer in December 1982, and now has plans to appear on a major networking service.

This Anniversary Reload 80 column is a complete guide to using Load 80.

Model I and III Load 80

Tapes for the Model I and III are available monthly for \$9.97 or at a yearly subscription rate of \$99.97. Each tape is 30 minutes long and recorded at 500 baud (the low rate for the Model III). The tapes usually include 12 or more programs totalling up to 100K bytes.

Disks for the Model I and III are \$19.97 each or \$199.97 for a year's subscription. The disks are Model I, single-density, 35-track data disks. They are ready to use in a Model I and in a Model III after using the TRSDOS



Index and guide to Load 80

Convert utility (see details below). The disk is two sided and can be flipped to read both sides. As with tapes, the disks include 12 or more programs.

A special Anniversary Load 80 is available for the Model I and III on both tape and disk for \$9.97 and \$19.97. Articles with programs included in Load 80 are marked with the Load 80 logo in the index and on the first page of the article. A complete list is also printed below in the Load 80 directory.

Back issues of all Load 80s are available. Some of the programs published in the last year include two machine-language monitors in April, a machine-language disk zapper in June/July, 23

games in August's game issue, and a Basic Compiler in October. A complete listing of all programs ever included on Load 80 is published in this special issue of *80 Micro*.

Color Computer Load 80 Cassettes

The first Color Computer Load 80 is available starting with the December 1982 *80 Micro*. This cassette version of the major 1982 Color Computer program listings is available for only \$14.97.

Subsequent Color Load 80s will be available every three months covering the past three issues of the magazine for only \$9.97. At the Color Computer's 1,500-baud rate, these 15-minute tapes are real bargains. Color Load 80 is not available for this special issue.

Documentation

The Load 80 documentation consists of a list of the programs, the language each is in, and a phone number and name to call if you need help. The documentation for the individual programs are the accompanying articles in *80 Micro*. If you don't read it you cannot expect to use Load 80.

Each program is the program listing as it appears in the magazine. Some programs include remark statements detailing changes needed to run under different systems. Your guide, however, should be the keybox on the first page of each article. If your system is not listed there, the program will probably not run correctly on it.

This column is also a valuable source of Load 80 information, on everything from loading tapes to modifying programs to run under different systems.

Model I/III Cassettes

Model I/III cassettes are written at 500 baud. Model III users must respond L to the CASS? prompt or type POKE 16913,0 to set the baud rate low. On the Model I with Disk Basic, type CMD"T" before loading any files.

Basic files are loaded by using CLOAD"file name." If you use disks, a simple SAVE"file name" will save the program to disk.

Loading tapes requires changing the volume on the recorder. Start at one end of the volume scale and work up if

Program	Title	Page	Comments
1	COPYRGHT/BAS	—	None
2	XASMZ865/BAS	130	None
3	STARTRCK/BAS	156	None
4	CASSREAD/BAS	164	None
5	CASSREAD/SRC	164	Needs EDTASM
6	GALLERY/BAS	190	None
7	SENTENCE/BAS	228	None
8	DSKCLEAN/BAS	238	None
9	SPCBOMBR/SRC	244	Needs EDTASM
10	DVMUSIC/BAS	253	None
11	DVMUSIC/SRC	253	Needs EDTASM
12	FLEXCAT1/BAS	264	None
13	FLEXCAT2/BAS	264	None
14	FLEXCAT3/BAS	264	None
15	CATALOGS/BAS	316	None
16	PROGRAMA/BAS	316	None
17	PROGRAMB/BAS	316	None

Anniversary Load 80 Directory

you have trouble. Other measures that might help are aligning the heads of the recorder (see September 1981 Reload 80), demagnetizing the heads, or cleaning the heads.

Model I/III Disks

Load 80 disks are supplied on TDOS (TinyDOS), the DOSPLUS 3.4 kernel. These disks are floppies, meaning that each side has data on it. To read the other side, simply flip the disk over.

Model I users can simply insert the disk in drive 0. Model III users must use Convert to copy the files to TRSDOS:

- Back up a copy of TRSDOS. Insert the back-up in 0 and remove the other disk.
- Type Purge and then the master

password for the back-up disk.

- Type Y for each file. It will be purged from the back-up disk.

- Insert the Load 80 disk in drive 1. Type Convert.

- Answer source as 1, destination as 0. The Load 80 files will be copied from the Load 80 disk onto the TRSDOS disk.

- Flip the Load 80 disk and repeat the last two steps.

All Load 80 files are now on your TRSDOS disk, ready for use.

Basic files are loaded by entering Disk Basic and typing LOAD“file name.” Remember that if a program is written for a cassette-based machine, it might not run on your system.

Using Assembly-Language Files

Many utilities and high-speed games

are written in machine language. These programs are a numeric code immediately recognizable to the computer. For instance, the sequence of numbers 33,0,60,54,65 means “place a 65 in memory address 15360.”

Machine-language programs are written using Assembly language, which uses more English-like instructions than machine language. For example:

```
LD HL,15360
LD (HL),65
```

means the same as the sequence of numbers above. Instructions like this are called source code and must be assembled into machine language before being executed.

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of modifying the program, Load 80 sells programs in Assembly language, not machine language. This requires that you own an editor/assembler, a program that writes (edits) Assembly language and assembles it. Two such programs are EDTASM from Radio

Shack and EDTASM-Plus from Apparat. Not all editor/assemblers will load files from both tape and disk, so be sure you buy the right one.

Radio Shack introduced their disk version of EDTASM later than many other companies and made their source

code incompatible. For this reason Load 80 uses the Apparat format for source code. If you are buying Load 80 disks be sure to buy an editor/assembler that uses the same format.

Basic programs do not, of course, require an editor/assembler. ■

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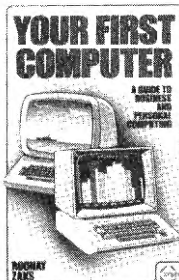
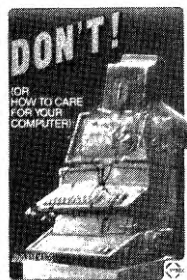
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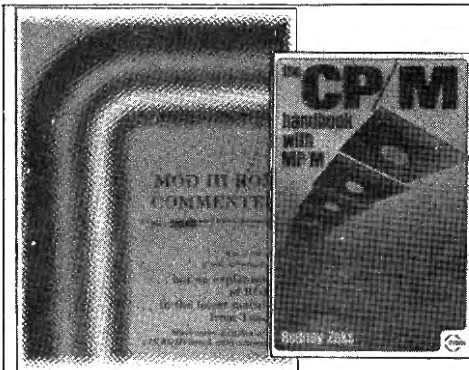
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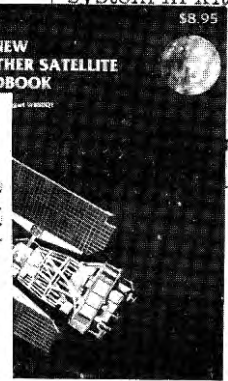
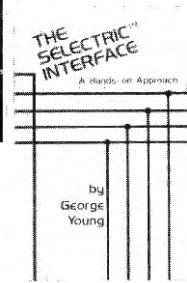
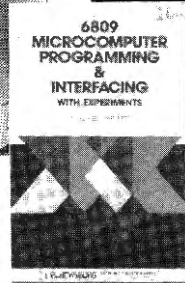
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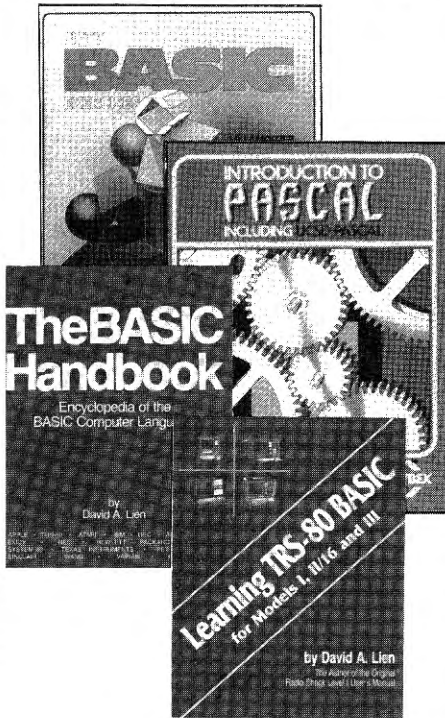
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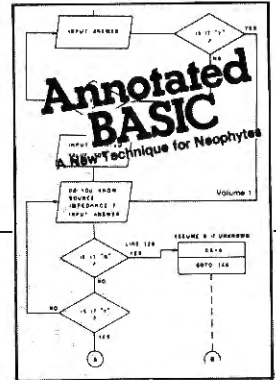
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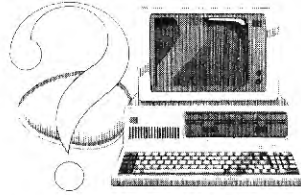
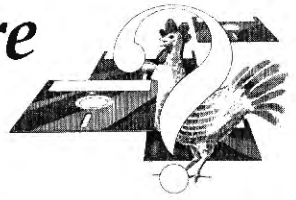
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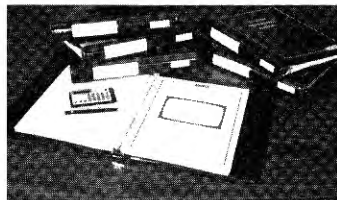
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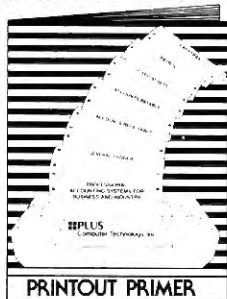


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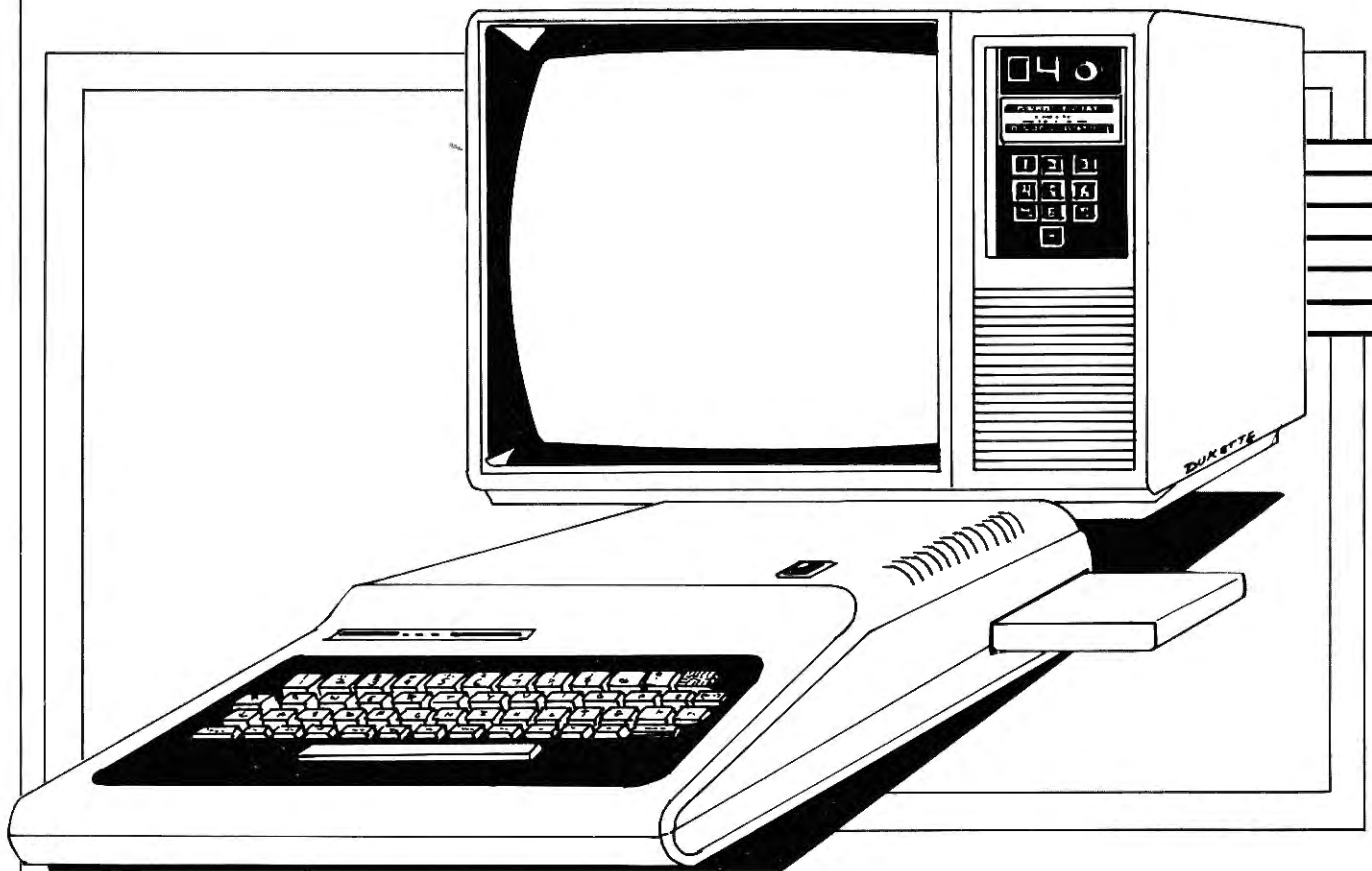
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Part III.

COLOR

COMPUTER



Teach Your CC New Words

by Allen Curtis

The size and versatility of the Color Computer's Basic vocabulary is more than adequate for the majority of programs. However, there are occasions when it would be convenient to use statements, commands, or functions not available in the Color Computer's vocabulary.

Microsoft, writers of the Color Computer's Basic interpreter, have developed a systematic procedure for adding Extended Color Basic key words to the Color Basic vocabulary, and in turn adding Disk Basic key words to the Extended Color Basic vocabulary. I will describe this procedure. I will also

Add commands, statements, and functions to Color Basic and gain more computing power.

demonstrate a more economical way of drawing and animating graphics.

ROM Tables

A machine-language subroutine corresponds to each Basic word in the Color Computer's vocabulary in the associ-

ated ROM. In the Color Basic ROM there are two tables of Color Basic key words and two associated tables of addresses. The addresses are the entry addresses to the subroutines that execute the statements, commands, or functions associated with the Basic key words. The first Basic key-word table is

The Key Box

**Color Computer
16K RAM
Extended Color Basic**

Color Basic Word	Subroutine Entry	Token
FOR	AD47	80
GO	AE86	81
REM	AEE3	82
'	AEE3	3A83
ELSE	AEE3	3A84
IF	AF14	85
DATA	AEE0	86
PRINT	B8F7	87
ON	AF42	88
INPUT	AFF5	89
END	AE02	8A
NEXT	B0F8	8B
DIM	B34E	8C
READ	B046	8D
RUN	AE75	8E
RESTORE	ADE4	8F
RETURN	AEC0	90
STOP	AE09	91
POKE	B757	92
CONT	AE30	93
LIST	B764	94
CLEAR	AE41	95
NEW	AD17	96
CLOAD	A498	97
CSAVE	A44C	98
OPEN	A5F6	99
CLOSE	A416	9A

LLIST	B75E	9B
SET	A880	9C
RESET	A8B1	9D
CLS	A910	9E
MOTOR	A7BD	9F
SOUND	A94B	A0
AUDIO	A990	A1
EXEC	A53E	A2
SKIPF	A5EC	A3
TAB(		A4
TO		A5
SUB		A6
THEN		A7
NOT		A8
STEP		A9
OFF		AA
+		AB
-		AC
*		AD
/		AE
		AF
AND		B0
OR		B1
>		B2
=		B3
<		B4

Table 1

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located at addresses AA66-AB19, where the addresses are in hexadecimal notation.

The table of subroutine entry addresses associated with the key-word table is located at addresses AB67-ABAE (Table 1). In Table 1 the Token column is not part of either ROM table, but I included it for the sake of completeness.

When you key in a Basic program, the Basic key words you type are not

stored in that form in memory. To conserve memory space, the Basic interpreter encodes these key words into tokens. The tokens for the Basic key words in Table 1 range from hexadecimal 80-B4. The Basic interpreter uses the ROM tables in Table 1 to translate each key word therein to its corresponding token.

The ROM table of subroutine addresses does not include addresses for the final 17 words of Table 1. These key

words are suffixes and operators whose subroutines are parts of other ROM subroutines. Assembly-language programmers wanting to incorporate some of the subroutines into their programs will find the information in Tables 1-6 helpful.

The other word table in the Color Basic ROM is devoted to key words for functions. This table starts at address AB1A and ends at AB66. Its associated subroutine entry-address table is located

Color Basic Word	Subroutine Entry	Token
SGN	BC7A	FF80
INT	BCEE	FF81
ABS	BC93	FF82
USR	0112	FF83
RND	BF1F	FF84
SIN	BF78	FF85
PEEK	B750	FF86
LEN	B681	FF87
STR\$	B4FD	FF88
VAL	B716	FF89
ASC	B6A0	FF8A
CHR\$	B68C	FF8B
EOF	A5CE	FF8C
JOYSTK	A9C6	FF8D
LEFT\$	B6AB	FF8E
RIGHT\$	B6C8	FF8F
MID\$	B6CF	FF90
POINT	A8F5	FF91
INKEY\$	A564	FF92
MEM	B4EE	FF93

Table 2

Extended Color Basic Word	Subroutine Entry	Token
ATN	8EB0	FF94
COS	8378	FF95
TAN	8381	FF96
EXP	84F2	FF97
FIX	8524	FF98
LOG	8446	FF99
POS	86AC	FF9A
SQR	8480	FF9B
HEX\$	8BDD	FF9C
VARPTR	86BE	FF9D
INSTR	877E	FF9E
TIMER	8968	FF9F
PPOINT	9339	FFA0
STRING\$	874E	FFA1

Table 4

Extended Color Basic Word	Subroutine Entry	Token
DEL	8970	B5
EDIT	8533	B6
TRON	86A7	B7
TROFF	86A8	B8
DEF	8871	B9
LET	AF89	BA
LINE	93BB	BB
PCLS	9532	BC
PSET	9361	BD
PRESET	9365	BE
SCREEN	9670	BF
PCLEAR	968B	C0
COLOR	9546	C1
CIRCLE	9E9D	C2
PAINT	98EC	C3
GET	9755	C4
PUT	9758	C5
DRAW	9CB6	C6
PCOPY	9723	C7
PMODE	9621	C8
PLAY	9A22	C9
DLOAD	8C18	CA
RENUM	8A09	CB
FN		CC
USING		CD

Table 3

Disk Basic Word	Subroutine Entry	Token
DIR	CBCF	CE
DRIVE	CDE9	CF
FIELD	CFE0	D0
FILES	D080	D1
KILL	C6C2	D2
LOAD	C99A	D3
LSET	D026	D4
MERGE	C98B	D5
RENAME	CF3F	D6
RSET	D025	D7
SAVE	C932	D8
WRITE	CF8A	D9
VERIFY	D65B	DA
UNLOAD	D146	DB
DSKINI	D4AB	DC
BACKUP	D175	DD
COPY	D2CC	DE
DSKI\$	D3FF	DF
DSKO\$	D474	E0

Table 5

Disk Basic Word	Subroutine Entry	Token
CVN	CD1A	FFA2
FREE	CDC0	FFA3
LOC	CD36	FFA4
LOF	CD5B	FFA5
MKN\$	CD28	FFA6
AS	B277	FFA7

Table 6



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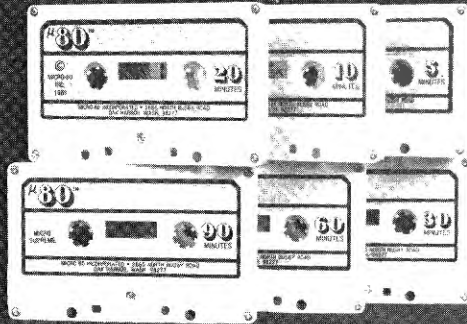
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ed at addresses AA29-AA50. These two ROM tables combine to form Table 2. The tokens for the function key words require two bytes each.

In the Extended Color Basic and Disk Basic ROMs, there are tables analogous to those in Tables 1 and 2. Their locations are at addresses 8183-81EF, 81F0-821D, 821E-8256, 8257-8272, C17F-C1DA, C1DB-C200, C201-C213, and C214-C21F. The substance of these ROM tables is in Tables 3, 4, 5, and 6.

Auxiliary RAM Control Bytes

In the auxiliary RAM (addresses 0000-03FF) of the Extended Color Basic ROM there are bytes used to control the Basic interpreter's action in determining from the current token which subroutine entry to make. These control bytes are located at addresses 0120-013D. At 0120 is the number of Color Basic key words in the ROM table that is part of Table 1. The two bytes at 0121 and 0122 point to this ROM table of Color Basic key words. The succeeding two bytes point to the associated ROM table of subroutine entry addresses.

The succeeding five addresses, 0125-

0129 serve similar purposes for the ROM tables associated with Table 2. The next five bytes diverge somewhat from the established pattern. The byte at 012A contains the number of key words in the Extended Color Basic ROM shown by Table 3.

The bytes at 012B and 012C point to the ROM table of Extended Color Basic key words. The divergence occurs at 012D and 012E. These bytes point to a subroutine that helps determine the subroutine entry address for tokens B5-CB. The subroutine also takes care of tokens FF90 and FF9F.

The bytes at addresses 012F-0133 have a purpose similar to the previous five bytes. The final two bytes at 0132 and 0133 point to a subroutine that helps determine the subroutine entry addresses for tokens FF94-FFA1, with the exception of FF90 and FF9F.

The two subroutines that help in determining subroutine entry addresses also provide exits to addresses stored at 0137, 0138 and 013C, 013D. When the Color Computer does not have a Radio Shack Disk System, these latter addresses lead to a subroutine that sends the SN error message to the screen. When the machine does have a Disk

System, the 10 bytes in locations 0134-013D have properties analogous to the preceding 10 bytes.

HPOKE, EXG, and EOR

The following two statements are extremely valuable additions to Extended Color Basic.

● A POKE-like statement that transfers hexadecimal bytes to successive RAM addresses: For example, HPOKE &H2900,CE,3E,9C,8E,C1,7F,C6,5C,BD,A5,9A sends the bytes CE, 3E, . . . 9A to addresses 2900-290A. HPOKE provides a convenient means of typing in machine-language programs. It also greatly simplifies the use of elegant string-packing techniques. HPOKE eliminates the need for the slow Read, Data, POKE loops used in string packing. Ironically, string packing is used in the program that adds HPOKE to the Extended Color Basic vocabulary. HPOKE is also the key to a new high-resolution graphics technique.

● A single statement that quickly does the equivalent of:

```
FOR I=0TO3
  B=PEEK(VARPTR(A$(X))+1)
  POKEVARPTR(A$(X))+1,
```

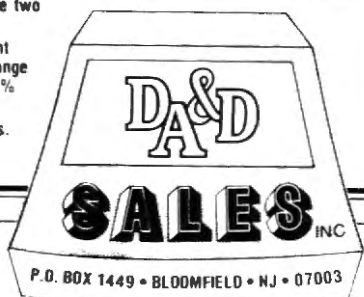
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```
PEEK(VARPTR(A$(Y))+1)
POKEVARPTR(A$(Y))+I,B
NEXT
```

without using variables I and B. This statement, called EXG, quickly exchanges two strings. Suppose A\$ = "FIRST" and B\$ = "SECOND". After the execution of EXG(A\$,B\$), then A\$ = "SECOND" and B\$ = "FIRST". The loop

```
FORI = A TON
EXG(A$(I),A$(I+1))
NEXT
```

can be invaluable in rapid string sorts.

A useful tool for specialists is the EOR function. C = EOR(A,B) executes twice as fast as its equivalent C = (NOTA AND B)OR(A AND NOTB).

Adding to Basic's Vocabulary

The following are the steps I use to add to the Basic vocabulary. You can use this general procedure to add words of your own.

First, write subroutines for HPOKE, EXG, and EOR and assign them to RAM locations. Choose high RAM addresses that you can protect using the Clear statement. For a 16K RAM, use

```
20 REM ** THERE ARE 210 SPACES IN STRING OF LINE 30. **
30 A$=""
```

```

40 X=VARPTR(A$)+2:X=256*PEEK(X)+PEEK(X+1)
50 FORI=X TOX+209
60 READJ
70 POKEI,J
80 NEXT
100 DATA2,&H3F,&H57,&H3F,&H68,1,&H3F,&H63,&H3F,&H77
110 DATA&H34,&H60,&H30,&H8C,&HF1,&HCE,1,&H34,&HC6,&HA,&HBD,&HA5,
&H9A,&H6F,&HC4,&H7F,1,&H43
120 DATA&HCE,&H3F,&H57,&H30,&H8C,7,&HC6,&HB8,&HBD,&HA5,&H9A,&H35,
&HE0
130 DATA&H48,&H50,&H4F,&H4B,&HC5,&H45,&H58,&HC7,&H3F,&H85,&H3F,&
HBC
140 DATA&H45,&H4F,&HD2,&H3F,&HE5
150 DATA&H81,&HD0,&H25,3,&H7E,&HB2,&H77,&H8E,&H3F,&H5F,&H80,&HCE,
&H7E,&HAD,&HD4
160 DATA&HCl,&H44,&H23,2,&H20,&HEF,&HC0,&H44,&H8E,&H3F,&H66,&H7E,
&HB2,&HCE
170 DATA&HBD,&HB7,&H3D,&H9D,&HA5,&H81,&H2C,&H26,&H2D
180 DATA&H8D,&H10,&H48,&H48,&H48,&H48,&H34,2,&H8D,8,&HAB,&HE0
190 DATA&HA7,&H80,&H9D,&H9F,&H20,&HE8,&H9D,&H9F,&H81,&H30,&H25,&
HC
200 DATA&H81,&H3A,&H25,&HF,&H81,&H41,&H25,4,&H81,&H47,&H25,5
210 DATA&H32,&H62,&H7E,&HB2,&H77,&H80,7,&H80,&H30,&H39
220 DATA&HBD,&HB2,&H6A,&HBD,&HB3,&H57,&H34,&H10
230 DATA&HBD,&HB2,&H6D,&HBD,&HB3,&H57,&H35,&H40,&HA6,&HC4
240 DATA&HE6,&H84,&HA7,&H81,&HE7,&HCl,&HBD,6,&H8D,4,&HBD,&HB2,&H
67
250 DATA&H39,&HA6,&HC4,&HE6,&H84,&HA7,&H80,&HE7,&HC0,&H39
260 DATA&HBD,&HB2,&H6A,&HBD,&HB7,&H3D,&H34,&H10,&HBD,&HB2,&H6D,&
HBD,&HB7,&H3D
270 DATA&HBD,&HB2,&H67,&H1F,&H10,&HA8,&HE0,&HE8,&HE0,&HBD,&HB4,&
HF4,&H39
```

Program Listing 1

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change the &H3Fs in lines 100 and 120-160 to &H7Fs.

If you own a 16K Color Disk System you must make the following changes: In line 110 replace the second &H34 with &H3E. Also in line 110, replace the last item &H43 with &H4D. In line 150 replace &HD0 and &HCE with &HE3 and &HE1, respectively. In line 160 replace each &H44 with &H50.

Programs that add key words to the Basic vocabulary have one restriction. You must not use the first three USR functions—USR0, USR1, and USR2—after those programs have been executed. This is no real hardship because the addition of key words reduces the need for USR functions, and you may add to the Basic vocabulary a larger set of USR-like functions of your own. The restriction applies only to Extended Color Basic and *not* to Disk Basic.

Carefully type in Program Listing 1, save it on tape or disk, and run it.

After the program has been executed, there is no need for any of the lines except 30 and 40. Therefore, delete line 20 along with lines 50-270. Then augment the program by adding the following lines:

*"If you have a
Color Computer,
change line 10 to
CLEAR200,&H7F57."*

```
10 CLEAR200, &H3F57
50 DEFUSR = X + 10
60 X = USR(0)
70 NEW
```

If you have a 32K Color Computer, change line 10 to CLEAR200,&H7F57. The augmented program is its final form. Save it on tape or disk before you run it.

Some Examples

These example programs illustrate HPOKE, EXG, and EOR. If they do not work as described, you may not have keyed in Program Listing 1 correctly.

Program Listing 2 is entitled Caterpillar. It moves a caterpillar-like graphics creature across the screen. I devel-

oped HPOKE primarily for facilitating string packing, but Program Listing 2 shows HPOKE's utility in the composition of economical graphics programs, using only 238 bytes.

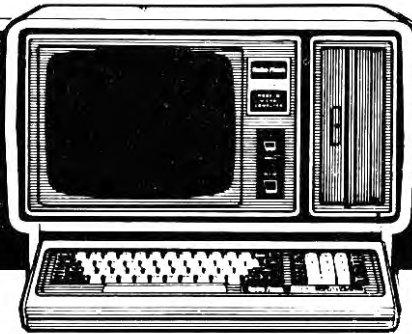
Program Listing 3 is similar to Listing 2. It uses the Color Computer's Draw, Get, and Put statements to move the caterpillar across the screen, but at a cost of 330 bytes.

The HPOKE graphics program requires only 72 percent of the bytes needed using the conventional graphics statements. This example indicates that you may expect potentially high savings using HPOKE for large graphics programs.

Program Listing 4 prints 1E3F on the screen.

Program Listing 5 prints on the first five screen lines the words first, second, third, fourth, and fifth, respectively. The words second, third, fourth, fifth, and first should appear on the seventh to eleventh lines of the screen. ■

H. Allen Curtis is self-employed and has degrees from William and Mary, MIT, and Harvard. He lives at 172 Dennis Drive, Williamsburg, VA 23185.



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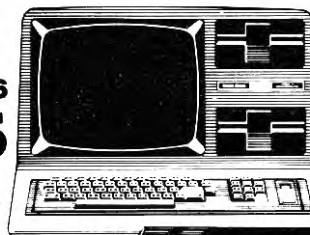
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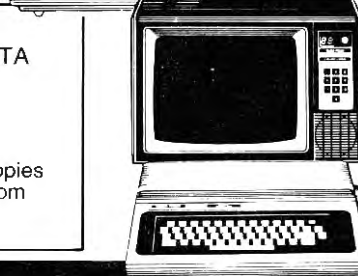
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Games in Color

by Robert Toscani

These games for the Color Computer will test you, amuse you, and frustrate your friends!

Dave McGlumphy's program that imitated the hand-held game, Simon (*80 Micro*, August 1981), is a natural for the Color Computer. I rewrote his program to fit my 16K Extended Color Basic computer, but I have written a 4K version as well.

I often let print statements run together, and to prevent words from being cut in half, I add and remove spaces as needed. So, my lines may have long spaces or no space where one should be, but this keeps the text neat. If necessary, you could compress many of the lines to save memory.

In my version of Simon, lines 45-55 are the color test. Line 60 tells you which letter to push for each color.

Line 75 controls time. The higher the difficulty level, the less time a color is shown, and the less time you have to press buttons. Line 80 determines if the color pattern repeats with each new color or not.

Line 185 is the base line for the 12-piece color sequence. Line 190 randomizes the color selections and line 200 starts the game. The 50-Y*9 at the end is length of time the color appears.

Line 195 compares the answers in the right order, as will be shown later. Lines 210-394 present each color while the IFX= lines determine when to stop.

Lines 400-405 set the screen to black, clear the computer for your answer, and set up the timing loop. Line 410 gives the letter answer a numerical value for comparison in lines 430-540. This is where N comes in, to make sure you're comparing the right color question and

letter answer.

If you've made an error, lines 570 and 900-910 tell you, and if you've run out of time before pressing the button, lines 950-980 let you know.

Line 800 plays and shows your answer. If it's correct, lines 810 and 815 determine if you have more buttons to press in that run. If the sequence is up to four colors, you have to press four buttons. Press all four in the correct order and you move up one to five colors. Lines 850 and 860 end the game when the maximum 12-color sequence has run and determine which of the winning answers you get.

These winning answers are in lines 1000-1170 along with some music and the option of playing again or ending the program.

Takeaway

The second game I altered is Richard Ramella's *Tanterian Takeaway*, from *80 Micro*, December 1981. The program runs on the Color Computer without modification, but I added graphics and wrote another version for two players.

In both versions, you take turns moving from one to ten jewels from one box to another. The winner is the one who moves the 100th jewel, and in the one-person game, the computer always wins. I'll explain why later, but first I'll point out the changes I've made in the one-person program.

Up to line 85, the programs are almost identical. Line 100 starts the graphics. From 100-170, the two boxes are set with the blue one containing 100

jewels. Lines 180-240 remove the jewels from the blue box and place them in the red box. Line 260 determines whose turn it is.

Line 275 starts the game proper and the rest of the program controls it. Most of the listing is self-explanatory, except for the 11-X moves the computer makes. This is the key to the computer's winning. The computer will always move first with one and from then on will take your move and add on enough to move up 11. For example, the computer moves one, you move seven for a total of eight, and the computer moves four for a game total of 12. Then you move five and the computer moves six for a total of 23. But in each case, the computer moved up by 11.

After playing the game a few times, you'll see the computer always ends on the same numbers: 1, 12, 23, 34, 45, 56, 67, 78, 89, and 100. Each number is 11 higher than the last. Realizing this, I knew a two-person game could be written that would allow either person to move first, but would let me win because I knew the key numbers. I could get onto them at some point and from then on move up by 11.

With that in mind, I wrote the program that you can play with your friends and win, as long as they don't know the key numbers. Since the program picks the starter at random, I suggest you keep your beginning moves random and not get onto the key sequence until at least half the jewels are moved. This way, your opponent will be quite mystified by your constant winning.

My program, *My Owner*, begins by explaining the rules. Line 80 picks a number that decides who starts. Lines 100-240 are almost the same as the other program. They set up the boxes and lights and move them in accordance with the number picked. These lines have some differences from the previ-

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↗131

ous program, so it's best to type them in anew.

The same applies to lines 250-500. The value of Q determines whose turn it is to move and sends the program to the proper line.

Lines 500 and up are the ending remarks. On the off chance you lose, I've enclosed the appropriate comments. You can also play again without letting the program end.

So, you now have two programs with which to astonish friends and make enemies. The first program has one bug. When the computer makes the first move of one, a dot appears in the red box, but one dot does not wink out in the blue. But, the first dot disappears from the blue box, along with the others, as soon as the next move is made.

Math Test

The third program is a math test. Lines 20 and 40 let you pick the numbers that provide the computer with the numbers for the question pool.

Line 50 lets you pick addition, subtraction, multiplication, or division as the math to be tested on. In subtraction, if the second number is larger than the first, the answer will be negative. To prevent that, answer N to line 55.

Line 60 sets the time limit per problem in seconds, while line 70 lets you pick the total number of problems to be asked and even cut the test short if you answer a given number of questions correctly. The time limit should be no more than 90 to prevent problems with the display.

Line 85 keeps a count of the total questions asked, and line 120 starts the timer. Line 110 asks the question.

Line 121 prints a red bar along the bottom as a visual indication of the time. It decreases by one for each second that ticks off, which is line 132. Also, when half the time has passed, lines 126 and 142 come into play, flashing the message, "Hurry," across the screen.

Lines 122, 125, and 128 set the computer to receive your answer. Line 130 prints it, along with the time, and line 145 completes the loop, enabling the computer to count down. Depending on the moment you press the key, the number may not appear for another second. The computer has to loop to the print command again. Don't hold the key down, just press it in a normal manner. A related problem is that you cannot correct a mistake.

After putting in the complete answer, press enter to break the loop.

Line 147 produces the correct answer

Program Listing 1

```
1 REM CC SIMON BY ROBERT TOSCANI, 4744 WHITAKER AVE. PHILA. PA.
19120
10 CLS
20 PRINT@128,STRING$(32,"*"):PRINT@288,STRING$(32,"*"):PRINT@204
,"CC SIMON"
22 PLAY "T3O3L4CFGAFAGCFPGAL2FL4E"
25 CLS
30 PRINT"THIS GAME IS BASED ON SIMON. THE SCREEN WILL SHOW DIFFE
RENT COLORS. YOU HAVE TO PRESS THE RIGHT LETTER IN THE RIG
HT SEQUENCE."
35 PRINT"WE'LL SHOW THE COLORS AND THE MATCHING LETTERS NOW."
40 FORZZ=1TO3000:NEXTZZ
45 FORAA=1TO63:FORBB=1TO31
50 CC=INT(AA/8+1)
55 SET(AA,BB,CC):NEXTBB,AA
60 PRINT" G Y B R W C M O"
65 PRINT"PRESS ANY KEY TO CONTINUE"
70 C$=INKEY$:IF C$="" THEN70
75 INPUT"PICK LEVEL 1(EASY)-5(HARD)";Y
80 INPUT"DO YOU WANT THE COLOR SEQUENCE TO CHANGE WITH EACH NEW
COLOR, Y(HARDER) OR N(EASIER)";B$
85 CLS
90 PRINT"OK, THE GAME WILL START WITH ONECOLOR AND INCREASE BY O
NE WITH EACH CORRECT ANSWER. WHEN THE SCREEN GOES BLACK, THAT
'S YOUR SIGNAL TO BEGIN PRESSING BUTTONS"
95 PRINT"AND REPEAT THE SEQUENCE.WHEN YOU'RE READY, PRESS ANY
KEY TO START."
100 C$=INKEY$:IFC$="" THEN100
185 X=1
190 A=RND(8):D=RND(8):E=RND(8):F=RND(8):H=RND(8):I=RND(8):J=RND(
8):K=RND(8):L=RND(8):P=RND(8):Q=RND(8):S=RND(8)
195 N=1
200 CLS(0):FORZZ=1TO190:NEXTZZ:CLS(A):SOUND40+20*A,50-Y*9
210 IF X=1 THEN 400
230 CLS(D):SOUND40+20*D,50-Y*9
240 IF X=2 THEN 400
250 CLS(E):SOUND40+20*E,50-Y*9
260 IF X=3 THEN 400
270 CLS(F):SOUND40+20*F,50-Y*9
280 IF X=4 THEN 400
290 CLS(H):SOUND40+20*H,50-Y*9
300 IF X=5 THEN 400
310 CLS(I):SOUND40+20*I,50-Y*9
320 IF X=6 THEN 400
330 CLS(J):SOUND40+20*J,50-Y*9
340 IF X=7 THEN 400
350 CLS(K):SOUND40+20*K,50-Y*9
360 IF X=8 THEN 400
370 CLS(L):SOUND40+20*L,50-Y*9
375 IF X=9 THEN 400
380 CLS(P):SOUND40+20*P,50-Y*9
385 IF X=10 THEN 400
388 CLS(Q):SOUND40+20*Q,50-Y*9
392 IF X=11 THEN 400
394 CLS(S):SOUND40+20*S,50-Y*9
400 CLS(0):T=0
403 A$=INKEY$:T=T+1:IF T=500-(Y*75) THEN 950
405 IF A$="" THEN 403
410 IF A$="G" THEN Z=1 ELSE IF A$="Y" THEN Z=2 ELSE IF A$="B" TH
EN Z=3 ELSE IF A$="R" THEN Z=4 ELSE IF A$="W" THEN Z=5 ELSE IF A
$="C" THEN Z=6 ELSE IF A$="M" THEN Z=7 ELSE IF A$="O" THEN Z=8
430 IF N=1 AND Z=A THEN 800
440 IF N=2 AND Z=D THEN 800
450 IF N=3 AND Z=E THEN 800
460 IF N=4 AND Z=F THEN 800
470 IF N=5 AND Z=H THEN 800
480 IF N=6 AND Z=I THEN 800
490 IF N=7 AND Z=J THEN 800
500 IF N=8 AND Z=K THEN 800
510 IF N=9 AND Z=L THEN 800
520 IF N=10 AND Z=P THEN 800
530 IF N=11 AND Z=Q THEN 800
540 IF N=12 AND Z=S THEN 800
570 GOTO 900
800 CLS(Z):SOUND40+20*Z,5
810 IF N=X AND B$="N" THEN 850
815 IF N=X AND B$="Y" THEN 860
820 N=N+1:GOTO400
850 X=X+1:IF X=13 THEN 1000 ELSE GOTO 195
860 X=X+1:IF X=13 THEN 1100 ELSE GOTO 190
900 PRINT "WRONG ANSWER, SORRY.";
905 PLAY "T3O3L2CL3CL8CL2CE-L8DL3DL8CL3CO2L8BO3L2C"
```

Listing 1 continues



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Listing 1 continued

```
910 INPUT"CARE TO TRY AGAIN Y/N";C$:IF C$="Y" THEN 185 ELSE END
950 PRINT"TIME'S UP. YOU LOSE."
960 PLAY"O3L8AAAAL4AGL1GP4L8GGGGL4GFL1F"
980 INPUT"WANT TO TRY AGAIN Y/N";C$:IF C$="Y" THEN 185 ELSE END
1000 PRINT"YOU WIN!!!"
1005 PLAY"O2L8A#O3L4CL8E-L3GL16G-L8GB-O2B-O3L4CL8E-L1G"
1010 PRINT"WHY NOT TRY THE NEXT LEVEL?"
1020 INPUT"PRESS 1 TO MOVE UP, 2 TO STAY AT THE SAME LEVEL AND 3
TO END";C$
1030 IF C$="1" THEN 100 ELSE IF C$="2" THEN 185 ELSE IF C$="3" T
HEN END
1100 PRINT "TERRIFFIC. YOU'VE WON.";
1110 PLAY"T3O3L8.DDDL2GO4DP8L8.CO3BAO4L2GL4DP8L8.CO3BAO4L2GL4DL8
.CO3BO4CL2O3A"
1140 PRINT"WANT TO TRY AGAIN SINCE YOU'RE"
1150 PRINT"DOING SO WELL? PRESS 1 TO GO "
1160 INPUT"AGAIN, 2 TO CHANGE SETTING AND 3 TO END";C$
1170 IF C$="1" THEN 185 ELSE IF C$="2" THEN 100 ELSE IF C$="3" T
HEN END
```

Program Listing 2

```
1 REM CC SIMON BY ROBERT TOSCANI, 4744 WHITAKER AVE. PHILA. PA.
19120
10 CLS
45 FORAA=1TO63:FORBB=1TO31
50 CC=INT(AA/8+1)
55 SET(AA,BB,CC):NEXTBB,AA
60 PRINT" G Y B R W C M O"
65 PRINT"PRESS ANY KEY TO CONTINUE"
70 C$=INKEY$:IF C$="" THEN 70
75 INPUT"PICK LEVEL 1(EASY)-5(HARD)";Y
80 INPUT"DO YOU WANT THE COLOR SEQUENCE TO CHANGE WITH EACH NEW
COLOR, Y(HARDER) OR N(EASIER)";B$
95 PRINT"PRESS ANY KEY TO START"
100 C$=INKEY$:IFC$="" THEN100
185 X=1
190 A=RND(8):D=RND(8):E=RND(8):F=RND(8):H=RND(8):I=RND(8):J=RND(
8):K=RND(8):L=RND(8):P=RND(8)
195 N=1
200 CLS(0):FORZZ=1TO190:NEXTZZ:CLS(A):SOUND40+20*A,50-Y*9
210 IF X=1 THEN 400
230 CLS(D):SOUND40+20*D,50-Y*9
240 IF X=2 THEN 400
250 CLS(E):SOUND40+20*E,50-Y*9
260 IF X=3 THEN 400
270 CLS(F):SOUND40+20*F,50-Y*9
280 IF X=4 THEN 400
290 CLS(H):SOUND40+20*H,50-Y*9
300 IF X=5 THEN 400
310 CLS(I):SOUND40+20*I,50-Y*9
320 IF X=6 THEN 400
330 CLS(J):SOUND40+20*J,50-Y*9
340 IF X=7 THEN 400
350 CLS(K):SOUND40+20*K,50-Y*9
360 IF X=8 THEN 400
370 CLS(L):SOUND40+20*L,50-Y*9
375 IF X=9 THEN 400
380 CLS(P):SOUND40+20*P,50-Y*9
400 CLS(0):T=0
403 A$=INKEY$:T=T+1:IF T=500-(Y*75) THEN 950
405 IF A$="" THEN 403
410 IF A$="G" THEN Z=1 ELSE IF A$="Y" THEN Z=2 ELSE IF A$="B" TH
EN Z=3 ELSE IF A$="R" THEN Z=4 ELSE IF A$="W" THEN Z=5 ELSE IF A
$="C" THEN Z=6 ELSE IF A$="M" THEN Z=7 ELSE IF A$="O" THEN Z=8
430 IF N=1 AND Z=A THEN 800
440 IF N=2 AND Z=D THEN 800
450 IF N=3 AND Z=E THEN 800
460 IF N=4 AND Z=F THEN 800
470 IF N=5 AND Z=H THEN 800
480 IF N=6 AND Z=I THEN 800
490 IF N=7 AND Z=J THEN 800
500 IF N=8 AND Z=K THEN 800
510 IF N=9 AND Z=L THEN 800
520 IF N=10 AND Z=P THEN 800
570 GOTO 900
800 CLS(Z):SOUND40+20*Z,5
810 IF N=X AND B$="N" THEN 850
815 IF N=X AND B$="Y" THEN 860
820 N=N+1:GOTO400
850 X=X+1:IF X=11 THEN 1000 ELSE GOTO 195
```

Listing 2 continues

to the question. In division questions, the program rounds off the answer to the first decimal point. If the second decimal is 5 or higher, increase the first decimal by one to get the correct answer.

Line 150 compares your answer with the correct one, and lines 160-300 print the appropriate response. Line 302 keeps track of the number of correct answers. Line 306 ends the program if either it or the total number of questions is reached. If they are, lines 400-417 provide a brief sound and light show, and then lines 430-500 tell you how many questions you got right and the percentage of correct answers. Line 440 rounds off the answer to two decimal places and then converts that to a whole number to provide you with the percentage.

Line 505, based on the percentage, chooses which phrase to print from the next nine lines, and then lines 700-729 let you begin again or end the program. Lines 1000 and up are the introduction, explaining the rules of the test. ■

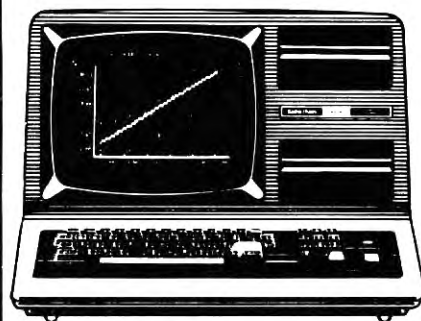
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Listing 2 continued

```

860 X=X+1:IF X=11 THEN 1100 ELSE GOTO 190
900 PRINT "WRONG ANSWER, SORRY.";
905 SOUND 20,6
910 INPUT"CARE TO TRY AGAIN Y/N";C$:IF C$="Y" THEN 185 ELSE END
950 PRINT"TIME'S UP. YOU LOSE."
960 SOUND80,6
980 INPUT"WANT TO TRY AGAIN Y/N";C$:IF C$="Y" THEN 185 ELSE END
1000 PRINT"YOU WIN!!!"
1005 SOUND 150,10
1010 PRINT"WHY NOT TRY THE NEXT LEVEL?"
1020 INPUT"PRESS 1 TO MOVE UP, 2 TO STAY AT THE SAME LEVEL AND 3
TO END";C$
1030 IF C$="1" THEN 100 ELSE IF C$="2" THEN 185 ELSE IF C$="3" T
HEN END
1100 PRINT "TERRIFFIC. YOU'VE WON.";
1110 SOUND200,12
1140 PRINT"WANT TO TRY AGAIN SINCE YOU'RE"
1150 PRINT"DOING SO WELL? PRESS 1 TO GO "
1160 INPUT"AGAIN, 2 TO CHANGE SETTING AND 3 TO END";C$
1170 IF C$="1" THEN 185 ELSE IF C$="2" THEN 100 ELSE IF C$="3" T
HEN END

```

Program Listing 3

```

10 CLS
20 PRINT"HUMAN RAPSCALLION!"
30 PRINT@64,"I'VE CAUGHT YOU STEALING THE 100JEWELS OF PLANET TA
NTER."
40 PRINT@160,"ORDINARILY, THE PENALTY IS          SEVERE AND TERMINA
L..."
50 PRINT@256,"BUT I'M A GAMESMAN. FOR YOUR      LIFE AND THE JEWEL
S YOU MUST      MATCH WITH ME AT TANTERIAN      TAKEAWAY. HIT ENTE
R FOR RULES."
60 INPUT A$:CLS
70 PRINT"WE TAKE TURNS MOVING 1 TO 10      JEWELS FROM THE BLUE TO
THE RED BOX. THE ONE WHO MOVES THE 100THJEWEL IS THE WINNER OF
LIFE AND TREASURE. HIT ENTER TO START."
80 INPUT A$
85 GOTO 275
100 PMODE 3,1:SCREEN 1,0
110 PCLS1
115 COLOR 3,2
120 LINE(17,50)-(17,150),PSET:LINE(17,150)-(123,150),PSET:LINE(1
23,150)-(123,50),PSET
125 COLOR 4,2
130 LINE(140,50)-(140,150),PSET:LINE(140,150)-(250,150),PSET:LIN
E(250,150)-(250,50),PSET
140 FOR A=54 TO 146 STEP 10
150 FOR B=24 TO 118 STEP 10
160 PSET(B,A,2)
170 NEXT B,A
180 C=24:D=54
185 FOR Y=1 TO X
192 SOUND C,1
195 PRESET(24,54)

```

```

200 PRESET(C,D)
210 PSET((267-C),(198-D),2)
220 C=C+10:IF C=124 THEN D=D+10:IF C=124 THEN C=24
240 NEXTY
250 FOR Z=1 TO 1100:NEXTZ
260 IF Q=0 THEN 300 ELSE IF Q=1 THEN 400 ELSE IF Q=3 THEN 500
275 CLS
280 PRINT"I GO FIRST, MOVING 1 FOR A TOTALOF 1."
285 FOR Z=1 TO 1000:NEXTZ
287 X=1:Q=0
288 N=1
290 GOTO 100
300 CLS
310 INPUT"HOW MANY ARE YOU MOVING";X
320 IF X<1 THEN 350 ELSE IF X=<10 THEN 370
330 PRINT"THE HUMAN CHEATS! TAKE 10 OR      FEWER!"
340 GOTO 310
350 PRINT"YOU MUST MOVE AT LEAST ONE."
360 GOTO 310
370 PRINT"YOUR TOTAL IS AT "N+X
380 PRINT"BY TAKING "X
385 FOR Z=1 TO 1100:NEXTZ
390 PMODE3,1:SCREEN1,0:Q=1:GOTO 185
400 PRINT"I MOVE "11-X
410 PRINT"FOR A TOTAL OF "N+X+(11-X)
415 FOR Z=1 TO 1100:NEXTZ
418 N=N+X+(11-X)
420 IF N=100 THEN Q=3 ELSE Q=0
425 X=11-X
430 PMODE3,1:SCREEN 1,0:GOTO 185
500 CLS
510 PRINT"I WIN, MY DOOMED FRIEND."
520 PLAY"V25T3O3L2CL3CL8CL2CE-L8DL3DL8CL3CO2L8BO3L2C"
530 PRINT@64,"AND NOW FOR A CONFESSION:"
540 PRINT@128,"THE GAME IS RIGGED SO I ALWAYS WIN. THIS SHOULD
TEACH YOU TO NEVER TRUST A TANTERIAN..."
550 FOR Z=1 TO 1500:NEXTZ
560 CLS
570 FOR E=1 TO 320
580 PRINT "HA";
590 NEXT E
600 CLS
610 PRINT"LET'S PLAY AGAIN AND PROLONG      YOUR MISERABLE LIFE. Y
ES OR NO?"
620 INPUT W$
630 IF W$="YES" THEN 275 ELSE CLS
640 PRINT"THAT'S ALL FOLKS"
650 END

```

Program Listing 4

```

1 REM MY OWNER BY ROBERT TOSCANI, 4744 WHITAKER AVE. PHILA. PA.
19120
10 CLS
20 PRINT"YOU ARE ABOUT TO MATCH WITS WITHMY OWNER. I WARN YOU, M

```

Listing 4 continues

Listing 4 continued

```
Y OWNER IS VERY SMART AND WILL PROBABLY BEAT YOU."
30 PRINT"THE RULES OF THE CONTEST ARE VERY SIMPLE. WE HAVE A
BLUE BIN FILLED WITH 100 LIGHTS. TAKING TURNS EACH OF YOU WILL
MOVE FROM 1 TO 10 LIGHTS OVER TO THE RED BOX."
40 PRINT"WHOEVER MOVES THE 100TH LIGHT WINS!"
50 INPUT"IF YOU'RE READY, PLEASE ENTER YOUR NAME";B$

55 CLS
60 PRINT"OKAY, I WILL NOW PICK A NUMBER AT RANDOM. IF IT IS ODD
,"B$
70 PRINT"WILL GO FIRST. EVEN AND MY OWNER STARTS."
75 FOR Z=1 TO 1100:NEXT Z
80 U=RDND(10):IF U=1 OR U=3 OR U=5 OR U=7 OR U=9 THEN 90
85 PRINT"THE NUMBER IS "U" SO MY OWNER BEGINS.":FOR Z=1 TO 110
0:NEXTZ:GOTO 100
90 PRINT"THE NUMBER IS "U" SO YOU START.":FOR Z=1 TO 1100:NEXT Z
100 PMODE3,1:SCREEN1,0

110 PCLS1
115 COLOR 3,2
120 LINE(17,50)-(123,150),PSET,BF
125 COLOR 4,2
130 LINE(140,50)-(250,150),PSET,BF
140 FOR A=54 TO 146 STEP 10
150 FOR B=24 TO 118 STEP 10
160 PSET(B,A,2)
170 NEXT B,A
175 FOR Z=1 TO 300:NEXTZ
180 C=24:D=54
181 IF U=1 OR U=3 OR U=5 OR U=7 OR U=9 THEN 300 ELSE GOTO 399
182 IF Q=1 OR Q=3 THEN X=N ELSE X=N
185 FOR Y=1 TO X
192 SOUND C,1
195 PSET(C,D,3)

210 PSET((267-C),(198-D),2)
220 C=C+10:IF C=124 THEN D=D+10:IF C=124 THEN C=24
240 NEXTY
250 FOR Z=1 TO 1100:NEXTZ
260 IF Q=0 THEN 300 ELSE IF Q=1 THEN 399 ELSE IF Q=3 THEN 500 EL
SE IF Q=4 THEN 530
300 CLS

310 INPUT"HOW MANY ARE YOU MOVING";N
320 IF N<1 THEN 350 ELSE IF N=<10 THEN 370
330 PRINT"TAKE 10 OR LESS."
340 GOTO 310
350 PRINT"YOU MUST MOVE AT LEAST ONE."
360 GOTO 310
370 PRINT"YOU MOVE "N
375 R=N+R
380 PRINT"THAT MAKES THE TOTAL MOVED "R
385 FOR Z=1 TO 1100:NEXTZ
387 IF R=100 THEN Q=3 ELSE Q=1
```

```
390 PMODE3,1:SCREEN1,0
395 GOTO 182
399 CLS
400 INPUT"HOW MANY DOES MY OWNER WANT TO MOVE";H
401 IF H>0 AND H<=10 THEN 404
402 PRINT"MY OWNER JOKES WITH YOU THAT IS AN ILLEGAL MOVE AS MY
OWNER KNOWS."
403 GOTO 400
404 R=H+R
410 PRINT"MY OWNER MOVES "H
415 PRINT"FOR A TOTAL OF "R
418 FOR Z=1 TO 1100:NEXT Z
420 IF R=100 THEN Q=4 ELSE Q=0
430 PMODE3,1:SCREEN 1,0
440 GOTO 182
500 CLS
510 PRINT B$" WINS?!?!?!?"
520 PRINT" AW, YOU JUST GOT LUCKY."
530 P$="T4O4L4CO3L4.BL8O4DL4O3B-L2B-L4B-L4.AL8FL4AL1BP4"
532 S$="O4L4CL4.O3GL8EL4DL2DL4DL4.CL8DL4EL1FP4"
534 T$="L4O3EL4.EL8EL4DDDDLIC"
540 PLAY P$:PLAY P$
542 IF Q=4 THEN 550
545 GOTO600
550 CLS
560 PRINT"MY OWNER WINS!!! HA HA. I TOLD YOU MY OWNER WAS TOO
SMART FOR YOU."
600 PLAY S$:PLAY T$
605 CLS
610 PRINT"CARE TO, UH, TRY YOUR LUCK AGAIN "B$"?"
615 PLAY S$
620 PRINT"MAYBE THE RESULTS WILL BE A LITTLE DIFFERENT NEXT
TIME. YES OR NO?"
625 PLAY T$
630 INPUT W$: IF W$="NO" THEN 640
635 R=0:GOTO 60
640 PRINT"THAT'S ALL FOLKS"
650 END
```

Program Listing 5

```
1 REM MATH QUIZ BY ROBERT TOSCANI, 4744 WHITAKER AVE. PHILA. PA.
19120
9 GOSUB 1000
10 CLS
12 INPUT "WHAT'S YOUR NAME";N$
20 INPUT"PICK A NUMBER";A
40 INPUT"PICK ANOTHER";B
50 INPUT"DO YOU WANT TO ADD(+), SUBTRACT (-), MULTIPLY(*), OR DI
VIDE(/)";Z$
52 IF Z$="+" OR Z$="-" OR Z$="*" OR Z$="/" THEN 55 ELSE PRINT"MU
ST BE ONE OF THOSE SIGNS"
53 GOTO50
55 INPUT"ARE NEGATIVE NUMBERS OK Y/N";Y$
```

Listing 5 continues

Listing 5 continued

```

60 INPUT"WHAT TIME LIMIT PER PROBLEM";Z
65 U=0:I=0
70 INPUT"TOTAL NUMBER OF PROBLEMS";P:INPUT"AND CORRECT ANSWERS B
EFORE IT ENDS";O
75 PRINT"PRESS ENTER TO BEGIN. GOOD LUCK":INPUT A$
80 CLS
85 I=I+1
90 X=RND(A):Y=RND(B)
100 IF Y$="N" AND X<Y THEN 90
110 PRINT@8,"WHAT IS "
111 X$=STR$(X)
112 PRINT@17,X:PRINT@18+LEN(X$),Z$:PRINT@19+LEN(X$),Y
120 T=Z
121 FOR L=352 TO 351+Z:PRINT@L,CHR$(143+48);:NEXTL
122 R$=""
125 W$=INKEY$
126 IF T=<(Z+1)/2 THEN PRINT@448,"          HURRY!!! ";
128 R$=R$+W$
130 PRINT@40,R$:PRINT@470,"TIME "T
132 PRINT@L,CHR$(143);:L=L-1
135 T=T-1:SOUND128,1
138 FOR Q=1 TO 275: NEXT Q
140 IF T=<-1 THEN 147
142 IF T=<(Z+1)/2 THEN PRINT@448,"          ";
144 IF W$=CHR$(13) THEN 147
145 IF T>-1 THEN 125
147 IF Z$="+" THEN D=X+Y ELSE IF Z$="-" THEN D=X-Y ELSE IF Z$="*"
" THEN D=X*Y ELSE IF Z$="/" THEN D=INT((X/Y)+.05)*10/10
149 IF VAL(R$)=D AND T=<-1 THEN 205 ELSE IF VAL(R$)=D THEN 300
160 PRINT@73,"WRONG, "N$
165 GOTO 210
205 PRINT@73, "TIME'S UP "N$
207 IF VAL(R$)=D THEN 300
210 PRINT@102,"THE ANSWER IS "D
220 GOTO 305
300 PRINT@137,"CORRECT, "N$
302 U=U+1
305 PRINT@161,"THAT'S "U" OUT OF "I" CORRECT"
306 IF U=O OR I=P THEN 400
307 PRINT@226,"TO TRY AGAIN, PRESS (ENTER). "
320 INPUT A$:GOTO 80
400 FOR W=1 TO 460:NEXT W
401 G=0
402 Q=RND(8):S=RND(255)
410 CLS(Q):SOUND S,1
416 G=G+1
417 IF G<12 THEN 402
430 PRINT @ 3, "THAT'S "U" RIGHT OUT OF"
432 PRINT @ 35, I"QUESTIONS."
440 V=(INT(((U/I)+.005)*100)/100)*100
500 PRINT@67,"THAT'S "V"% CORRECT."
505 IF V=100 THEN 510 ELSE IF V=>80 THEN 560 ELSE IF V=>50 THEN
605 ELSE IF V<50 THEN 660
510 PRINT@99,"EXCELLENT, "N$
520 GOTO 700
560 PRINT@99, "VERY GOOD, "N$". "
570 GOTO 700
605 PRINT@99,"COULD BE BETTER, "N$". "
620 GOTO 700

```

```

660 PRINT@99,"THAT'S TERRIBLE, "N$"! "
665 SOUND 45, 15
670 PRINT@162,"TRY AGAIN AND SEE IF YOU CAN DO BETTER!";
700 PRINT@226,"TO TRY AGAIN PRESS 1, TO LET SOMEONE ELSE TRY,
PRESS 2 AND TO END, PRESS 3"
710 INPUT Q
720 IF Q=1 THEN 20 ELSE IF Q=2 THEN 10 ELSE IF Q=3 THEN END
1000 CLS
1010 PRINT"THIS IS A MATH QUIZ. (BOO,HISSS) HOWEVER, YOU HAVE QU
ITE A FEW CHOICES. YOU WILL PICK THE LARGEST NUMBERS FROM
WHICH THE QUESTIONS WILL BE DRAWN. YOU CHOOSE WHAT TYPE OF
MATH TO BE DRILLED ON. YOU SET THE TIME LIMIT FOR
1020 PRINT"EACH PROBLEM, HOW MANY TOTAL QUESTIONS THERE WILL
BE AND HOW MANY CORRECT ANSWERS YOU MUST HAVE TO END. YOU CAN
ALSO DECIDE IF NEGATIVE NUMBERS WILL BE USED IN SUBTRACTION."
1030 INPUT"PRESS ENTER TO CONTINUE";A$
1040 CLS
1050 PRINT"ALL DECIMALS MUST BE ROUNDED OFF TO THE FIRST PLACE.
EX. 2.34 WOULD BE 2.3 BUT 2.38 WOULD BE 2.4 IF THE SECOND DEC
IMAL IS 5 OR OVER THEN INCREASE THE FIRST DECIMAL BY ONE."
1060 PRINT"ONCE YOU HAVE PUT THE ANSWER IN, PRESS ENTER."
1065 INPUT"PRESS ENTER TO CONTINUE";A$
1067 CLS
1070 PRINT"ALSO KNOW THAT ONCE ANYTHING APPEARS, IT CAN'T BE
CHANGED. IF YOU PRESS THE WRONG KEY, YOU CANNOT CHANGE THE ANSW
ER."
1075 FOR Q=1TO1000:NEXTQ:CLS
1080 PRINT"ONE FINAL POINT. IT MAY TAKE A SECOND OR TWO FOR THE
ANSWER TO APPEAR. DON'T WORRY, JUST BE CAREFUL AND WAIT."
1090 INPUT"PRESS ENTER TO CONTINUE";A$
1100 RETURN

```

Program Listing 6

```

1 REM MATH QUIZ BY ROBERT TOSCANI, 4744 WHITAKER AVE. PHILA. PA.
19120
10 CLS
12 INPUT "WHAT'S YOUR NAME";N$
20 INPUT"PICK A NUMBER";A
40 INPUT"PICK ANOTHER";B
50 INPUT"DO YOU WANT TO ADD(+), SUBTRACT (-), MULTIPLY(*), OR DI
VIDE(/)";Z$
52 IF Z$="+" OR Z$="-" OR Z$="*" OR Z$="/" THEN 55 ELSE PRINT"MU
ST BE ONE OF THOSE SIGNS"
53 GOTO50
55 INPUT"ARE NEGATIVE NUMBERS OK Y/N";Y$
60 INPUT"WHAT TIME LIMIT PER PROBLEM";Z
65 U=0:I=0
70 INPUT"TOTAL NUMBER OF PROBLEMS";P:INPUT"AND CORRECT ANSWERS B
EFORE IT ENDS";O
75 PRINT"PRESS ENTER TO BEGIN. GOOD LUCK":INPUT A$
80 CLS
85 I=I+1
90 X=RND(A):Y=RND(B)
100 IF Y$="N" AND X<Y THEN 90
110 PRINT@18,"WHAT IS "

```

Listing 6 continues


```

111 XS=STR$(X)
112 PRINT@17,X:PRINT@18+LEN(X$),Z$:PRINT@19+LEN(X$),Y
120 T=Z
122 RS=""
125 W$=INKEY$
128 RS=RS+W$
130 PRINT@40,RS:PRINT@470,"TIME "T
135 T=T-1:SOUND128,1
138 FOR Q=1 TO 375:NEXT Q
140 IF T<-1 THEN 147
144 IF W$=CHR$(13) THEN 147
145 IF T>-1 THEN 125
147 IF Z$="" THEN D=X+Y ELSE IF Z$="-" THEN D=X-Y ELSE IF Z$="*"
" THEN D=X*Y ELSE IF Z$="/" THEN D=INT((X/Y)+.05)*10/10
149 IF VAL(RS)=D AND T=-1 THEN 205 ELSE IF VAL(RS)=D THEN 300
160 PRINT@73,"WRONG,"NS$
165 GOTO 210
205 PRINT@73,"TIME'S UP "NS$
207 IF VAL(RS)=D THEN 300
210 PRINT@102,"THE ANSWER IS "D
220 GOTO 305
300 PRINT@137,"CORRECT,"NS$
302 U=U+1
305 PRINT@161,"THAT'S "U" OUT OF "I" CORRECT"
306 IF U=0 OR I=P THEN 400
307 PRINT@226,"TO TRY AGAIN, PRESS (ENTER)."
320 INPUT AS:GOTO 80
400 FOR W=1 TO 460:NEXT W
401 G=0
402 Q=RND(8):S=RND(255)
410 CLS(Q):SOUND S,1
416 G=G+1
417 IF G<12 THEN 402
430 PRINT @ 3,"THAT'S "U" RIGHT OUT OF"
432 PRINT @ 35,"QUESTIONS."
440 V=INT(((U/I)+.005)*100)/100*100
500 PRINT@67,"THAT'S "V"% CORRECT."
505 IF V=100 THEN 510 ELSE IF V>80 THEN 560 ELSE IF V>50 THEN
505 ELSE IF V<50 THEN 660
510 PRINT@99,"EXCELLENT,"NS$
520 GOTO 700
560 PRINT@99,"VERY GOOD,"NS$
570 GOTO 700
605 PRINT@99,"COULD BE BETTER,"NS$
620 GOTO 700
660 PRINT@99,"THAT'S TERRIBLE,"NS$
665 SOUND 45,15
670 PRINT@162,"TRY AGAIN AND SEE IF YOU CAN
DO BETTER!"
700 PRINT@226,"TO TRY AGAIN PRESS 1, TO LET
PRESS 2 AND TO END, PRESS 3"
710 INPUT Q
720 IF Q=1 THEN 20 ELSE IF Q=2 THEN 10 ELSE IF Q=3 THEN END
1060 PRINT"ONCE YOU HAVE PUT THE ANSWERE IN, PRESS ENTER."
1067 CLS

```

ComSoft

MEANS BUSINESS

Hardware and Software

Products for the TRS 80⁺ Models I & III

TSHARE 2.0 MULTI-USER SYSTEM TRS-80⁺



MODELS I & III

SPECIFICATIONS:
TSHARE is a multi-tasking operating system for two users. It patches itself to your NEWDOS or TRSDOS SYSTEM. TSHARE allows simultaneous and separate operations for two users within a single computer.

AVAILABLE USER MEMORY ABOVE 7F80 HEX

- 32K TRS-80: 16K FREE
- 48K TRS-80: 32K FREE

TIMESHARING MODES:

- SIMPLEX MODE: With TSHARE 1.3 and 2A Only
- STANDARD MODE: With All Systems

SUPPORT EQUIPMENT:

- One + Disk Drive
- 32K + Memory
- A Printer
- A Terminal
- TRS-232 (optional)
- RS-232 or MPR 232

EXECUTION SPEED STANDARD MODE:
(Without Clock Speedup Mods)

- BENCHMARK executed by 2 simultaneous users: 37 sec.
- BENCHMARK executed once by standard TRS-80: 14 sec.

FEATURES:

- Type-ahead during Disk I/O (V2.0 Only)
- Communications between users
- Concurrent execution of single program
- Foreground/background task design
- Address up to two printers

PRICES:

•TRS-13 for TRSDOS 2.3	\$89 (MOD I)
•TRS-13 for NEWDOS 2.1	\$89 (MOD I)
•TRS-2A for NEWDOS V1	\$99 (MOD I)
•TRS-2B1 for NEWDOS V2	\$99 (MOD I)
•TRS-2BIII for NEWDOS V2	\$99 (MOD III)



SERIAL I/O MPR-232

AT LAST! A serial input/output put interface designed for connection to the TRS80 Model I with or without an expansion interface.

MPR232 Specifications

- Glitch free operation
- Connects with card edge connector
- Baud rates 75-19,200 are switch selectable
- Integral Power Supply included!
- May be daisy chained with other MPR 232s

PRICES:

•MPR232I	\$129.00 (MOD I)
•MPR 232III	\$139.00 (MOD III)

CSTOCK \$99

A) CSTOCK maintains a securities data base

- Maintains data on up to 3 stock market indexes
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- Two years of continuous data per stock

B) CSTOCK is a professional technical tool

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- Short term betas computed (stock volatility in terms of market return)
- Data plotting capabilities

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For Ease of Use THE FILE CLERK TRS-80⁺ Models I & III Version 5.5

SPECIFICATIONS:

- A multi-feature file manager
- Plus a simple data base (multi-file data sets)
- File handling capacity for 12000 records
- Up to 20 data fields/record
- MAX record and field length 255
- MAX effective record length w/Indexing 7905
- Assembly language sorts on single and combined data fields
- Multiple search parameters and chained queries
- Fast (KSAM) record retrieval on sorted key fields
- Flexible report generator with Pagination & User titles
- Computational fields
- Files can extend over several diskettes
- All diskettes need not be on line.
- AUTO MOUNT REQUESTS
- Fields can be redefined, deleted, or added
- 140-page manual

LOOK

DMB5 provides four data management features:

- A) A comprehensive FILE MANAGER for defining your records, data entry or edit, and general record retrieval.
- B) A flexible REPORT GENERATOR for information retrieval.
- C) A simple data base for advanced applications, where DATA SETS involving file pairs can be defined.
- D) A COPY file facility to transfer SORTS, SEARCHES, and transfer data to NEW formats.

PRICES:

•DB-5I	\$99 (MOD I)
•DB-5III	\$99 (MOD III)

VIEW 3.0 \$49

A SCREEN FORMATTER FOR DBM5

- Full CURSOR control for MASK design
- Screen design with keyboard GRAPHICS
- Elegant & professional looks
- File data entry, inquiry, & edit
- Word processor style field editing
- VIEW is a stand-alone data base

COMPUTED FIELDS
KSAM Master Keys
Requires DBM5 for SORTS



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SURPRISE!

3-D

It had to happen—sooner or later someone was going to write a stereoscopic 3-D program for the Color Computer. The following two programs are *80 Micro's* pioneering efforts in what we hope will become a popular programming technique.

Our efforts are by no means spectacular; our intentions are to present the principles involved in writing 3-D programs with examples.

Dennis Kitz, who has long been a guru for Color Computer users, gives a good discussion on how the illusion of 3-D works. His program draws a stack of blocks on the screen—actually two angles of the same stack superimposed.

Our resident CC wiz, Jake Commander, used the same basic concepts, but added motion. His program displays a rotating cube. We're sure you'll find his techniques fascinating.

As the authors point out, you must be able to get a good picture on the monitor, and the color and contrast adjustments must be precise. And, of course, you must have a color monitor. If you have trouble getting the 3-D effect on your monitor, try a friend's.

Remember, though, that these pro-

grams give only the illusion of 3-D, just as the 3-D movies of the 1950s created only illusions. Some sections of the 3-D figures in the programs might appear to “come out” more than others.

We Are Not Alone

Like any good idea, someone else is bound to think of it, too. Well, that happened with the 3-D Color Computer programs. The November 1982 issue of *The Rainbow*, a magazine for the Color Computer, features a 3-D arcade game called Star Trench Warfare by Fred Scerbo. *The Rainbow's* publisher, Lonnie Falk, said he isn't going to have the bind-in 3-D glasses, though. The glasses found elsewhere in this issue will work with that program.

We welcome *The Rainbow's* efforts in 3-D programming, and we suggest you pick up their November issue if 3-D interests you. *The Rainbow's* address is 5803 Timber Ridge Drive, P.O. Box 209, Prospect, KY 40059, (502) 228-4492.

We hope to generate a whole new genre of Color Computer programs using 3-D, but it's up to you readers to refine this technique. If you come up with any ideas, improvements, or interesting applications for 3-D programs, let us know. ■

3-D for Real

by Dennis Bathory Kitz

Until now, "3-D" has been a misnomer for CC graphics. Our CC expert has done the groundwork for real 3-D. It'll come out and grab you!

Simulated three-dimensional imagery from two dimensions is fascinating, but I found the prospect of programming it intimidating. I am far from being a

mathematician, so high-powered, three-dimensional rotation algorithms are simply outside my scope. Instead, I can handle a camera well enough, and can play around in my darkroom. I decided this could be put to work to learn more about 3-D principles.

My idea was to back into 3-D computer graphics by first creating the photographic images—"Vu-Master" style—and rendering these into simple computer versions. The steps I chose were straightforward:

- Select the subject to be examined.
- Photograph it from the desired distance.
- Photograph it again from a short distance to one side.
- Develop and print the separate photos.
- Create and position overlay films.
- Determine X-Y coordinates for each photo.

● Enter the information into the computer.

The original subject matter was a small pile of wooden pieces (Photos 1a and 1b), with pleasantly sharp angles. The principle of three-dimensional photography is well known: each eye views a subject from a slightly different angle, and these images are resolved by the brain into a sense of depth. By providing individual and slightly different flat photographic images to each eye, an illusion of 3-D can be created.

To view Photos 1a and 1b in 3-D, place the magazine comfortably in front of you and in good light, relax your eyes and focus into the distance; move your eyes slowly down to the images in the magazine. It is essential to relax, or else you will see only one of the two images. Once your eyes "float" apart, begin to focus slowly until the images are clear, but still overlap. You can improve this effect by viewing these photos simultaneously through separate magnifying eyepieces, so each eye is forced to see a unique view.

This technique was used for novelty photographs especially at the turn of the century, and is still used in Vu-Master

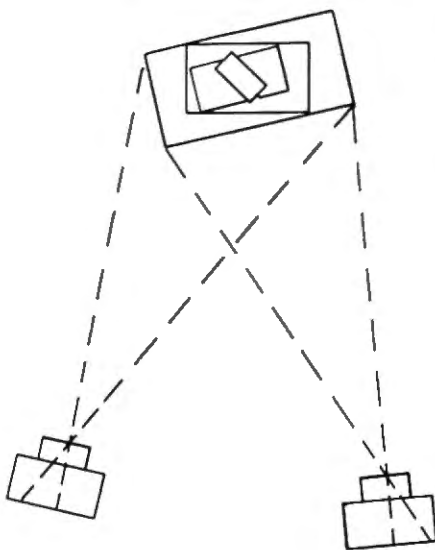


Fig. 1. Camera setup for stereoptical photo. Although any pair of photos taken 3 to 4 inches apart will work in stereo, most impressive results are obtained with longer depth of field, with different objects at several distances from the lens.

The Key Box

Color Computer
16K RAM
Extended Color Basic



Photo 1. Stereoptical view of a pile of wooden blocks for separated eyes. (a) Left eye. (b) Right eye. Ektachrome 64, natural lighting, f/16, 1/1000 second.

and other stereoptical viewers. It is employed for the photographing of extremely fragile museum specimens. Four pairs of views—top, bottom, and two sides—are usually taken, and the results examined with a simple viewer. This provides a detailed, perspective view so interested visitors don't handle the original specimen.

The trick, however, is to produce a single photograph that appears in three dimensions. Somehow the images must be separated, drawn off the page, and relegated one to the left eye and the other to the right. A composite image is therefore created that can be printed in two distinct (actually complementary) colors, and can be viewed through

special lenses.

The colors are usually green and red. When the red printing is viewed through

“The trick . . . is to produce a single photograph that appears in three dimensions.”

the red lens, it effectively disappears; the green printing looks black through the red lens. Likewise, when green

printing is viewed through the green lens, it disappears; the red printing looks black through that lens.

Again, the two-color process has been used for novelty photography in books and magazines, as well as for special effects in films. For readers old enough to remember, it enjoyed brief popularity in 1950s horror films, and is undergoing a small renaissance today.

A three-dimensional computer image would use the same process by drawing on a single screen two slightly different pictures in complementary colors. You can use three-dimensional algorithms to draw directly from design information, a tablet or light pen for input, or you can program the coordinates of an ex-



Photo 2. Stereoptical view of David Gunn, for crossed eyes. (a) Right eye. (b) Left eye. David had to hold the pose carefully since only one camera was used and had to be moved between shots; nevertheless, he did raise one eyebrow. Ektachrome 64, natural lighting, $f/22$, $1/1000$ second.

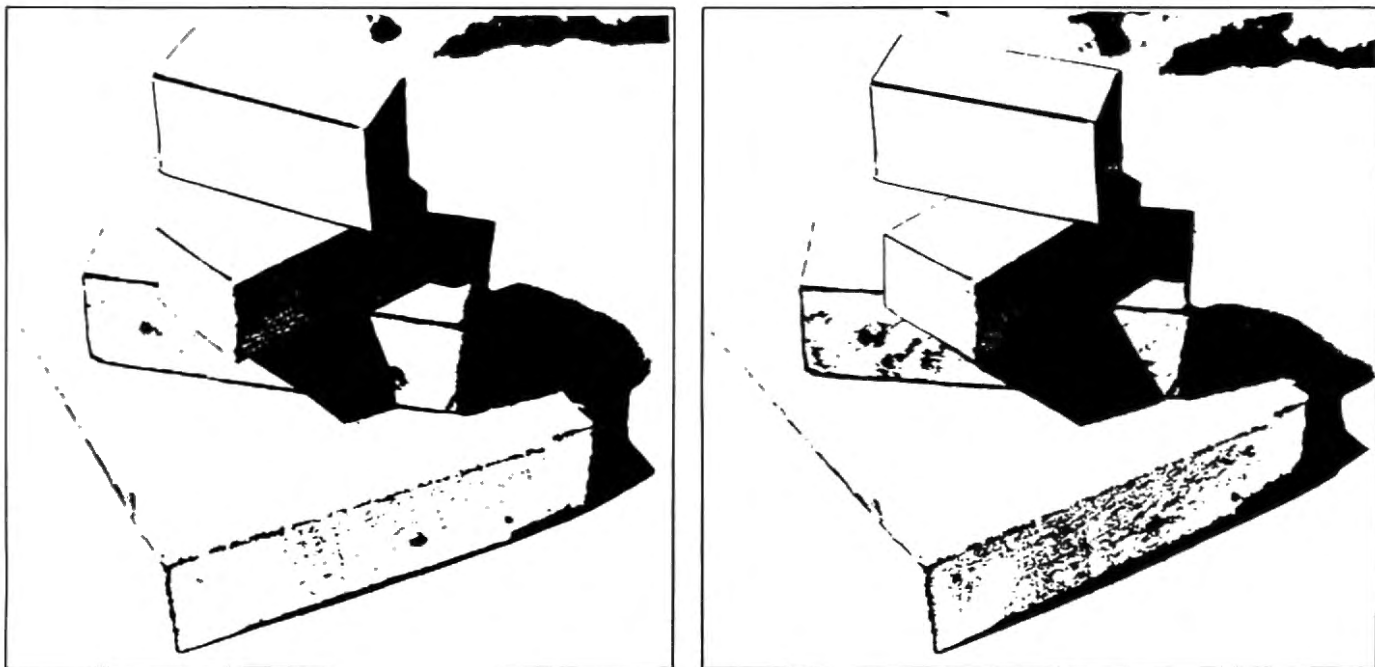


Photo 3. High-contrast film stereoptical view of the blocks in Photo 1. (a) Left eye. (b) Right eye. Kodalith, natural lighting, $\perp/2.8$, $1/15$ second, printed on Kodabrome II ultra-hard paper developed in graphic arts developer.

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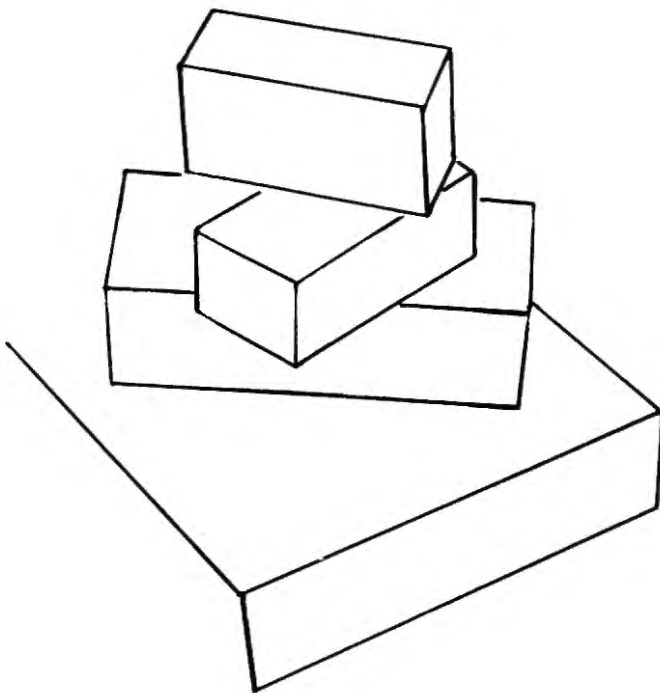
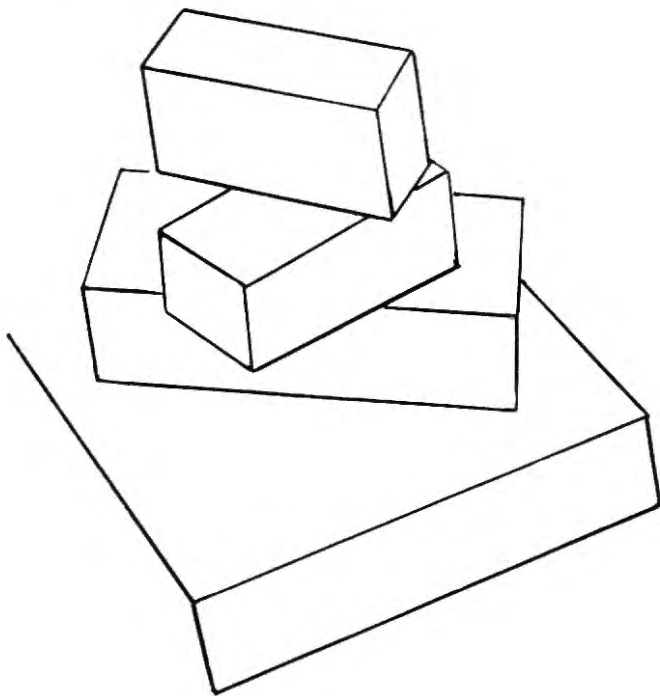
isting image. I used the last method.

Taking the Photo

Ideally, 3-D photographs are taken using a stereoptical camera—two-

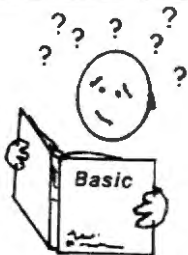
lensed animals that allow "real-time" photography of moving objects. However, if things are stationary, you need only a single camera. Take the photo,

then carefully move the camera a few inches to your left or right. The distance you move the camera depends on the intensity of depth you would like—the



Figs. 2a and 2b. A line drawing of the two images. These drawings were done on tracing paper so X-Y coordinates could be derived for computer input.

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farther, the deeper, up to the point where your eyes can no longer resolve the separate images into a single one. Start with about three inches, and move

up to a foot—the closer the object, the smaller the move. Take the second photo using the same film, focus, depth of field, exposure time, and f-stop, and

be sure to keep the same vertical position; a tripod helps. Otherwise, the pictures you take will make sense only if you hang your head to one side. Figure

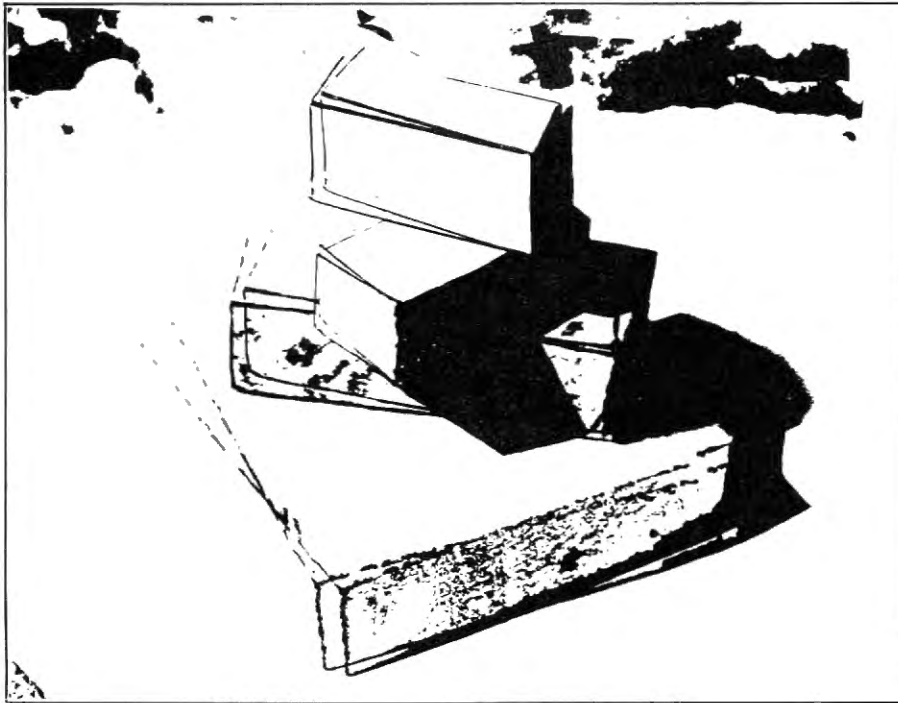



Photo 4. Overlay composite of two views of the blocks, exposed on Kodalith sheets from the same film used for Photo 3.

“To view this pair of photographs in 3-D... focus on the images while relaxing your eyes, but this time crossing them.”

1 shows the setup, and Photos 2a and 2b are a stereoptical result with a six-inch spacing.

To view this pair of photographs in 3-D, place the magazine at a comfortable distance, focus on the images while relaxing your eyes, but this time crossing them. Again, it is essential to relax,




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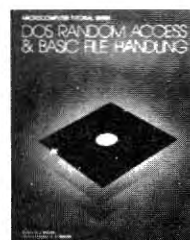
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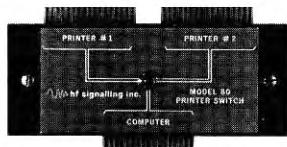
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or else you will see only one of the two images. You want your eyes to "float" together, so each sees a separate but very similar image. The result is an extremely effective simulated 3-D.

From a stereoptical photo, a composite and simplified result must be developed to use as computer input. I made the pile of wooden blocks as the easiest first endeavor because of its straight lines and sharp angles. Photos 3a and 3b are the same pile of blocks as in Photos 1a and 1b but photographed using high-contrast document film and reproduced on similar high-contrast paper. If your original objects have been well detailed (I blackened the edges of the original blocks as you can see in Photo 1), then this is an easy way of obtaining a pair of clear line drawings of the original objects—especially if, like me, you do not have a good drawing hand.

Next, I produced an aligned overlay of the two black-and-white photos. In order to work up a composite 3-D image in two colors, I would need some sort of guide, and the aligned overlay would do the job. Each photo was again printed, this time on 8 by 10 sheet film. These were aligned and taped together for a composite. Photo 4 is the result, and is ready for use as computer input. However, I wanted to have a sneak preview.

Color Composite

The color composite photo was tricky, if only because I had to do the thing in darkness. I taped the film overlay to an exposure frame, and focused the negative on its matching image. I added magenta Cibachrome filters (a total of .90 filtering), inserted the color photo paper, lifted aside the negative overlays, and made an exposure. I

```

10 PCLEAR8
20 CLS
30 REM * UPPER IMAGE OVERLAY
40 DATA 35,6,77,18,77,40,69,51
50 DATA 69,29,77,18,69,29,26,18
60 DATA 35,6,26,18,26,36,69,51
70 DATA 65,49,41,61,26,48,40,42
80 DATA 26,48,26,62,40,76,40,61
90 DATA 40,76,81,58,81,42,77,40
100 DATA 81,42,74,47,81,42,81,47
110 DATA 95,49,88,70,86,88,10,74
120 DATA 10,57,26,60,10,57,10,74
130 DATA 86,88,88,70,64,66,999
140 REM * LOWER IMAGE OVERLAY
150 DATA 24,19,30,9,74,18,74,38
160 DATA 69,50,69,29,74,18,69,29
170 DATA 24,19,24,38,64,49,44,60
180 DATA 25,50,38,43,25,50,25,65
190 DATA 42,77,42,60,42,77,80,60
200 DATA 80,42,76,40,80,42,72,46
210 DATA 80,42,80,46,91,48,84,86
220 DATA 90,68,60,65,90,68,84,86
230 DATA 8,78,8,60,25,62,999
240 PMODE3,1:SCREEN1,1:PCLS:SCREEN1,1
250 READA,B,C,D
260 LINE (A*2,B*2)-(C*2,D*2),PSET
270 READ:IFE=999THEN290ELSEREADF
280 LINE -(E*2,F*2),PSET:GOTO270
290 COLOR7,5
300 READ A,B,C,D
310 LINE (A*2,B*2)-(C*2,D*2),PSET
320 READ E:IFE=999THEN340ELSEREADF
330 LINE-(E*2,F*2),PSET:GOTO320
340 GOTO340
    
```

Program Listing 1

NEW! FOR THE COLOR COMPUTER!



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placed a black sheet over the color photo paper, flipped back the film overlay, matched the second negative to its

image, removed the magenta filtering, and added an equal intensity of cyan (blue). Finally, I flipped back the nega-

tive and removed the cover sheet, and the exposure was made.

The result was a color composite that can be viewed with 3-D glasses. It is Photo 5.

Into the Computer

I had several ideas for this process, including an ill-fated one that involved extending one of the joysticks with a portable radio antenna and "tracing"

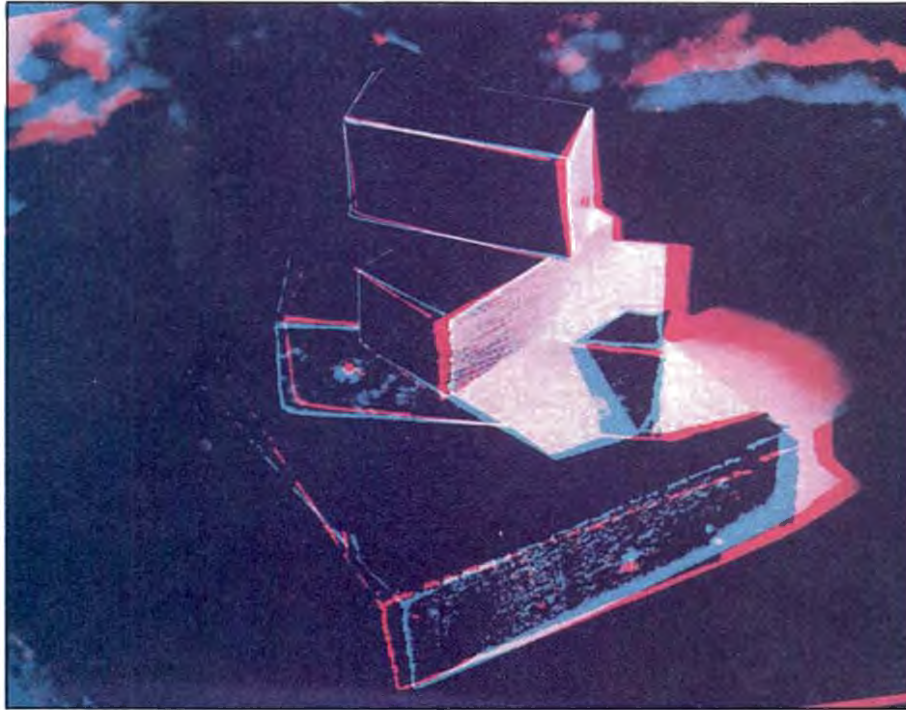


Photo 5. Color composite of two views of the blocks, exposed on Cibachrome-A paper alternately with .90 magenta and .90 cyan filters, using the overlay in Photo 4 as a guide for the double exposure. The white streaks in the center are the shadows, since this is a negative color print. Use your 3-D glasses to view this photograph.

"... an imaginative contraption with lots of pulleys and strings, made out of an Erector Set, fell to rubble on the first use."

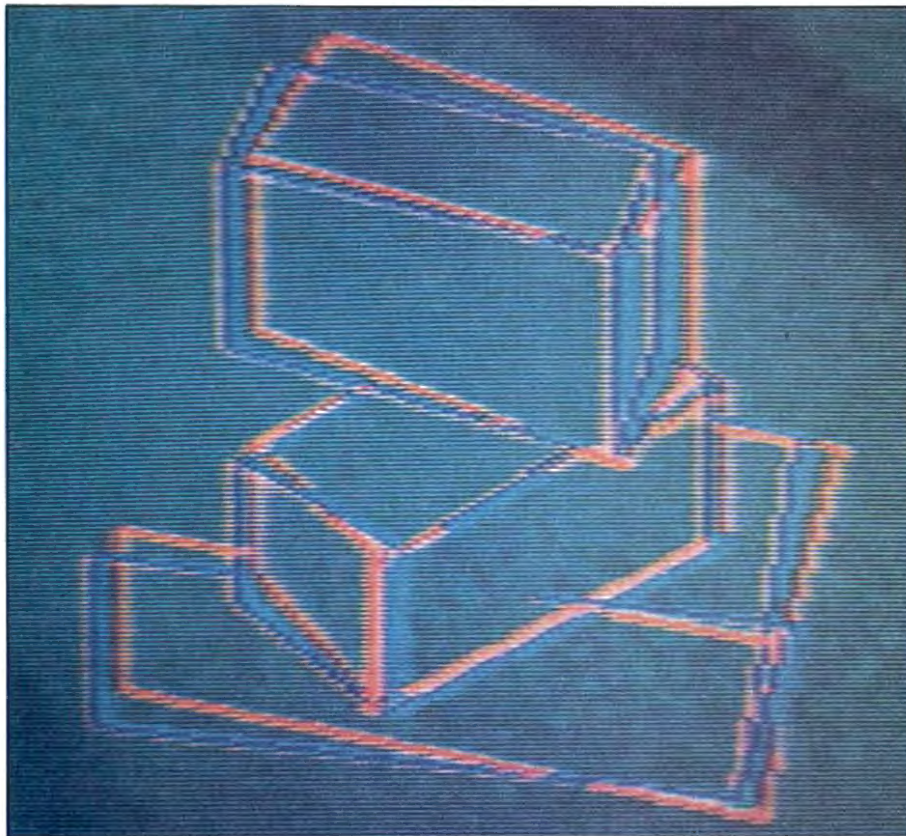


Photo 6. Screen photo of the results, using X-Y coordinates derived from the color composite in Photo 5. Unessential information ("noise") and shadows are left out of this result.

the image into the computer. Unfortunately, the accuracy just wasn't there. X-Y tablets were too expensive, and an imaginative contraption with lots of pulleys and strings, made out of an Erector Set, fell to rubble on the first use.

All that remained was manual input. Fortunately, Extended Basic's flexible Line command could be used. I prepared a tracing-paper version of the two images, placing them on graph paper, and marking down the X-Y coordinates. These were fed into the computer using data statements (see the Program Listing), and the image was drawn. A similar Basic program can be used with the LNW-80 for higher-resolution color imagery.

I'll leave the rotation and manipulation to those with more perceptive minds than mine; in the meantime, I trust this method will help readers get started with three-dimensional computer imagery. ■

Dennis Kitz may be reached c/o the Post Office, Roxbury, VT 05669.

Ed. note: The 3-D effect you get by running this program depends on the color and contrast adjustment on your monitor. Try to get as clear a picture as possible and match the colors of the 3-D glasses.

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Something-Or-Other 3-D

by Jake Commander

With great perseverance, Jake Commander has come up with this stereoscopic 3-D program that features a rotating cube in two colors.

Why is it I always walk into these things? Fools rush in where angels fear to tread, so I'm told, which makes me a 24-carat sucker.

"I've got a great idea," says Eric Maloney, our managing editor, after a sudden brainstorm. "We'll do an anniversary issue featuring 3-D graphics and give away glasses to our readers. You'll be able to write something for it, won't you, Jake?" The temptation was too much for me, I'm afraid. I in-

stantly promised a something-or-other that would fit the bill. Little did I realize how the fates were aligning themselves to make the potentially simple something-or-other a whopping task.

I thought about the concept for a while to see if any good ideas surfaced. Nothing. I was convinced I could do something in a manner similar to some magazine pictures I'd seen as a child. The pictures were of countryside scenery and all in startling 3-D—lots of

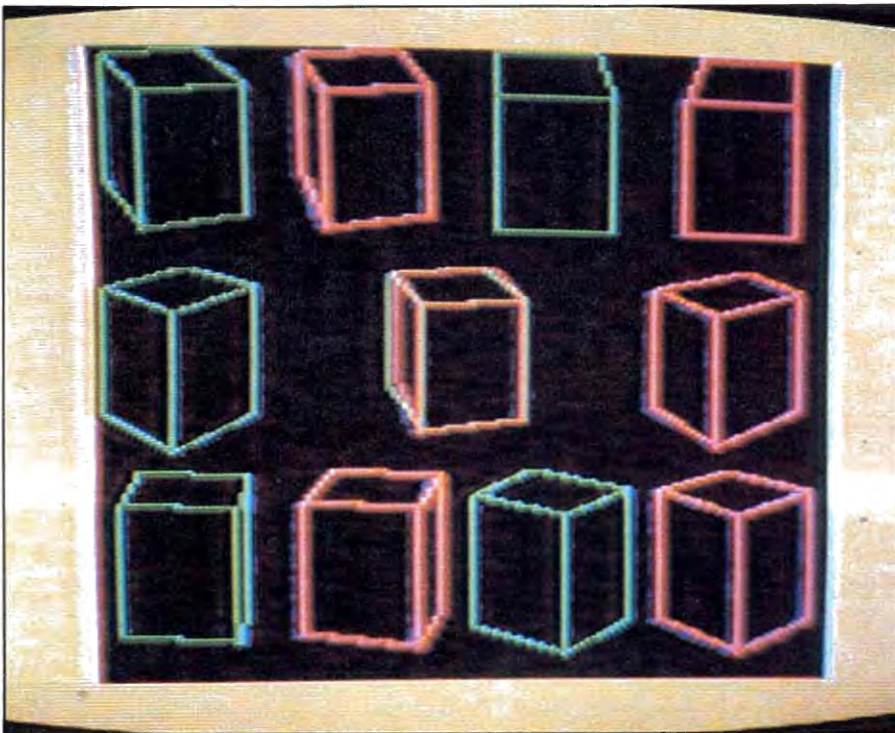
trees on the horizon with cows' rumps jutting out menacingly close to the eyeballs.

The method employed was to print the left eye's view in green and the right eye's view in red. By placing a red filter over the left eye, the red image disappeared, thus leaving the correct image behind. Using a green filter over the right eye, the other side was accounted for. With two separate images entering both eyes, the brain fell hook, line, and sinker for the appearance of three dimensions. It was intriguing how convincing the illusion of depth could be, considering the simple separation of two images from a flat piece of paper. Similar methods are, of course, used in cinematography to produce those scary movies.

I felt there just had to be a way to achieve the same illusion using a two-color separation on the Color Computer. I was reminded of a program we'd already published, the idea of which was to present a three-dimensional point of view from any perspective in space. The clever part of the program was the way it decided what was in front of or behind each object from a set of geometric shapes that appeared in true perspective. That gave me the idea at last: How about a simple geometric shape such as a cube rotating before your eyes and seeming to do so in 3-D? Good enough, but how on earth was I going to simulate those overlapping colors I'd seen in that magazine?

At first I toyed with the idea of actually placing the images side by side using two colors in a medium-resolution graphics mode. I had to be kidding; the separation needed would have been sufficient to require a frown and deeply crossed eyes in order to make both images overlap.

Finally, I resorted to the good old



Jake's 3-D Program as It Appears on the Screen

animators' technique using image retention. If I alternated a red and green image fast enough, they'd actually appear to be in the same place and no crossed eyes would be called for. As I had to use multiple images anyway to make the cube rotate, it was simply a matter of alternately switching between the two colors—one for each eye. I craftily chose a clockwise direction that ensured that the rotation naturally followed the images seen by the eyes in a left-right, left-right fashion. This helps the flow of movement so it appears to flow smoothly even without the glasses. Not only that, but after 90 degrees of rotation, the cube would be back in its original position and I could repeat the procedure ad infinitum.

I knew I could get the color separation by using the color artifacts I'd gotten many times while experimenting with color graphics in PMODE 4. By setting odd or even dots, it's possible to draw figures in two distinct colors. The colors are blue and red (or green and red, depending on your television). As long as the 3-D glasses could filter the colors to get two separate images, the illusion seemed feasible. I did a couple simple experiments drawing lines from Basic and was convinced that the separation was sufficient. Armed with a lot of theory, an experiment or two, and the idea coalescing in my mind, I had to complete the work in England—an event that didn't help one bit.

The first thing to be done was to decide how many angular views of the cube would be needed to give a smooth flow. The sequence of images would also have to be stored somewhere in memory, and it seemed reasonable to merely draw them onto the screen and leave them stored there. As long as there was a destination on the screen for the actual rotation, there would be no need to remove any image in the animation sequence. By dividing the screen into a 3-by-4 grid, I could get 12 cubes—or more accurately, six left/right images. That didn't leave room for the moving picture itself, so I dropped one out to allow five double images. Remembering I needed only 90 degrees of rotation, an image every 18 degrees or so would produce a steadily changing picture.

At this point, I should have been able to use an algorithm from somewhere in my software library to generate perfectly aligned cubes at every 18 degrees. The problem was my library was now 3,000 miles the wrong side of the Atlantic and this project was be-

```

100 PCLEAR4:PMODE4,1:PCLS:A$=STRING$(103,32):AD=VARPTR(A$):AD=PE
EK(AD+2)*256+PEEK(AD+3):DEFUSR=AD
120 FORX=0TO103:READOP:POKEAD+X,OP:NEXT
130 SCREEN1,1
1000 READXS:IFXS=-1THENGOSUB2000:GOTO1000ELSEIFXS=-2THEN2500ELSE
READYS,XE,YE
1050 XA=XE-XS:YA=YE-YS
1100 IFYS>YE THENI0=-1ELSEI0=1
1200 IFXS>XE THENI1=-1ELSEI1=1
1400 IFABS(XA)<ABS(YA) THENIX=ABS(XA/YA)*I1:GOTO1600ELSEIFXA=0TH
ENIX=0ELSEIX=ABS(YA/XA)*I0
1500 GOSUB1700:PSET(XP,YP,1):IFXS=XE THENI000ELSEXS=XS+I1:YS=YS+
IX:GOTO1500
1600 GOSUB1700:PSET(XP,YP,1):IFYS>YE THENYS=YS+I0:XS=XS+IX:GOTO
1600ELSEI000
1700 IFLR=1THENXP=XS OR1 ELSEXP=XS AND254
1900 XP=XP+(XO AND255):YP=YS+YO:RETURN
2000 IFLR=1THENLR=0 ELSELR=1
2100 XO=XO+64:IFXO=320THENXO=448
2200 IFXO=256ORXO=512THENYO=YO+64
2300 RETURN
2500 X=USR(0)
5000 DATA158,186,95,52,4,52,16,141,48,53,16,53,4,92,193,10,39,23
8,52,4,193,4,39,17,193,5,39,8,193,6,39,17,48,8,32,225,48,136,24,
32,220,220,186,139,8,31,1,32,212,220,186,139,16,31,1,32,204
5100 DATA220,186,139,8,203,12,31,3,16,142,0,64,52,32,16,142,0,4,
236,129,237,193,49,63,38,248,48,136,24,51,200,24,53,32,49,63,38,
230,16,142,12,0,49,63,38,252,57
6000 DATA12,0,12,12,12,0,46,0,46,0,52,12,52,12,12,12,12,12,12,52
,12,52,52,52,52,52,12,-1
6100 DATA12,12,18,0,18,0,52,0,52,0,52,12,52,12,12,12,12,12,12,52
,12,52,52,52,52,52,12,-1
6200 DATA22,0,12,10,22,0,56,2,56,2,48,12,48,12,12,10,12,10,12,48
,12,48,48,52,48,52,48,12,48,52,56,36,56,36,56,2,-1
6300 DATA26,0,10,10,26,0,58,2,58,2,46,12,46,12,10,10,10,10,48
,10,48,46,52,46,52,46,12,46,52,58,38,58,38,58,2,-1
6400 DATA30,0,10,6,30,0,62,6,62,6,40,14,40,14,10,6,10,6,10,44,10
,44,40,56,40,56,40,14,40,56,62,44,62,44,62,6,-1
6500 DATA32,0,8,6,32,0,60,6,60,6,36,14,36,14,8,6,8,6,8,46,8,46,3
6,58,36,58,36,14,36,58,60,46,60,46,60,6,-1
6600 DATA36,0,6,6,36,0,60,6,60,6,32,14,32,14,6,6,6,6,6,46,6,46,3
2,56,32,56,32,14,32,56,60,46,60,46,60,6,-1
6700 DATA40,0,6,6,40,0,60,8,60,8,28,14,28,14,6,6,6,6,6,46,6,46,2
8,56,28,56,28,14,28,56,60,48,60,48,60,8,-1
6800 DATA46,0,8,2,46,0,56,10,56,10,16,12,16,12,10,2,8,2,8,42,8,4
2,16,54,16,54,16,12,16,54,56,50,56,50,10,-1
6900 DATA48,0,10,2,48,0,54,10,54,10,14,12,14,12,10,2,10,2,10,40,
10,40,14,52,14,52,14,12,14,52,54,50,54,50,54,10,-2

```

Program Listing

coming more and more urgent. The only thing for it was to do it by hand.

So I took a Rubik's cube, placed it on a piece of paper marked at the required angles, and drew 10 pictures onto a piece of graph paper. First I had to close my right eye and draw, keeping my head in a predetermined position relative to the cube, and then the same thing with the left eye—for the total of five angles. Once drawn on graph paper, I calculated the X and Y coordinates for every point at each corner of every cube.

By feeding these coordinates to the Color Computer and writing an algorithm to join them together with lines of the right color, the drawings would be on the screen ready to animate. This explains those data statements in lines 6000-6900; each one represents a different cube.

By this time, it was dawning on me what I'd let myself in for. Not only was my software library 3,000 miles away from me, but so was my Color Com-

puter and reference material on the 6809 microprocessor, which I needed to help write a small machine-code subroutine. This routine was needed to copy the successive images into place fast enough to fool the eye into seeing smooth action.

I was beginning to think I'd set myself an impossible task. The only recourse was to beg, steal, or borrow the required items. At last, armed with a 6809 reference book, lots of pictures of cubes, lots of data on these pictures, and a rough draft of the program, I found myself in a Tandy computer store in front of their Color Computer. To add a little spice to the pressure I was under, they even placed a young programmer next to me "to watch and learn." Can you imagine those odds?

Naturally, the program didn't work the first time. Nor the second. Nor the third or fourth. I lost count. After the second day, the cubes were being drawn nicely into position on the screen. If nothing else, the young pro-

grammer sitting next to me was learning the art of patience.

The final sting in the tail was that none of the cubes came out the right color. It was unbelievable. After all my hard work, applied theory, and having reached this far, surely the colors could at least come out right.

I checked the variables and they were correct; left cubes were being drawn at even-numbered pixel locations and right cubes at odd locations. Then I realized: I was working on a European PAL TV set—a different color standard than the NTSC All-American format I was used to. The color artifacts available on American TV sets were unobtainable in the UK. Thus, I was not going to be able to place my glasses on my nose and see the final fruits of my labors—a cruel trick of fate.

After convincing myself that the color problem was indeed the fault of the hardware and not the software, I debugged the machine code. The animation looked a real mess. The cubes rotated all right, but they danced and jiggled all over the place. Apparently, when drawing each cube, I'd moved my head this way and that. My drawing ability hadn't helped any either.

So I arrived at the last step, which was to analyze the sequence in slow motion and fine-tune each cube until the results were convincing. I now had something I could send the editors of *80 Micro* for a trial run to see if the colors were right and the illusion had succeeded.

Ten days later I received the cryptic message, "It works. Send the article ASAP." What, no medal?

There you have the whole tale including the evolution of the idea and solution of the problems using a brute-force approach.

The Technique

Five cubes are drawn in Basic using the algorithm in lines 1050–2300. Each cube is drawn twice, one for the left eye and the other at a slightly different angle for the right eye—a total of 10 cubes in all. Left cubes are drawn in blue (or green, depending on your monitor), and the right cubes in red. That's why simple Line commands can't be used—there's no control over the color artifacts.

Finally, a machine-code routine is entered at line 2500 that copies each image in sequence to the center of the screen at sufficient speed to achieve an-

imation. The machine code is POKed into a string from data statements at lines 5000–5100. It's written in position-independent code so it doesn't matter where it resides in RAM. Once the machine code is running, there's no provision to pause or stop it, so you'll have to use the reset button (the program will still be intact).

To set the thing up and get the best illusion, let the program draw two full cubes, then pause it with the shift @. Put your 3-D glasses on with the green filter over your left eye and adjust the monitor controls so that the left eye sees the maximum brightness of blue (or green) cubes and minimum brightness of red cubes. Now close your left eye and adjust so that you get maximum rejection of blue (or green) images and maximum brightness of red.

By doing two or three adjustments of color, brightness, and contrast, it's possible to get a fairly good separation of left and right images with the glasses supplied. Each cube should be about the same brightness balanced with maximum left/right separation to get the best effect. Let the program continue and watch the pretty cube. By the time you read this, I might even be able to enjoy it myself. ■



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Solitary Maneuvers

James Wood

Since Colorful Maneuvers was published in the November 1981 issue of *80 Micro*, I have received several letters requesting more games for the 4K Color Computer. Colorful Maneuvers involves two players each controlling the direction of an ever-growing line. The first player to run his line into itself, the other line, or the border is the loser.

Solitary Maneuvers is for the Color-

Solitary Maneuvers is a follow-up game to Colorful Maneuvers. The computer is the opponent.

ful Maneuvers player when he is without a friend. It's a challenge of one's reasoning ability versus the computer's ability to look ahead of its line and make perfect turns as it approaches a barrier.

Listing 1 is a set-graphics game. If it becomes boring try Listing 2. It is a POKE-graphics version of the same game. With POKE graphics being twice as wide and tall as set graphics, the game proceeds much more rapidly. The POKE game also allows your line, the computer's line, and the border to be different colors. ■

James Wood, a teacher at Atwood Hammond High School, can be reached at 424 N. Missouri, Atwood, IL 61913.

Program Listing 1

```

0 REM JAMES W. WOOD, 424 N. MISSOURI, ATWOOD, IL, 61913, DEC 1981
1 CLS:PRINT:PRINTTAB(12)"TRAP"
2 PRINT:PRINT" USE THE ARROWS TO MANEUVER"
3 PRINT"THE LINE ON THE RIGHT."
4 PRINT" THE COMPUTER CONTROLS THE"
5 PRINT"LINE ON THE LEFT."
6 PRINT" YOU MUST NOT DIRECT YOUR":PRINT"LINE INTO A COLORED SE
CTION."
7 PRINT:PRINT"PRESS <ENTER> TO CONTINUE"
8 A$=INKEY$:IFA$=" "THEN8
9 CLS:INPUT"NAME";G$
10 S=RND(4):CC=0
11 IFS=1THENW$=CHR$(8):R$="A":GOTO15
12 IFS=2THENW$=CHR$(9):R$="D":GOTO15
13 IFS=3THENW$=CHR$(94):R$="E":GOTO15
14 W$=CHR$(10):R$="C"
15 U=12:X=51:V=10+RND(10):Y=10+RND(10)
16 CLS0:Z=RND(8):FORQ=0TO63:SET(Q,0,Z):SET(Q,31,Z):NEXTQ:FORQ=0T
031:SET(0,Q,Z):SET(63,Q,Z):NEXTQ
17 Q$=INKEY$:IFQ$=""THENQ$=W$
18 W$=Q$:CC=CC+1
19 IFQ$=CHR$(8)THENX=X-1:GOTO23
20 IFQ$=CHR$(9)THENX=X+1:GOTO23
21 IFQ$=CHR$(94)THENY=Y-1:GOTO23
22 IFQ$=CHR$(10)THENY=Y+1
23 IFPOINT(X,Y)<>0THEN44
24 SET(X,Y,Z)
25 IFR$="A"THENU=U-1:GOTO29
26 IFR$="D"THENU=U+1:GOTO29
27 IFR$="E"THENV=V-1:GOTO29
28 IFR$="C"THENV=V+1
29 IFPOINT(U,V)<>0THEN30ELSE42
30 IFR$="A"THENONRND(2)GOTO31,32ELSE33
31 IFPOINT(U+1,V-1)=0THENU=U+1:V=V-1:R$="E":GOTO42ELSEIFPOINT(U+
1,V+1)=0THENU=U+1:V=V+1:R$="C":GOTO42ELSEGOTO46
32 IFPOINT(U+1,V+1)=0THENU=U+1:V=V+1:R$="C":GOTO42ELSEIFPOINT(U+
1,V-1)=0THENU=U+1:V=V-1:R$="E":GOTO42ELSEGOTO46
33 IFR$="D"THENONRND(2)GOTO34,35ELSE36
34 IFPOINT(U-1,V-1)=0THENU=U-1:V=V-1:R$="E":GOTO42ELSEIFPOINT(U-
1,V+1)=0THENU=U-1:V=V+1:R$="C":GOTO42ELSEGOTO46
35 IFPOINT(U-1,V+1)=0THENU=U-1:V=V+1:R$="C":GOTO42ELSEIFPOINT(U-
1,V-1)=0THENU=U-1:V=V-1:R$="E":GOTO42ELSEGOTO46
36 IFR$="E"THENONRND(2)GOTO37,38ELSE39

```

Listing 1 continues

0-9	rules
10-14	determines initial direction of lines
15	starting position of lines
16	draws border
17	Inkey for direction to turn your line
19-22	turns your line
23	determines if you lose
24	extends your line
25-28	extends computer's line, but doesn't display it yet
29	determines if computer must turn line
30-41	determines which direction computer should turn
42	extends computer's line
43	loops to line 17 to see if player wants to change direction
44-48	messages for winning or losing

Table 1. Line Description

The Key Box
Color Computer
4K RAM

Listing 1 continued

```

37 IFPOINT(U+1,V+1)=0THENU=U+1:V=V+1:R$="D":GOTO42ELSEIFPOINT(U-
1,V+1)=0THENU=U-1:V=V+1:R$="A":GOTO42ELSEGOTO46
38 IFPOINT(U-1,V+1)=0THENU=U-1:V=V+1:R$="A":GOTO42ELSEIFPOINT(U+
1,V+1)=0THENU=U+1:V=V+1:R$="D":GOTO42ELSEGOTO46
39 IFR$="C"THENONRND(2)GOTO40,41
40 IFPOINT(U+1,V-1)=0THENU=U+1:V=V-1:R$="D":GOTO42ELSEIFPOINT(U-
1,V-1)=0THENU=U-1:V=V-1:R$="A":GOTO42ELSEGOTO46
41 IFPOINT(U-1,V-1)=0THENU=U-1:V=V-1:R$="A":GOTO42ELSEIFPOINT(U+
1,V-1)=0THENU=U+1:V=V-1:R$="D":GOTO42ELSEGOTO46
42 SET(U,V,Z)
43 GOTO17
44 FORE=1TO30:SOUND200,1:SET(X,Y,Z):RESET(X,Y):NEXTE
45 A=A+1:CLS:PRINT"COMPUTER WINS":GOTO48
46 FORE=1TO30:SOUND100,1:SET(U,V,Z):RESET(U,V):NEXTE
47 B=B+1:CLS:PRINTG$;" WINS"
48 PRINT:PRINTCC;"MOVES":PRINT:PRINT"TOTAL WINS":PRINT"COMPUTER"
;A:PRINTG$;B
49 PRINT:PRINT"PRESS <ENTER> TO CONTINUE"
50 A$=INKEY$
51 A$=INKEY$:IFA$=""THEN51ELSE10
    
```

```

1 'JAMES WOOD, 424 N. MISSOURI, ATWOOD, IL, 61913
2 CLS:PRINTTAB(10)"POKETRAP":PRINT:PRINT"USE THE ARROWS TO MANEU
VER":PRINT"THE LINE ON THE RIGHT."
3 PRINT:PRINT"THE COMPUTER CONTROLS THE":PRINT"LINE ON THE LEFT.
":PRINT
4 PRINT"YOU MUST NOT DIRECT YOUR":PRINT"LINE ONTO A COLORED SECT
ION."
5 PRINT:PRINT"PRESS <ENTER> TO CONTINUE"
6 A$=INKEY$:IFA$=""THEN6
7 CLS:INPUT"NAME";G$
10 S=RND(4)
11 IFS=1THENW$=CHR$(8):R$="A":GOTO15
12 IFS=2THENW$=CHR$(9):R$="B":GOTO15
13 IFS=3THENW$=CHR$(94):R$="C"ELSEW$=CHR$(10):R$="D"
15 U=1258:X=1268
16 CLS:FORQ=1024TO1055:POKEQ,255:POKEQ+480,255:NEXTQ:FORQ=1024T
O1504STEP32:POKEQ,255:POKEQ+31,255:NEXTQ
17 Q$=INKEY$:IFQ$=""THENQ$=W$
18 W$=Q$
19 IFQ$=CHR$(8)THENX=X-1:GOTO23
20 IFQ$=CHR$(9)THENX=X+1:GOTO23
21 IFQ$=CHR$(94)THENX=X-32:GOTO23
22 IFQ$=CHR$(10)THENX=X+32
23 IFPEEK(X)<>128THEN44
24 POKEX,191:ONASC(R$)-64GOTO25,26,27,28
25 U=U-32:GOTO29
26 U=U+1:GOTO29
27 U=U+32:GOTO29
28 U=U-1
29 IFPEEK(U)<>128THENONASC(R$)-64GOTO30,33,36,39ELSE42
30 ONRND(2)GOTO31,32
31 IFPEEK(U+33)=128THENU=U+33:R$="B":GOTO42ELSEIFPEEK(U+31)=128T
HENU=U+31:R$="D":GOTO42ELSE46
32 IFPEEK(U+31)=128THENU=U+31:R$="D":GOTO42ELSEIFPEEK(U+33)=128T
HENU=U+33:R$="B":GOTO42ELSE46
33 ONRND(2)GOTO34,35
34 IFPEEK(U-33)=128THENU=U-33:R$="A":GOTO42ELSEIFPEEK(U+31)=128T
HENU=U+31:R$="C":GOTO42ELSE46
35 IFPEEK(U+31)=128THENU=U+31:R$="C":GOTO42ELSEIFPEEK(U-33)=128T
HENU=U-33:R$="A":GOTO42ELSE46
36 ONRND(2)GOTO37,38
37 IFPEEK(U-31)=128THENU=U-31:R$="B":GOTO42ELSEIFPEEK(U-33)=128T
HENU=U-33:R$="D":GOTO42ELSE46
38 IFPEEK(U-33)=128THENU=U-33:R$="D":GOTO42ELSEIFPEEK(U-31)=128T
HENU=U-31:R$="B":GOTO42ELSE46
39 ONRND(2)GOTO40,41
40 IFPEEK(U-31)=128THENU=U-31:R$="A":GOTO42ELSEIFPEEK(U+33)=128T
HENU=U+33:R$="C":GOTO42ELSE46
41 IFPEEK(U+33)=128THENU=U+33:R$="C":GOTO42ELSEIFPEEK(U-31)=128T
HENU=U-31:R$="A":GOTO42ELSE46
42 POKEU,207:GOTO17
44 FORE=1TO20:SOUND10,1:POKEU,191:POKEU,128:NEXTE:A=A+1:CLS:PRIN
T"COMPUTER WINS":GOTO48
46 FORE=1TO20:SOUND200,1:POKEU,207:POKEU,128:NEXTE:B=B+1:CLS:PRI
NTG$;" WINS"
48 PRINT:PRINT"TOTAL":PRINT"COMPUTER",A:PRINTG$;B
49 PRINT:PRINT"PRESS <ENTER> TO CONTINUE"
50 A$=INKEY$
51 A$=INKEY$:IFA$=""THEN51ELSE10
    
```

Program Listing 2

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The program was inspired by a course I teach on applied German phonetics. The class is intended to improve the German pronunciation of our more advanced students and to eliminate some of their American accent. Our students have had about 20 years of practice hearing and speaking

English, and perhaps two or three years speaking German. As with most naive speakers, they have no idea what their mouth is doing when they speak.

To help my students change their ingrained habits I spend some time describing the structure of the sound-producing organs of the mouth. While this has been a help in the past, it is static.

Now I use the Color Computer to dynamically show the different configurations the mouth can take on during the production of different vowels. I chose vowels rather than consonants because German consonants are almost identical with their English counterparts, while the vowels are noticeably different and difficult for an English speaker to master.

Using the Program

The program gives you two options: You can go directly to an abstract schematic drawing, including all the vowels in their correct relative position in the mouth, or you can specify a certain vowel.

The first option is useful for gaining the overall picture. This option is a subroutine that you can enter either here, before displaying any one vowel, or again between displays of the individual vowels for reorientation. If you don't use this subroutine the program will ask you to input a vowel. This can be any simple vowel listed (see Program Listing 2, line 20), or

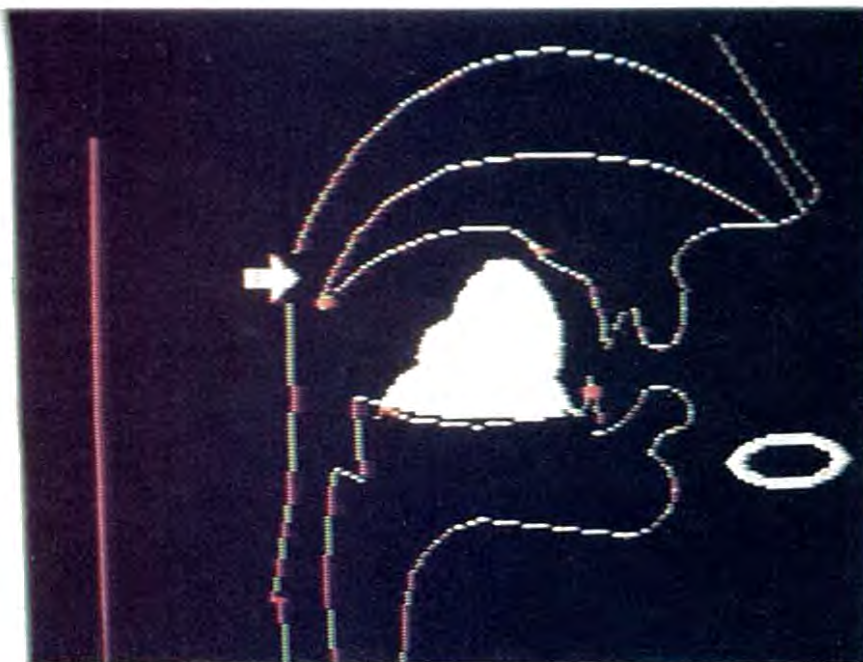


Photo 1

The Key Box

Color Computer
16K RAM
Extended Color Basic

diphthong. You can also specify whether you want a nasal or non-nasal version of the vowel. After you have entered a vowel, the program draws the mouth and tongue and displays the completed drawing (Photo 1.)

If you specify a diphthong, the graphics screen is called at the first tongue position, then the shift of the tongue and lips is drawn visibly. With German vowels, the position of the lips is also important in vowel production. Therefore the program displays a schematic front view of the lips to show whether they are rounded or spread. In English the lips are always rounded for the vowels u and o, as in boot or bow (and arrow), and spread for i and e, as in heat or bet. German has vowels, the so-called Umlaut vowels, where the tongue is in the front of the mouth, as for English i or e, but the lips are rounded as for English u or o. The program shows this. During the display of the diphthong oi, the change of lip position is also shown.

At this point the display is held until you make further input. If you hit any key except enter the program will loop back to the question "Diagram? (Y/N)." This means that after each time a vowel is shown, you can return to the diagram showing the schematic containing all the vowels. If you press N the program will move on to the input statement again, and you can enter a new vowel for display.

Pressing the enter key during vowel display enables the pointer routine. A menu is displayed from which you can pick any of 13 predefined positions in the mouth, or define your own position. The routine returns immediately to the graphics screen, this time with an arrow pointing at the chosen spot. Hitting any key erases this arrow. Then you can call the pointer routine again or return to show the schematic.

Once the program is begun, the only way to end it is by using the break key. Inappropriate input at any other point goes to a default routine and recycles to a predetermined point.

Program Description

When you turn on the Color Computer, it automatically reserves four pages of video memory (4 by 1.5K bytes), and 200 bytes of string space. However, if these numbers are changed any time while the computer is on, either by direct command or as part of a program, the computer uses the new parameters until they are changed again. When we revised this program, we included line 5 as a safety

measure. If the program does not load, you will have to issue the direct commands NEW: PCLEAR4: CLEAR50 to make sure there is enough free memory available.

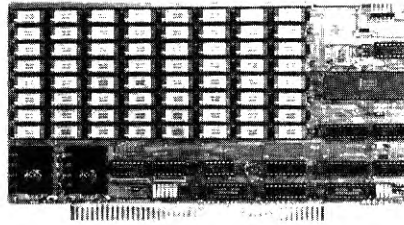
Another solution is to write a separate loading program, as we did when using five pages of video memory (see Program Listing 1.) This assures that there will be no problem in relocating the main program if a different PCLEAR command is given. This also makes it possible to eliminate line 5 from the main program. If you choose this method (highly recommended whenever your program requires more than four pages of video memory), it is best to enter this program, then

CSAVE it under an appropriate name. Issue the New, the appropriate PCLEAR and the Clear commands directly, then key in the main program. CSAVE the main program directly after the loader program, but without a name. From this point on you will experience no problems in loading and running your program. The repetition of line numbers in the two programs is no problem—when you CLOAD the main program it overwrites the old program.

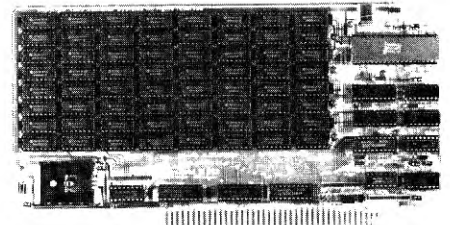
Line 10 dimensions the two arrays used for the arrow, and for returning the original graphics after the arrow is erased.

Line 50 clears and provides a blue

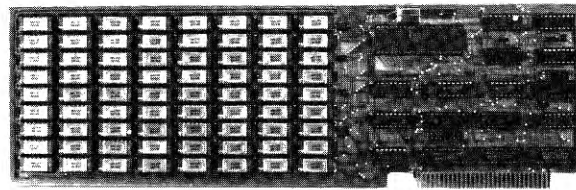
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✓ 372

text screen. A blue screen is much less glaring when switching back and forth between text and graphics with its black background. It also avoids a momentary flash of garbage on the screen that the CLS0 command gives every time you call the text screen.

Lines 60-70 set the graphics mode 4, the highest resolution, requiring four pages of video memory. They also set the starting page at page 1, and clear all this memory, making it ready for drawing. Lines 100-130 draw a small arrow in the lower left corner of the screen and fill it in (Paint). The information for this drawing is then stored in the array AR, with full graphic detail (G) for later use. Finally, the drawing is erased using a Preset and BF (box fill) command. If this were not done, the arrow would always be present in the lower left corner when the graphics screen was called. Incidentally, you can use this technique in any program when you want to erase only a certain portion of the screen.

Lines 140-280 draw the lower portion of the head from the level of the lower teeth on down. Up until this point, nothing has been displayed on the screen. If you would like to see the

computer draw, insert a line 90 SCREEN1,1. This calls the graphics screen, and you can see the arrow being drawn, erased, and then the lower mouth appear. This portion stays fixed. In PMODE4, each page of video memory contains the information for 1/4 of the graphics screen. Even though the first drawing is done at the middle of the screen, it is stored in pages 3 and 4 of video memory.

Lines 450-460 represent the reentry point after each vowel display, giving

the possibility of going to the schematic. Line 300 skips this option the first time through, since it had already been given earlier (line 15). Here and at other places in the program we used an INKEY\$ routine (lines 8000-8010) to perform two functions. It holds the present display until some input is given and it is used as the check for processing commands. This approach eliminates the use of the INKEY\$ subroutine followed by an input command, which requires another key-

Program Listing 1

```

5 CLEAR 50
10 DIMAR(16,12),AE(16,12)
15 CLS:PRINT" FOR SCHEMATIC, PRESS <S>, OTHERWISE HIT AN
Y OTHER KEY TO CONTINUE":GOSUB 8000
16 IF I$=CHR$(83)THEN GOSUB 10000
20 CLS:PRINT"AVAILABLE OPTIONS ARE:":PRINT"A A: E E: I I: O O: U
U:":PRINT"AI AU OI":PRINT"UMLAUTS: UE U:E OE O:E":PRINT"SCHWA:
@":PRINT"TYPE 'N' AFTER ANY VOWEL TO SHOWNASALIZATION.":PRINT:PR
INT"PRESS ANY KEY FOR NEW VOWEL."
30 PRINT"TO ACTIVATE THE POINTER, PRESS <ENTER> DURING THE VOWE
L DISPLAY. TO EXIT, PRESS ANY KEY TWICE EXCEPT <ENTER>."
40 PRINT:PRINT"PRESS ANY KEY WHEN READY.":GOSUB8000
50 CLS3
60 PMODE4,1
70 PCLS
95 'DRAW FIGURE
100 LINE(12,176)-(4,182),PSET:LINE-(12,188),PSET:LINE-(12,184),P
SET:LINE-(20,184),PSET:LINE-(20,180),PSET:LINE-(12,180),PSET:LIN
E-(12,176),PSET
110 PAINT(11,179) 'DRAW ARROW
120 GET(4,176)-(20,188),AR,G
130 LINE(4,176)-(20,188),PRESET,BF 'ERASE ARROW
140 CIRCLE(112,75),80,,.4,.17,.3 'MOUTH BOTTOM
150 LINE(88,106)-(86,96),PSET 'LOWER TEETH #1
160 LINE-(83,108),PSET 'LOWER TEETH #2
170 CIRCLE(86,96),18,,.9,.28,.45 'LOWER LIP #1
180 CIRCLE(65,106),10,,.8,.4,.85 'LOWER LIP #2
190 CIRCLE(60,117),8,,.9,.75,1 'LOWER LIP #3
200 CIRCLE(75,127),15,,.87,.22,.68 'CHIN
210 LINE(75,139)-(120,134),PSET'LOWER JAW
220 CIRCLE(118,159),25,,1,.77,1 'ADAMS APPLE
230 LINE(143,160)-(144,181),PSET 'NECK
240 CIRCLE(210,101),35,,2.5,.4,.54 'WINDPIPE
250 LINE(157,101)-(155,123),PSET 'FRONT WINDPIPE #1
260 LINE-(163,120),PSET 'FRONT WINDPIPE #2
270 CIRCLE(62,151),105,,1.5,.97,.04 'GLOTTIS
280 LINE(181,156)-(179,181),PSET 'BOTTOM WINDPIPE
300 GOTO500
450 CLS3:PRINT"DIAGRAM? (Y/N)":GOSUB8000
460 IF I$=CHR$(89)THENGOSUB10000
500 GL=0:Y=15:A=0
510 CLS3:LINE INPUT"WHAT VOWEL? ";V1$
520 IF RIGHT$(V1$,1)="N" THEN A=1:V1$=LEFT$(V1$,LEN(V1$)-1)
530 IF V1$="A:"THENY=11
540 IF V1$="U:" OR V1$="I:" OR V1$="E:" THEN Y=18
600 CIRCLE(120,82),50,,.55,.15,.35 'BASIC TONGUE #1
610 CIRCLE(120,106),30,,.6,.5,1 'BASIC TONGUE #2
620 PAINT(125,95) 'BASIC TONGUE #3
1000 LINE(233,181)-(233,15+Y),PSET 'BACK OF NECK
1010 IFA<>1THEN CIRCLE(77,Y+35),30,,.6,.08,.2:CIRCLE(130,Y+75),5
0,,.8,.65,.93:GOTO1030 'ROOF
1020 CIRCLE(77,Y+35),30,,.6,.08,.2:CIRCLE(130,Y+74),50,,.8,.65,.
7:CIRCLE(117,85+Y),60,,.8,.72,.92 'ROOF NASAL
1030 CIRCLE(131,Y+71),50,,.9,.52,.58 'TOP TEETH #1
1040 LINE(81,Y+70)-(76,Y+61),PSET 'TOP TEETH #2
1050 CIRCLE(65,Y+60),8,,1.5,1,.59 'TOP LIP
1060 PRESET(65,Y+72) 'ERASE
1070 CIRCLE(41,Y+49),20,,.6,.71,.1 'NOSE BOTTOM
1080 CIRCLE(36,Y+29),20,,.5,.28,.63 'NOSE
1090 LINE(22,Y+22)-(47,Y-11),PSET 'UPPER NOSE
1100 CIRCLE(95,71+Y),85,,.93,.58,.968 'UPPER NASAL
1110 IFA<>1THEN CIRCLE(95,81+Y),90,,.7,.64,.93:GOTO1130 'LOWER N
ASAL

```

Listing 1 continues

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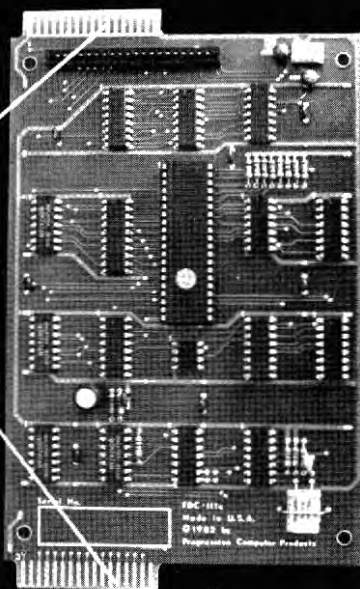
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1120 CIRCLE(95,81+Y),90,,.7,.64,.8:CIRCLE(110,73+Y),60,,.9,.79,.
96 'LOWER NASAL
1130 LINE(176,96)-(176,49+Y),PSET 'UP WINDPIPE
2000 GOSUB3000:IF V1$=""THEN2500
2010 SCREEN1,1
2020 GOSUB8000
2100 IFI$<>CHR$(13)THEN2300
2110 CLS:PRINT"SELECT POINTER POSITION":PRINT"PRINT" A NOSE":PR
INT" B NASAL PASSAGE":PRINT" C UPPER LIPS":PRINT" D UPPER TEETH"
:PRINT" E ALVEOLAR RIDGE":PRINT" F SOFT PALATE":PRINT" G VELUM"
2120 PRINT" H LOWER TEETH":PRINT" I TONGUE":PRINT" J FRONTAL VIE
W, LIPS":PRINT" K GLOTTIS":PRINT" L VOCAL CORDS":PRINT" M BACK O
F NECK":PRINT" N MANUAL OPERATION";
2130 GOSUB 8000
2140 PT=ASC(I$)-64:IF PT>14ORPT<1THEN2110
2150 IFPT=1THEND1=40:D2=40
2160 IFPT=2THEND1=90:D2=10
2170 IFPT=3THEND1=74:D2=72
2180 IFPT=4THEND1=86:D2=72
2190 IFPT=5THEND1=105:D2=52
2200 IFPT=6THEND1=140:D2=42
2210 IFPT=7THEND1=173:D2=63
2220 IFPT=8THEND1=90:D2=92
2230 IFPT=9THEND1=105:D2=89
2240 IFPT=10THEND1=48:D2=114
2250 IFPT=11THEND1=168:D2=118
2260 IFPT=12THEND1=183:D2=165
2270 IFPT=13THEND1=237:D2=150
2280 IFPT=14 THEN CLS3:INPUT"SUPPLY X AND Y COORDINATES";D1,D2
2290 SCREEN1,1:GET(D1,D2)-(D1+16,D2+12),AE,G:PUT(D1,D2)-(D1+16,D
2+12),AR,PSET:GOSUB8000:PUT(D1,D2)-(D1+16,D2+12),AE,PSET:GOTO 20
20
2300 CLS3:PRINTCHR$(128);:LINE(5,104)-(45,136),PRESET,BF
2500 PMODEL,1:PCLS:PMODE4,1
2510 GOTO450
3000 IF V1$="A:" THEN RETURN
3010 IFV1$="AI"THEN SCREEN1,1:GL=1:V1$="E":GOSUB4000
3020 IF V1$="AU" THEN SCREEN1,1:V1$="O":GL=1:GOSUB4000
3030 IF V1$="OI" THEN CIRCLE(130,108),23,,1.2,.52,1:PAINT(130,88
):SCREEN 1,1:GOSUB5010:GL=1:V1$="E":GOSUB4000
3040 IF V1$="A" THEN CIRCLE (120,100),35,,.6,.5,1:PAINT (120,85)
:RETURN
3050 IFV1$="O:" THEN CIRCLE(130,100),23,,1.2,.52,1:PAINT(130,80)
:GOSUB5010:RETURN
3060 IFV1$="O" THEN CIRCLE(130,108),23,,1.2,.52,1:PAINT(120,88):
GOSUB4000:GOSUB5010:IF GL=1 THEN V1$="U" ELSE RETURN
3070 IF V1$="U:" THEN CIRCLE(130,90),23,,1.3,.55,1.1:CIRCLE(115,
90),18,,.6,.1,.88:PAINT(130,80):GOSUB 5010:RETURN
3080 IF V1$="U" THEN CIRCLE(130,100),23,,1.3,.62,1:CIRCLE(115,90
),18,,.6,.1,.88:PAINT(111,85):PAINT(130,80):GOSUB5010:RETURN
3090 IF V1$="@" THEN CIRCLE(120,100),36,,.69,.5,1:PAINT(120,80):
RETURN
3100 IF V1$="E" THEN CIRCLE(101,93),15,,.80:PAINT(95,90):GOSUB60

```

are three different jaw positions, 18 different tongue configurations, two (or three) lip positions, and two positions for the velum, which causes nasalization.

Lines 3010-3030 identify the diphthongs. For any of these three, the SCREEN1,1 command is given immediately, instead of waiting to return from the subroutine to line 2010. This means that the first tongue position is shown immediately. We divided each diphthong into three positions: beginning, intermediate and final. After calling the graphics screen, the flag for a diphthong is set to one, V1\$ is redefined for the intermediate position, and a short time loop is entered. Processing drops through until V1\$ is found again, and this is then drawn over the existing position. Since GL is still one, V1\$ is redefined, and the subroutine is run through until the final member is displayed, again drawn over the existing display. Since there are three different cases (ai, au, oi) where each time three separate vowels will be displayed, the order in subroutine 3000-3170 is important. The order must be (ai, oi, au) followed by a, o (u), e, i (u). The position of the other vowels is unimportant.

The extra Paint commands in lines 3080 and 3120 are needed to display diphthongs because over-drawing is done. Without them some portion of the tongue would remain unpainted. Finally, the two subroutines at line 5010 and 6010 give the frontal view of the lips. In the case of oi, both possibilities will be displayed, with the spread lips drawn over the rounded lips.

Once the program has drawn the tongue position, execution returns from this subroutine. If V1\$ is empty, the program jumps to line 2500, then recycles; otherwise, the graphics screen is called. Issuing two SCREEN1,1 commands has no adverse effect when you input the diphthongs. This display remains until you input again. Hitting any key but enter causes a jump to line 2300. This clears the text screen, and calls it up blank, while the next commands are carried out. The first of these, Line . . . Preset, BF, erases the area where the frontal view of the lips was displayed.

Line 2500 shows how to erase the upper half of the display. Shift momentarily to the PMODE 1,1, which requires two pages (pages 1 and 2) of video memory. Then the PCLS command automatically erases the first two pages and you shift back to PMODE 4. This technique leaves the

stroke followed by an enter.

Line 500 reclears the text screen, and initializes the flags for diphthong (glide) GL, and for nasalization A, as well as the variable Y, which determines the degree to which the mouth is open (15 is the neutral position).

After a slight delay, the input command appears on the display, and this input is assigned to V1\$. A Line Input command has to be used in line 510, since the colon represents vowel length (the simple input command would ignore this). Line 520 is a check for nasalization. If the right-most element of the input string is N, the flag A is set to one, and the input string (V1\$) is redefined to eliminate this N.

Lines 530 and 540 reset Y in the case of an open vowel (a:) or closed vowels (i: u:, u:e). Otherwise Y retains its neutral value of 15. Lines 600-620

paint the basic tongue position (A:), and lines 1000-1140 complete the drawing of the head and mouth.

The check in lines 1010 and 1110 is necessary because of the option for showing nasalization. Nasalized vowels require that the roof of the mouth and the bottom of the nasal passage be drawn in a different position, allowing the velum to appear open. If the vowel is not nasalized, then the velum is drawn closed (lines 1020 and 1120).

The subroutine in lines 3000-3170 gives the individual draw commands for the different tongue positions. Line 3180 is the default routine for inappropriate input. Redefining V1\$ as empty enables us to skip the SCREEN1,1 command upon return (see line 2000).

Not counting the diphthongs, there

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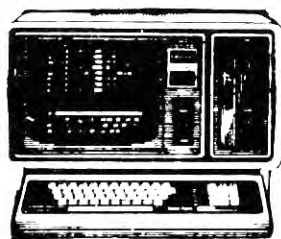
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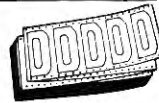
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top of the screen erased and ready for drawing and the bottom half untouched. Control returns to line 450 to give the option for the schematic, and then to reset variables and ask for more input. The video memory setup makes it possible to reenter here, rather than returning to line 50 and having the whole lower half of the screen redrawn each time.

If the time delay doesn't bother you, two solutions allow you to run the program with four pages of video memory. The first of these is to send control back to line 50, as mentioned above. Simply delete line 2500 and change line 2510 to read GOTO 50.

Line 2510 must also be changed to . . . THEN 50. The other way is to use a Preset and BF command. In this case, change line 2500 to LINE(20,96)-(178,0), PRESET,BF. Line 2510 remains unchanged.

The pointer subroutine is in lines 2100-2290. While the program displays the graphics, hitting the enter key enables this routine. This routine displays a menu listing 13 different positions where you can place the arrow. This routine lets you point out one particular part of the vocal tract. The most likely places are pre-defined, but there is also the option for manual operation, where you can sup-

ply your own X and Y coordinates. Line 2140 converts the input to usable form, and lines 2150-2270 set the correct coordinates.

The arrow displayed comes from the array AR, which we loaded earlier in the program (lines 100-120). Before we can use the Put command, we must save the graphics contents of the area where the arrow is to appear. The AE (arrow erase) array accomplishes this. The graphics information contained in the area given by the coordinates is first stored in AE, and then the arrow is displayed. Hitting any key puts the contents of AE back into the same area, thus returning what was there and erasing the arrow. The AR array is defined once at the beginning, and never changed, while the AE array is redefined every time you make a new choice. At this point a jump is made back to line 2020, where you can again call the pointer routine or return to the schematic input option.

Lines 10000-10230 are the subroutine for drawing the schematic of the mouth. This outline is shown on the text screen, so the entire graphics screen does not have to be erased and then redrawn after this subroutine. M\$ and N\$ in line 10000 define the characters used in lines 10140-10160 and lines 10170-10190 for drawing the lines separating the mouth into nine areas. L\$ marks the short vowel with a comma, indicating laxness.

Lines 10010, 10030, 10060 and 10110 print the labels. These are in lowercase in the Program Listing because in the actual display they are reversed (green letters on a black background). To enter them this way, type the quotation marks, shift 0, the label, and then shift 0 again before closing the quotes. Line 10070, which reads in part PRINT AT 339, CHR\$(93); CHR\$(91), prints left and right brackets in the lower right section of the central field. This marks the area of production for a German vowel, which is usually symbolized as an inverted V. This seemed the best solution, given the possible letters that could be used otherwise.

We would appreciate any comments readers might have for improvements to or other uses for the program. In return we are also willing to make cassette copies of this program available to anyone who will send us a blank cassette and the return postage. ■

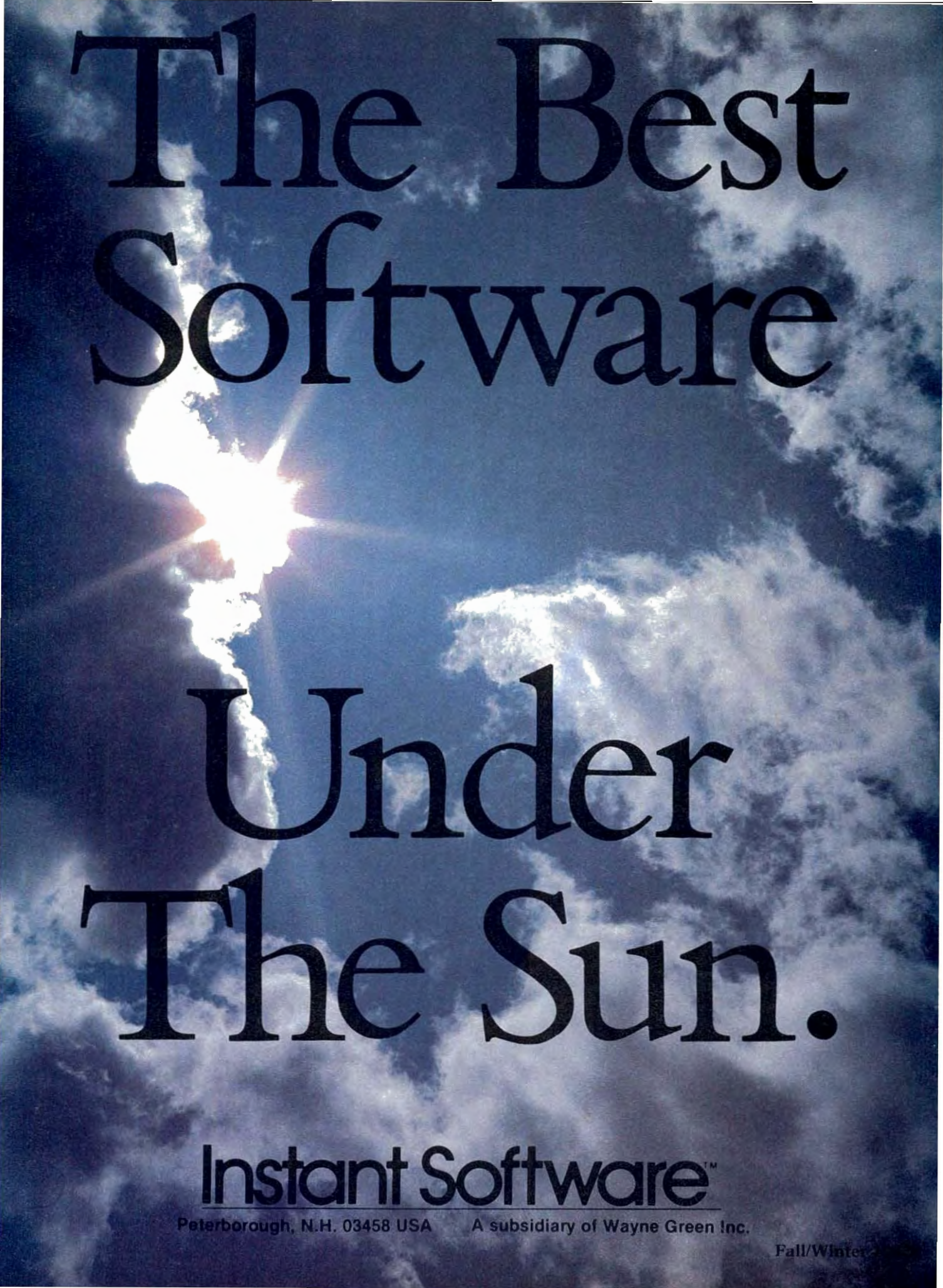
Dr. Alan Lacy (526 N. 14th St., Milwaukee, WI 53233) is an associate professor of German at Marquette University.

Program Listing 2

```

10:GOSUB4000:IF GL=1 THEN V1$="I" ELSE RETURN
3110 IF V1$="E:" THEN CIRCLE(95,93),10,,1.3,,.1,,83:CIRCLE(110,90
),17,,.6,,.51,1.1:PAINT(90,90):GOSUB6010:RETURN
3120 IFV1$="I"THEN CIRCLE(100,90),15,,1.1,,.2,,.9:CIRCLE(125,91),2
3,,.49,.62,1.1:PAINT(90,85):PAINT(120,83):GOSUB6010:RETURN
3130 IF V1$="I:"THEN CIRCLE(111,87),18,,1.3,,.39,.95:CIRCLE(128,
90),10,,1.7,1.2:PAINT(111,75):GOSUB6010:RETURN
3140 IF V1$="U:E" THENCIRCLE(111,87),18,,1.3,,.39,.95:CIRCLE(128,
90),10,,1.7,1.2:PAINT(111,75):GOSUB 5010:RETURN
3150 IF V1$="UE" THEN CIRCLE(100,90),15,,1.1,,.2,,.9:CIRCLE(125,91
),23,,.49,.62,1.1:PAINT(90,90):GOSUB5010:RETURN
3160 IF V1$="O:E"THEN CIRCLE(95,93),10,,1.3,,.1,,83:CIRCLE(110,90
),17,,.6,,.51,1.1:PAINT(90,90):GOSUB 5010:RETURN
3170 IF V1$="OE"THEN CIRCLE(101,93),15,,.80:PAINT(95,90):GOSUB50
10:RETURN
3180 V1$="":CLS0:PRINT@195,"SORRY, YOU MADE AN ERROR.":;PRINT@23
0,"PLEASE BEGIN AGAIN.";
3190 FOR T=0TO800:NEXTT
3200 RETURN
4000 FOR T=0TO300:NEXT T
4010 RETURN
5000 'ROUND LIPS
5010 CIRCLE (25,120),20,,.85
5020 CIRCLE (25,120),15,,.85
5030 PAINT (42,120)
5040 RETURN
6000 'SPREAD LIPS
6010 CIRCLE (25,120),15,,.4
6020 CIRCLE (25,120),20,,.4
6030 PAINT (42,122):PAINT(8,122)
6040 RETURN
8000 I$=INKEY$
8010 IFI$=""THEN8000ELSERETURN
10000 L$="":M$=CHR$(128):N$=CHR$(140)
10005 CLS:PRINT"TO EXIT THIS ROUTINE, PRESS ANY KEY":FOR B=1TO2:
GOSUB4000:NEXT
10010 CLS:PRINT@6,"front":;PRINT@15,"central":;PRINT@26,"back";
10020 PRINT@70,"I:(U:E)":;PRINT@94,"U:";
10030 PRINT@96,"high";
10040 PRINT@134," I (UE)":;PRINT@156,"U":;PRINT@167,L$:;PRINT@18
8,L$:;
10050 PRINT@263,"E:(O:E)":;PRINT@273,"@":;PRINT@283,"O:";
10060 PRINT@288,"mid";
10070 PRINT@328,"E(OE)":;PRINT@339,"[]":;PRINT@345,"O";
10080 PRINT@360,L$:;PRINT@377,L$:;
10090 PRINT@36,STRING$(28,N$);
10100 PRINT@388,STRING$(28,N$);
10110 PRINT@433,"A":;PRINT@448,"low":;PRINT@465,L$:;
10120 PRINT@497,"A:";
10130 PRINT@196,STRING$(28,N$);
10140 FOR P=78 TO 494 STEP 32
10150 PRINT@P,M$:;
10160 NEXT
10170 FOR P=86 TO 503 STEP 32
10180 PRINT@P,M$:;
10190 NEXT
10200 FOR P=68 TO 486 STEP 32
10210 PRINT@P,M$:;
10220 NEXT
10230 GOSUB8000:RETURN

```

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See page 4 for BUSINESS ANALYSIS, BOWLING LEAGUE SECRETARY and ELECTRONIC BREADBOARD. Page 5 has information on EASY-CALC. See the inside back cover for the ad on our great GENERAL LEDGER package.

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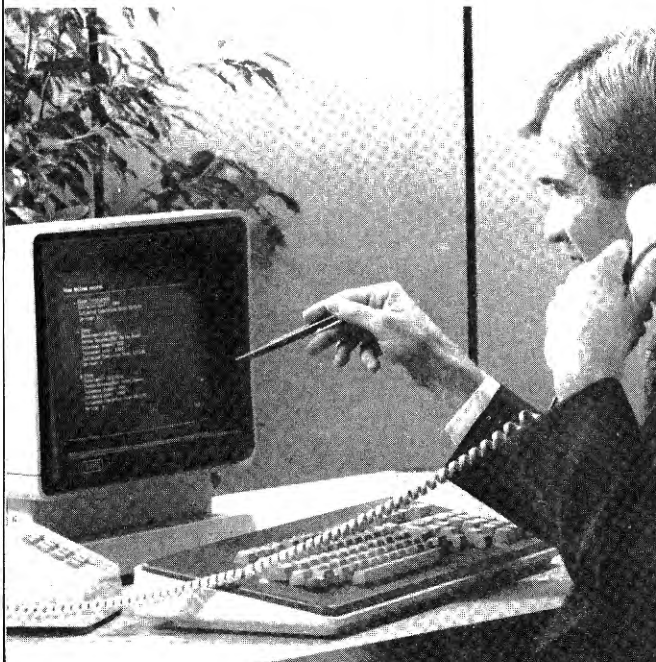
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Photo courtesy of Wang.



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Requires Scriptit and a compatible printer.

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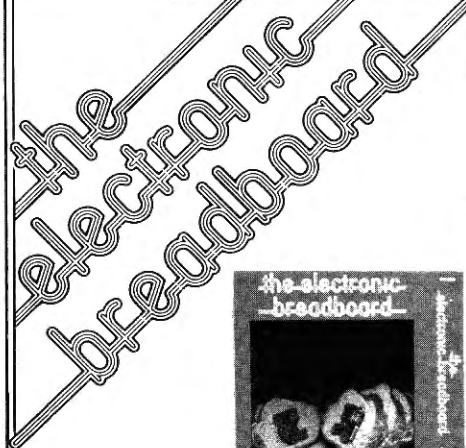
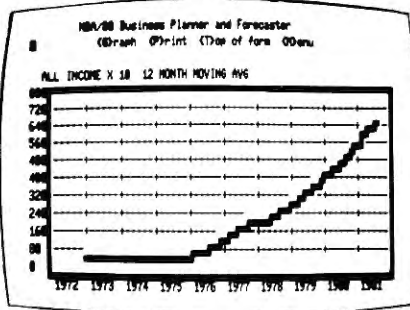
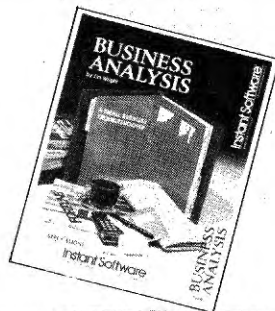
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ELECTRONIC BREADBOARD assists in the design and analysis of analog circuits and can be used to evaluate voltages, currents, impedance, and the frequency response of any circuit as well as dozens of other applications. Students verify electrical theory by entering sample circuits and determining frequency response. The documentation includes a tutorial designed to increase the newcomer's understanding of electronics. An ideal program for audio component repair technicians, electrical engineers, electricians, and students of electronics.

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 TRS-80 Disk Mod I and Mod III 32K 0222RD \$59.95
 Apple Disk Applesoft 32K 0428AD \$59.95

ELECTRONICS DESIGN CALCULATOR

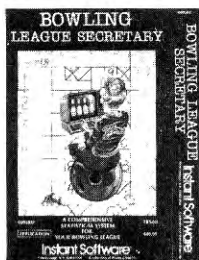
Dozens of complex calculations are computed and brought down to size with this comprehensive program. Calculations are given and displayed in their most readable form for reactance, resonant frequency, resistors and capacitors in parallel and series, along with over two dozen other complex formulas. Free yourself from the drudgery of endless calculating.

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astrology

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Here's a disk version of this essential program with all the above features PLUS...more storage capabilities (store up to 250 bowlers and 40 teams!), and the ability to record individual handicaps. You can utilize two different formats with the printout option, and, should you have any problems, simply type HELP to receive an explanation of what information is needed—complete with a sample entry.

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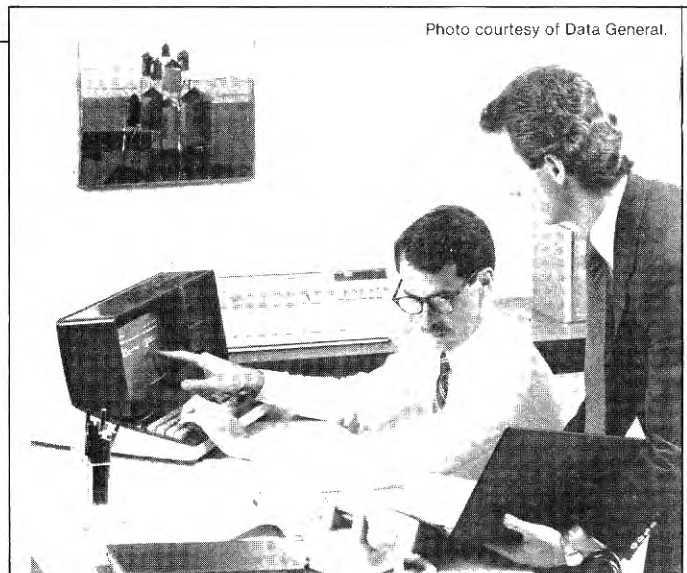
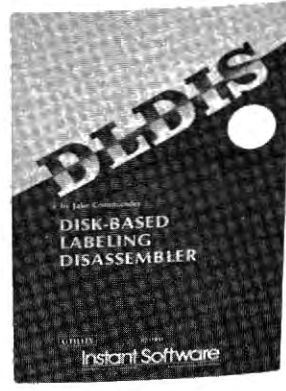
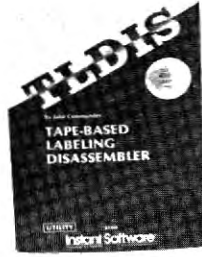
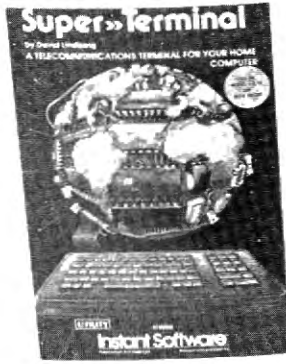


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See page 7 for SUPER>>TERMINAL. Page 8 has information on TLDIS, DLDIS and ASSEM/ZSIM.

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double listing

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apple clinic



The programming aids package for the Apple programmer: DISK DOC aids in documenting and maintenance of Apple DOS 3.2; APDOC helps APPLESOFT II programmers; COMPARE documents the line-by-line difference between two versions of the same program. Apple Disk Applesoft 32K 268AD
\$29.95

DISK EDITOR

Edit any track of any standard single-density disk in any drive; byte-by-byte! Now you can read and write to otherwise inaccessible sectors; modify system files; search for any eight-character string; and print any video display.

TRS-80 Disk Mod I Only 32K 180RD **\$39.95**

PROGRAMMER'S CONVERTER

Convert decimal numbers to binary, octal or hexadecimal—and back again. You get 1) straightforward conversions; 2) practice doing the conversions yourself; and 3) conversion quizzes. A great tool for beginning programmers!

TRS-80 Tape Mod I & Mod III 16K 0058R **\$14.95**

THE COMMUNICATOR

Provides an excellent, but economical means of communicating between HOST and REMOTE terminals. Lets you orchestrate the functions of your remote keyboard, RS-232C output and input ports, and your host terminal video display.

TRS-80 Tape Mod I only 16, 32 and 48K 0126R **\$14.95**

Super>>Terminal

Turn your ordinary TRS-80 into a Superterminal! Integrate all your microcomputer components with this super software. This package means SPEED: lets you simplify procedures for signing-on, transmitting files, and communicating with any remote computer system. It means POWER: integrate and orchestrate all communication pathways between your terminal and all peripherals. It means SIMPLICITY: comprehensive Menus permit you to select from many options at-a-glance. And it means VERSATILITY: make Special Command tables for arranging your various commands, make Control Key tables for adding previously inaccessible characters, and—it is compatible with any DOS! Other super features include direct XYZ cursor addressing and screen, cursor and printer controls, a text editor, HEX conversion utilities, plus compatibility with all present ROMs and DOSs! Get speed, power, simplicity and versatility—all in one super package! Requires RS-232C Interface.

TRS-80 Disk Mod I & Mod III 32K 5700RD **\$95.00**

DYNAMIC DEVICE DRIVERS

Reprogram your keyboard, video display and printer to make them perform better for you! Customize the commands your computer sends to its components and add some helpful features to your system!

TRS-80 Tape Mod I Only 16K 0228R **\$19.95**

TRS-80 Disk Mod I Only 16K 199RD **\$24.95**

disk-tape exchanger

Manipulate and manage your magnetic media! Put your tape files on disk where they're easier to work with; put your disk files on tape for reasons of storage space and cost; manage your media with no mistakes! TRS-80 Disk Mod I Only 32K 248RD
\$24.95



In reference to
**SUPER>>TERMINAL
(5700RD)...**

"...we had tried several different telecommunications packages, all which either did not meet our needs, or were insufficient in user friendliness. When we received SUPER>>TERMINAL, it opened up an entirely new dimension to the things that we could do. Without your program, I fear that we would not have been able to manipulate information with the ease and confidence that we do now. Please continue to produce products of this quality."

Bruce A. Bergman
Micro Programmer/Analyst
Seattle Pacific University
Seattle, WA 98119

* LABEL

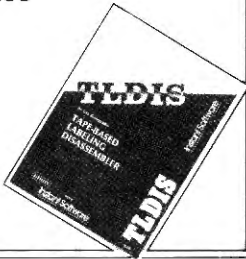
Free yourself from the tyranny of confusing line numbers! Label your BASIC program subroutines; GOTO 9105 becomes GOTO BUBBLE SORT ROUTINE, for example. Write and debug your programs more efficiently!

TRS-80 Tape Mod I & Mod III 16K 0168R **\$24.95**

TERMINAL-80

Plug your TRS-80 terminal into the world! This package lets you use your computer from remote terminals, communicate with just about ANY other computer system via your modem, and even transfer program code over the phone! Requires Expansion Interface and RS-232 Serial Interface.

TRS-80 Tape Mod I & Mod III 16K 0130R **\$24.95**



ASSEM/ZSIM

Assembly language programmers: solve all your programming problems from Assem. to Z-sim! ASSEM, the 3-pass editor/assembler, uses little RAM; provides a powerful line editor, is compatible with any parallel-port printer; and executes w/out modification on 16, 32, or 48K systems, w/1, 2, 3 or 4 disk drives! And ZSIM, the machine code simulator/debugger, emulates instructions using simulated registers; displays mnemonics for each instruction using ASSEM's symbol table; works as well in ROM as in RAM! This package allows you to assemble directly to disk, tape or memory—directly from disk, tape or memory! Trace program execution through ROM to debug larger, more complicated programs with speed and accuracy!

TRS-80 Disk Mod I only 32K 365RD **\$119.97**

PET UTILITY I

Two great programming aids for the PET enthusiast! With MONITR you can edit, save and verify any machine-language program while still having access to BASIC; and use the PROGRAMMER'S CALCULATOR as a floating-point calculator and to do decimal-binary-octal-hexadecimal conversions!

PET Tape Old and New ROM 8K 0105R **\$14.95**

UTILITY II

Great programming aids formerly available only in more expensive utility packages; search through any Level II tape to find filespecs, merge any two BASIC programs or any BASIC program w/one or more machine-language programs!

TRS-80 Tape Mod I Only 16K 0076R **\$14.95**

TLDIS

The tape-based disassembler that automatically assigns labels to machine language program routines. You can send the disassembly to your printer or save it on tape for editing and reassembly using Radio Shack's EDTASM.

TRS-80 Tape Mod I & Mod III 16K 0230R **\$19.95**

ULTRA-MON

The unique and powerful machine-language monitor that displays, disassembles, traces (hardcopy trace disassembly, too!), modifies, relocates memory, prints and even relocates itself with simple commands. Designed for the beginner as well as the professional programmer.

TRS-80 Tape Mod I & Mod III 16K 5003R **\$24.95**

ZSIM

Debug larger, more complicated programs with this simulating, labelling debugger! Any debugger will enhance the usefulness of your assembler, but only ZSIM can make your programming tasks easier! ZSIM

*****RUNS machine code instructions one-at-a-time at your bidding;

****EMULATES the instruction using simulated registers;

**INTERRUPTS the simulations whenever any one of a large number of user-specified conditions are met;

****DISPLAYS mnemonics for each instruction, using convenient labels;

*****LISTS register contents and corresponding memory locations.

ZSIM works on ROM as well as RAM since you don't need breakpoints to retain execution control (although breakpoint operation is also available). This is the best tool available to examine your code in DETAIL!

TRS-80 Tape 16K 0376R **\$29.95**

EDTASM

The disk-based disassembler that automatically assigns labels to machine language program routines. You can send the disassembly to your printer to say it on disk for editing and re-assembly using Apparat's extension of EDTASM!

TRS-80 Disk Mod I Only 32K 231RD **\$24.95**

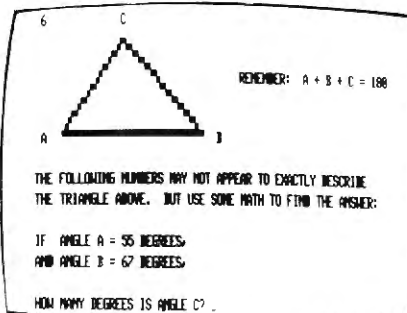
THE DISASSEMBLER

A single-pass, HEX-notation disassembler that sends output to tape or your line printer; shows displacement and absolute address of any relative jumps made by the disassembled program; displays any ASCII characters used in an LP or CP opcode.

TRS-80 Tape Mod I & Mod III 16K 0232R **\$14.95**

ed-u-ca-tion

Photo courtesy of Bell & Howell.



THE ELEMENTS

Here's a more interesting approach to learning the Periodic Table of Elements that every high school student will welcome. Quiz sections provide questions and answers that deal with element names, atomic numbers, weights and symbols. The reference section gives all information for each element.

TRS-80 Tape Mod I and Mod III 16K 0216R **\$17.95**

TRIANGLE TRIG

Trigonometry made painless! Triangle Trig is a step-by-step guide to Triangular Geometry and Beginning Trigonometry that reviews all necessary mathematical skills. Abundant graphics, careful explanations, and practice using new skills in practical situations make this one of the best tutorial programs we've seen. Suitable for advanced upper-elementary students through adults.

TRS-80 Tape Mod I and Mod III 16K 0309R **\$19.95**

WORDWATCH

Entertainment and education combined! Develop language skills using these four fun programs.

WORD RACE A game for two Grand Prix drivers who can define words quickly and accurately.

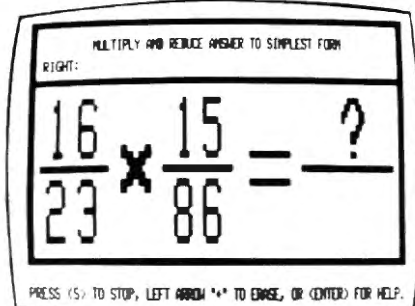
HIDE N SPELL Spot the misspelled word before you lose any points. Then spell it correctly!

SPELLING BEE Spell the word you hear on a cassette recorder and the computer will give you hints.

SPELLING TUTOR The computer gives you hints: words spelled backwards, or with missing or mixed up letters. You spell the words correctly.

Teachers and parents can easily put their own words and definitions in all these programs. Even German vocabulary can be fun! Interest level—age 6 through 12.

TRS-80 Tape Mod I and Mod III 16K 0111R **\$14.95**



MATH MASTER

Practice makes perfect. And now students get a chance to practice math skills at their own pace and on their own. MathCard presents addition, subtraction, multiplication and division problems using the time-honored flash card method. MathFrac gives practice in adding, subtracting, multiplying and dividing fractions. 25 levels of difficulty are available for elementary through junior high school students.

TRS-80 Tape Mod I and Mod III 16K 0257R **\$17.95**

CAPITALIZATION

This educational program introduces and exercises the twelve rules of capitalization in English. Students can progress at their own pace. An optional Model Mastery worksheet is provided for student and teacher use. Recommended for ages 12 through adult.

Apple II Disk Applesoft 32K 0339AD **\$24.95**

VIDEO SPEED-READING TRAINER

Increase your reading efficiency! If you read like t-h-i-s, Video Speed-Reading Trainer can train you to quickly recognize letters and numbers so that you'll begin to read whole phrases at a glance. Advance at your own pace to increased speed with better retention and recall.

For ages 12 to adult.

TRS-80 Tape Mod I and Mod III 16K 0100R **\$14.95**

In reference to
TRIANGLE TRIG
(0309R) . . .

"Excellent intro to Trig!!! Strongly suggest anyone who needs a review or who is planning to take Advanced Math take this course."

Laurence C. Lee
Kansas City MO 64138

POLYGONS

Lots of graphics and careful explanations introduce students to regular polygons. The program then delves into these related topics:

1. Circular approximation and calculation of pi.
2. Combinatorial associations of vertex points.
3. Tessellation of the plane or "mosaics" using regular and semiregular polygons.

Suggested grade level—high school through adult.

TRS-80 Tape Mod I and Mod III 16K 0244R **\$14.95**



See page 10 for the GEOGRAPHY EXPLORER SERIES and page 11 for the TYPING TEACHER.

GEOGRAPHY EXPLORER: USA

GEOGRAPHY EXPLORER SERIES

Here are three programs that will turn your children's lessons into child's play. Essential geographical facts are presented in an entertaining manner with fun features like animated graphic rewards for correct answers. Practical features, such as lesson planning suggestions and study aids, assure the educational benefits of these superior programs. Disk versions provide an additional "Teacher Options" file that allows parents or teachers to choose question format, determine which facts a student can view, and select scoring methods. Upper elementary through adult.

GEOGRAPHY EXPLORER: USA contains three lesson sets that include every state's location, capital, area in square miles, and population as well as other pertinent information.

GEOGRAPHY EXPLORER: EUROPE and **GEOGRAPHY EXPLORER: MID EAST** provide three lesson sets that include each country's name, government, chief export, language, geographical features, and many other important facts.

GEOGRAPHY EXPLORER: USA

TRS-80 Tape Mod I and Mod III 32K 0086R \$29.95
 TRS-80 Disk Mod I and Mod III 32K 0071RD \$49.95

GEOGRAPHY EXPLORER: EUROPE

TRS-80 Tape Mod I and Mod III 32K 0259R \$29.95
 TRS-80 Disk Mod I and Mod III 32K 0121RD \$49.95

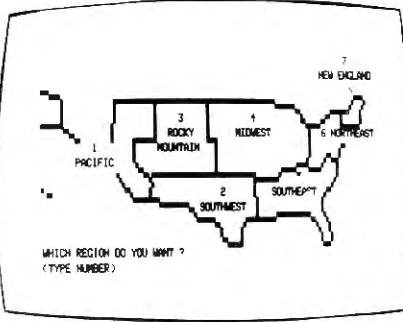
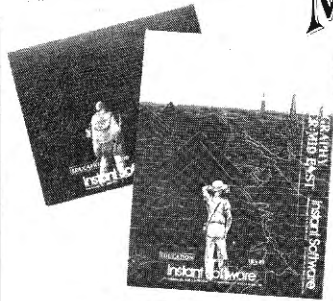
GEOGRAPHY EXPLORER: MID EAST

TRS-80 Disk Mod I and Mod III 32K 0276RD \$49.95
 TAPE NOT AVAILABLE

MID EAST

Europe

GEOGRAPHY EXPLORER USA



TEACHER

Create a computer teaching system for any subject! **TEACHER** allows you to record up to 20 questions and answers per lesson. Students can then do these lessons independently. You may choose to allow them to review the material beforehand, to receive hints, and to see animated displays as rewards for correct answers.

TRS-80 Tape Mod I and Mod III 16K 0065R \$14.95

TEACHER'S AIDE

Teachers, parents and students themselves can record a sequence of questions with answers. Create your own lessons, quizzes, tests and learning games. Correct answers are rewarded by some very clever video animations. Revise/update your lessons at will. Save student score in separate limited access file!

TRS-80 Disk Mod I & Mod III 32K 214RD \$39.95

GRADE BOOK

Use the speed and accuracy of your computer to calculate student grades. Grade Book enables you to do the following without hassles.

1. Calculate quarterly, monthly or other periodic averages using as many as five categories (tests, quizzes, homework classwork and projects).
2. Calculate semester and yearly averages.
3. Weight category and periodic scores, and convert raw scores to percentage points.

(No printer option.)

TRS-80 Tape Mod I and Mod III 16K 0050R \$14.95

Omni CONVERTER

One liter of gas is how many gallons? Convert one unit of measurement to another within each of 10 categories: length, volume, mass, velocity, area, density, power, energy, pressure and stress, and temperature. With all possible units within each category (including metric), the number of conversions you can do instantly is almost infinite. You can even print your results! Optional printer.

TRS-80 Tape Mod I and Mod III 16K 0200R \$14.95



Photo courtesy of Bell & Howell.

ARCHIMEDES' APPRENTICE

Learn the formulas for determining the volume of various geometric figures and be quizzed on your new abilities. Shapes include parallelepipeds, prisms, pyramids, cylinders, cones and spheres. Suggested grade levels: 6 through 12.

TRS-80 Tape Mod I and Mod III 16K 0092R \$14.95

SURVEYOR'S APPRENTICE

Learn the formulas for finding the areas within various geometric figures—AND how to use these formulas! This excellent learning tool even provides quizzes to sharpen your new skills to perfection!

TRS-80 Tape Mod I & Mod III 16K 0127R \$14.95

Omni CALCULATOR

Three simple-to-use programs that enable you to measure, calculate and convert quantities with ease:

ARCHIMEDES' APPRENTICE Learn how to find the areas of three dimensional figures. (See package #0092R.)

SURVEYOR'S APPRENTICE Learn how to find the areas of two dimensional figures. (See package #0127R.)

OMNICONVERTER Convert from one unit to another—effortlessly. (See package #0200R.)

TRS-80 Disk Mod I and Mod III 32K 0211RD \$29.95

Beginner's RUSSIAN

Learn Russian easily with this comprehensive language course. Learn to recognize the letters of the Cyrillic alphabet and practice pronouncing Russian words. As your skill increases, you'll advance to the next section, conquering the basics of Russian step-by-step.

TRS-80 Tape Mod I and Mod III 16K 0136R \$14.95

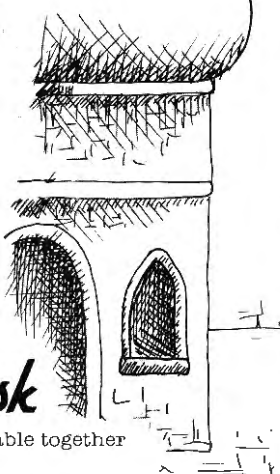
Everyday RUSSIAN

Now that you have the Russian alphabet down-pat with BEGINNER'S RUSSIAN (0136R), you can begin to speak EVERYDAY RUSSIAN. Quickly learn to read and speak necessary Russian words and phrases in the comfort of your home. You'll also learn the order of the Cyrillic alphabet for referencing in Russian dictionaries. Learning Russian couldn't be easier with this patient and never-tiring tutor.

TRS-80 Tape Mod I and Mod III 16K 0137R \$14.95

1. КОФЕ	COFFEE
2. ЧАЙ	TEA
3. МОЛОКО	MILK
4. ЛИМОНАД	LEMONADE

TYPE 8 TO GO ON.
WHICH WORDS DO YOU WANT TO TRANSLATE?
TYPE THE NUMBER...



RUSSIAN Disk

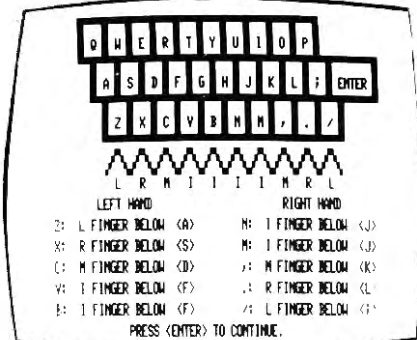
Beginner's Russian and Everyday Russian are available together on one convenient disk.

TRS-80 Disk Mod I and Mod III 32K 0212RD \$29.95

Apple Disk Applesoft 32K 0283AD \$29.95



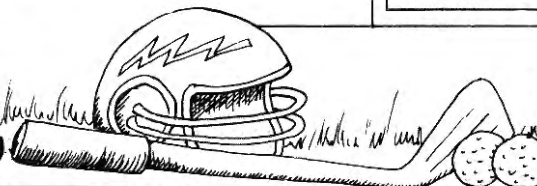
TYPING TEACHER



You'll never have to hunt-and-peck again! A seven-part tutorial allows you to advance at your own speed, providing plenty of space for practice without wasting paper. On-screen displays keep eyes up and away from the keyboard to develop proper technique. There's no teacher more patient than this program.

TRS-80 Tape Mod I and Mod III 16K 0099R \$17.95

GAMES



GOLF

Sit back and enjoy a rugged, challenging 18 hole game of golf! Get a complete choice of clubs and shooting angles—and let your computer keep score for you! For one or two players.

Apple Tape Applesoft 16K 0018A \$14.95

PET DEMO I

7 exciting games—a new challenge for every mood. Gamble, shoot, race and chase as you enjoy SLOT MACHINE, CHASE, FLYING PHEASANT, SITTING DUCKS, CRAPS, GRAN PRIX 2001, and FOX AND HOUNDS. Ages 7 through adolescence. Arcade.

Pet Tape Old and New ROM 8K 0035P \$14.95

CHIMERA

A legendary fire-breathing creature; or six fearsome arcade games for your Pet. Think quick and challenge your reflexes with DRAGON, DRAGON HUNT, DUNGEON, DROPOFF, REFLEX, and BATTER UP. Ages 7 through adolescence.

Pet Tape Old and New ROM 8K 0110P \$14.95

DUNGEON OF DEATH

Each step you take through the 12 levels of this diabolical maze brings you closer to the ultimate treasure... the Holy Grail. Hideous monsters and unspeakable dangers dog your every step. And once you find your treasure, you'll find yourself face-to-face with the most fearsome Smaug. Only those with supreme courage dare enter the DUNGEON OF DEATH. Adventure.

PET Tape Old and New ROM 8K 0064P \$14.95

HOUSE OF 30 GABLES

Tread softly as you enter the mysterious House of Thirty Gables. Inside awaits golden treasure for the stout of heart. But beware! Serpents, dragons and trolls lurk within, ready to trap the unwary stranger. Adventure.

TRS-80 Tape Mod I and Mod III 16K 0219R \$14.95

TURF AND TARGET

Here's the perfect package for the sportsman! Catch all the action—even when it's 20 below—with QUARTERBACK, SOCCER II, SHOOT, and TARGET. Ages 8 through adolescence. Arcade.

Pet Tape Old and New ROM 8K 0097P \$14.95

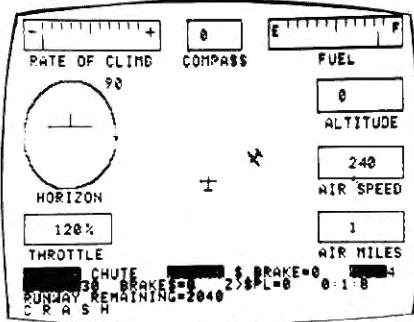
NIGHT FLIGHT

Dangerous photo-recon missions await as you wing your way through the murky night with only your instrument panel to guide you. This program lets you takeoff, land, and fly in a simulation so real we've included the basic principles of flight in the instructions.

TRS-80 Tape Mod I and Mod III 16K 0117R \$14.95

Apple Disk Applesoft 32K 0304AD \$24.95

JET FIGHTER PILOT



Takeoff, intercept the enemy, navigate to the airport or carrier, and land. Jet Fighter Pilot takes you as close to real combat flying as possible... without pulling G's. A challenge you will never outgrow—Jet Fighter Pilot offers you more commands and controls than any other flight simulation we know of! Simulation.

TRS-80 Tape Mod I and Mod III 16K 0159R \$14.95

Apple Disk Applesoft 32K 0329AD \$24.95

MUSIC MASTER

Turn your computer into an electronic organ and play music using this quartet of programs. **MICRO ORGAN** Your computer keyboard becomes an organ keyboard.

KALEIDOPY A combination of a kaleidoscope and a player piano... Watch while the computer creates a pattern and plays it as music.

COMPOSER Generate quasi-random music with a repeating refrain.

KEYMANIA Compete to reproduce the greatest number of notes generated by your computer. TRS-80 Tape Mod I and Mod III 4K 0084R \$14.95

PERFECT PONG

Ping Pong has entered the space age! Turn your computer into a fast-paced action machine. Hit the "ball" with your paddle—don't let it disappear off the screen! Choose from 8 different game boards. Arcade TRS-80 Tape Model I only 16K 0120R \$14.95

Domes of Kilgari

You are doomed to the lonely wasteland of the planet Kilgari forever—unless you can penetrate the Digitron Ion Station, (which is programmed to destroy all intruders) and retrieve an Ion rod to replenish your fuel supply. Puzzles and mazes abound in this high-caliber adventure.

TRS-80 Tape Mod I Only 16K 5014R \$19.95

TRS-80 Disk Mod I Only 32K 5015RD \$29.95

TRS-80 Disk Mod III 32K 5016RD3 \$29.95

MIMIC

A fast action memory game that tests your concentration and reflexes. Your computer flashes number sequences and you repeat them within the time limit. With three skill levels and sound effects option.

TRS-80 Tape Mod I Only 16K 0066R \$14.95

PET Tape Old and New ROM 8K 0039P \$14.95

Apple Tape 16K 0025A \$14.95

HOOPTEDOODLE

8 entertaining programs for you and your PET to enjoy. Among the many feats you'll be challenged to accomplish are to...make your way through a seemingly endless maze and avoid the monster within, cross treacherous mine fields, and fly dangerous bombing missions. Great for children. Arcade.

PET Tape Old and New ROM 8K 0091P \$14.95

TEMPLE OF THE SUN

You have discovered the ancient ruins of the long lost Temple of the Sun. Hidden in the underground chambers are treasures beyond your wildest dreams and the key that unlocks the magical powers of the Shamon, an order of supremely powerful wizards. Adventure.

TRS-80 Tape Mod I Only 5012R \$19.95

TRS-80 Disk Mod I Only 5011RD \$29.95

TRS-80 Disk Mod III 5013RD3 \$29.95

THE BUSINESS GAME

Play the game of tough-minded business persons. This game simulates an actual period in U.S. economic history; you manage your business by making hard decisions, bargaining, competing and (hopefully) succeeding! It's fast, challenging, rewarding and entertaining.

Let us give you the Business!

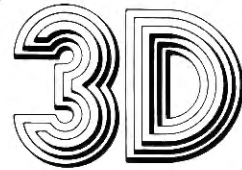
TRS-80 Tape Mod I & Mod III 16K 0158R \$14.95

Z-80 CHECKERS

An excellent version of computer checkers that has some outstanding features unavailable elsewhere: seven different skill levels, a board Editor, a practice mode, and more!

TRS-80 Tape Mod I & Mod III 16K 0310R \$14.95

Gomoku & Tic Tac Toe



A dynamic duo of popular games: GOMOKU, the ancient oriental board game of strategy and a three-dimensional version of tic-tac-toe.

Choose among different board sizes for even more challenge!

TRS-80 Tape Mod I & Mod III 16K 0210R \$14.95

PET Tape Old and New ROM 8K 0038P \$14.95

ARCADE I

Here's a package sure to please whether you like your fun in or out-of-doors.

KITE FIGHT You'll find high-flying excitement in this computer version of a sport the people of Japan and India have enjoyed for centuries.

PINBALL combines the superb graphics of the PET and the classic features of arcade pinball to provide a game so real, all you'll miss is the TILT. Audio amplifier and speaker required for sound. PET Tape Old and New ROM 8K 0074P \$14.95

ARCADE II

Challenge your memory and sharpen your reflexes with this package that offers something for everyone. Catch the elusive UFO before it gets away. **HIT** the target, if you can aim while your moving. **BLOCKADE** Skill and strategy are necessary to block your opponent's path without letting him block yours.

PET Tape Old and New ROM 8K 0045P \$14.95

SWAMP WAR

You are stranded on a wet and definitely unwonderful waterworld inhabited by some pretty slimy swamp creatures. Your only hope is to get the parts from the abandoned transporters located on the nearby islands to make repairs. This might not be an easy task, seeing as how a lot of crud and creatures stand between you and these spare parts. Do your best to rid the islands of their inhospitable inhabitants, collect all transporters, and get outta town!

Joysticks optional.

TRS-80 Tape Mod I and Mod III 16K 0312R \$14.95

ALL STARS

A collection of our most popular games.

SANTA PARAVIA (see program #0043R) Take the reins of this medieval city-state and control the lives of the serfs who produce the wealth of the realm. Your title and domain will increase if you rule well.

OIL TYCOON (see program #0023R) Two players compete to become top oil magnate in this game of strategy and luck.

PARADISE TRADER As captain of a trading schooner, you sail your ship about the Carribean acquiring valuable cargo, while you attempt to avoid pirates, ghost ships, and hurricanes.

MILLIONAIRE Can you turn \$1000 into \$1,000,000 in 15 years? It depends on your financial finesse in business dealings as you buy and sell properties, negotiate bank loans, collect rentals and accept bids.

TIMBER BARON Shrewd strategy is the key to your success as you attempt to avoid the many hazards of this profitable industry.

BATTLEGROUNDS (see program 0141R) You and your opponent command Allied and Axis forces in this World War II simulation. Find out if you're the stuff generals are made of.

TRS-80 Disk Mod I and III 32K 0213RD \$34.95

MENTAL GYMNASTICS

Challenge your mind with these ancient games.

REVERSI—An OthelloTM—type game

WARI—A real test of mental concentration.

Adolescence through adult. Strategy.

Heath Tape Benton Harbor BASIC 8K

0087H \$14.95

OIL TYCOON

Test your skill at money making as an oil magnate. Strategy and fate decide whether you'll increase your millions by out-drilling and under-selling your competitor, or lose your fortune to an oil spill. Two players.

TRS-80 Tape Mod I & Mod III 16K 0023R \$14.95

Apple Tape Applesoft 16K 0079A \$14.95

KID'S GALLERY

Here are 5 games that will keep the younger members of the family and their friends playing for hours.

3-D Tic-Tac-Toe You can play on the traditional 3x3x3 board or try the more difficult 4x4x4 version. Four levels of play.

Haunted House Escape the Haunted House by finding the right curse against resident ghosts, vampires and werewolves.

Shoot-out You and a friend compete to see who's fastest on the draw.

Frog Mountain Help Freddy the frog catch his lunch of bugs and butterflies and rack up your points.

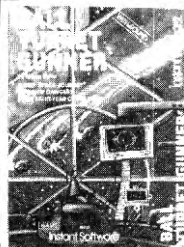
Vegas Here's a slot machine you and your friends can play without putting in a penny.

TRS-80 Tape Mod I Only 16K 0172R \$14.95

BALL TURRET GUNNER

Fight back against the Petro Giants that threaten your existence! Enter the elite service of the BTG; maneuver your laser cannon; destroy the invading gnat ships—just hope that you're equipped to deal with conditions in your space-zone. Fast action that's part of a tense interstellar drama! Arcade Sound.

TRS-80 Tape Mod I and Mod III 16K 0051R \$14.95



WHO DUN IT?

Two highly entertaining games that challenge your deductive powers. In WHO DUN IT? you're the crack detective who must investigate and solve any of five dastardly crimes. The second game, EDUCATION, is a game of logic that tests your deductive skills!

TRS-80 Tape Mod I & Mod III 16K 0047R \$14.95

MOUNTAIN PILOT

The fast buck can still be made... but there's a price. If you can bring supplies to the desperate miners of Goldtown, you'll be paid well. Your return trip with the gold bouillon is the real payload though. The catch? Can you make it through treacherous Eagle Pass not once, but TWICE?! Simulation

TRS-80 Tape Color Computer/Extended BASIC 0370RC 16K \$19.95



Battleground

It's late 1944 and the Allied Forces are sweeping toward Berlin. As the commander of your sector, you control tanks, planes, artillery, infantry, engineers, bunkers, and vehicles. The battle map shows how you have chosen to deploy your forces. Shoot, attack, drop paratroopers, lay mines. For two players.

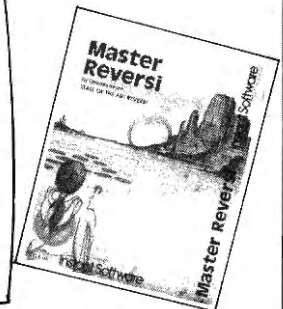
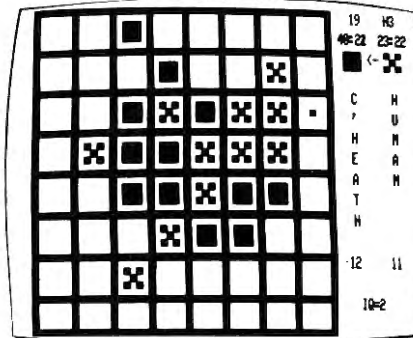
Strategy.

TRS-80 Tape Mod I and Mod III 16K 0141R \$14.95

Tower of Fear

Enter the castle of Blackheart Flamethrower, the last of the magnificent wizards who's magical prowess has conquered even death. Many have tried to penetrate this fortress but none survive to tell the story of the treasures and terror that await therein. Adventure.

TRS-80 Tape Color Computer 16K 5020RC \$19.95



Master Reversi

Overcome all barriers standing between you and an Othello championship. Match your wits against a topnotch, tournament-winning program. "Reversi" is an ancient board game that challenges you to bracket your opponent's piece and reverse them so your color shows. Master Reversi is special because it allows you to analyze your moves as well as the computer's moves and the games in amazing depth. No other program offers so many ways to improve your game. Master Reversi will challenge you, teach you and bring you innumerable hours of fun, no matter what your degree of expertise!

TRS-80 Tape Model I and III 16K 0417R \$19.95

MASTER REVERSI—Disk Version

All the features described for Master Reversi are contained on the disk PLUS you get a library of tournament games that you can study and even replay.

TRS-80 Disk Models I only 16K 0378RD \$24.95

Games

IQ TEST

There aren't too many of us who can justifiably claim to be a genius, but here's your chance to find out if your hunch is right. IQ Test will administer and score an intelligence test in just 30 minutes. While we wouldn't suggest you use this program in place of the tests administered by trained psychologists, you'll find them sufficiently accurate to be fun and entertaining.

TRS-80 Tape Mod I and Mod III 16K 0157R \$14.95

MINDWARD

Two devilishly-intricate games for the math-minded: MIND TWIST gives you a number series for which you must determine the correct formula; and MIND BENDER is a multi-level code game in which you must guess the next number in your computer's "secret" numeric sequence. The game theoretician's delight!

TRS-80 Tape Mod I & Mod III 16K 0118R \$14.95

DRAGONQUEST

The princess has been captured and you, faithful knight, must safely deliver her from the clutches of the most fearful Smaegor, monarch of dragons. Locate the weapons, charms, and tools you need to accomplish your task, but act quickly, for Smaegor dines when the sun sets. Adventure.

TRS-80 Tape Mod I and Mod III 16K 5006R \$15.95

TRS-80 Disk Mod I and Mod III 32K 5010RD \$21.95

INVESTOR'S PARADISE

Experience all the thrills and triumphs of the stock market without risking a dime.

STOCK TREK Can you transform \$5000 into a fortune in just 12 short months? Only if you possess the financial savvy to invest wisely and read the market right. Play with up to 5 other investors.

SPECULATION Short of actually investing real cash, this is the closest you can come to playing the stock market. Start with up to \$10,000 and an equal amount deposited in a savings account, then make your money work for you. Big risks can mean big gains, and just as well, big losses.

Both simulations are a great way to learn all about the stock market and preview your money-making abilities before you attempt the real thing.

TRS-80 Tape Mod I and Mod III 16K 0125R \$14.95

DANGER IN ORBIT



Nerves of steel and lightning reflexes will enable you to blast the alien ships and destroy the asteroids! Watch out! Your antimatter cannon fire will split the asteroids into smaller and smaller bodies that can still destroy your spaceship. The action game for action-lovers! Arcade. Sound. Joysticks optional.

TRS-80 Tape Mod I and Mod III 16K 0237R \$19.95

TRS-80 Disk Mod I and Mod III 16K 0247RD \$24.95

Air Flight Simulation



Takeoff, land, use flight instruments and perform daring aerial stunts. This simulation reproduces all the basic flying characteristics of a light aircraft. Do your crashing now—before you try the real thing!

TRS-80 Tape Mod I and Mod III 16K 0017R \$14.95

Apple Tape Applesoft 16K 0148A \$14.95

RAMROM PATROL

The Space Age has begun! But with new universes to explore come new dangers to combat in this package of exciting children's games.

RAMROM PATROL Defend the earth by shooting down the enemy ships.

TIE FIGHTER Man your X-wing fighter to destroy the Empire's dreaded Tie Fighters.

KLINGON CAPTURE Capture the newest battle cruiser, the pride of the Klingon's fleet, without destroying it!

TRS-80 Tape Mod I and Mod III 16K 0028R \$14.95

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Talk to a brilliant psychoanalyst—he'll listen empathetically and respond on your computer screen. He can coax your innermost feelings out of you. Dr. Chips is also a great ice-breaker at cocktail parties and a natural way to introduce your noncomputer friends to the computer.

TRS-80 Tape Mod I and Mod III 16K 0218R \$14.95

Apple Disk Applesoft and Integer 32K 0254AD \$19.95

DOODLES & DISPLAYS II

Six creative graphics programs in one package: DOODLE PAD lets you draw pictures and save them on tape; SYMMETRICS is a computer kaleidoscope; DRAWING is for the serious computer artist; RANDON PATTERN DISPLAY makes your computer do the artwork; MATH CURVES brings geometry lessons to life; and RUG PATTERNS helps you design rugs and just about anything else!

TRS-80 Tape Mod I only 16K 0042R \$14.95

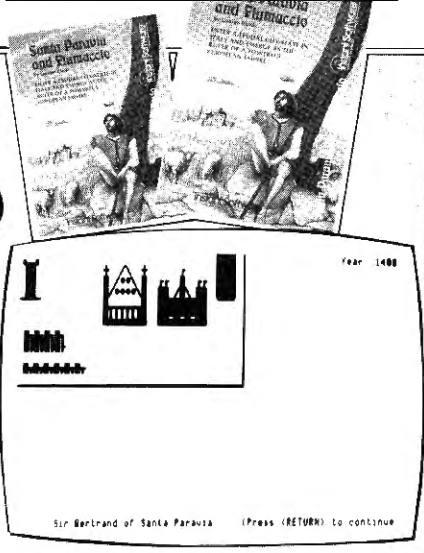


See page 14 for DANGER IN ORBIT, page 15 for ALIEN ATTACK FORCE and SANTA PARAVIA AND FIUMACCIO, page 16 for SKYBOMBERS, KITCHEN SINK and FLIGHT PATH.

Santa Paravia and Fiumaccio

You control grain harvests, set tax rates, and exercise justice in your attempt to increase your title and turn this insignificant city-state into a powerful kingdom. A classic strategy game that teaches modern economics in a medieval setting.

TRS-80 Tape Mod I & Mod III 16K 0043R \$14.95
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SPARROW COMMANDER

You have read about those brave men defending their ancient castle with a Kitchen Sink (see program #0386RD) and other oddments. Now the other side of the story can be told. Choose your strategy to guide your troops safely to their nesting ground amidst the barrage of shells, safes, and even kitchen sinks that their merciless enemies, the Cloud People, rain down upon them. As fearless leader of the sparrows, you can make the difference between sparrow survival and bird obliteration. Now you can experience the feeling of raw power as the brain behind the birds—the brave SPARROW COMMANDER. Arcade. Sound. TRS-80 Disk Mod I and Mod III 32K 0387RD \$19.95

MINOTAUR

Go far into the future to meet the past! The Labyrinth of ancient Crete has been recreated by the diabolic king of the planet of New Crete. The intended victims are your clones!—Your only source of wealth and prestige! Become a Lord Citizen of the forbidding planet. Strategy. Sound. TRS-80 Tape Mod I and Mod III 16K 0318R \$14.95

LIFE

Creation made easy! With this educational program your computer becomes a mini-laboratory. You can study the life cycle of cellular colonies choosing the formations you wish to observe, and even experiment with cell structures of your own invention. Ages 12 to adult. TRS-80 Tape Mod I Only 16K 0078R \$14.95

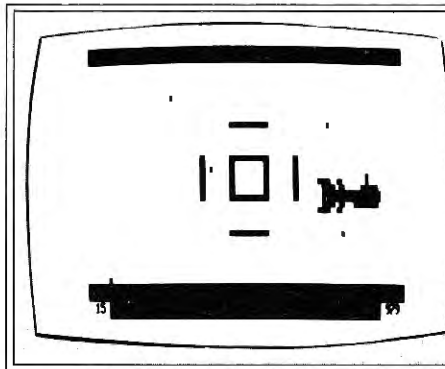


COSMIC PATROL

A quick wit and reflex are required by players in this space odyssey where you must do unto others before they do unto you. For each Quelon space ship you miss, precious units of your energy supply will be drained resulting in the loss of life and limb of said player. Fast real-time action, optional sound and remarkable graphics put this machine language program at the head of its class. Arcade. Joysticks optional. TRS-80 Tape Mod I and Mod III Sound Option 16K 0223R \$19.95
 TRS-80 Disk Mod I and Mod III Sound Option 16K 0224RD \$24.95

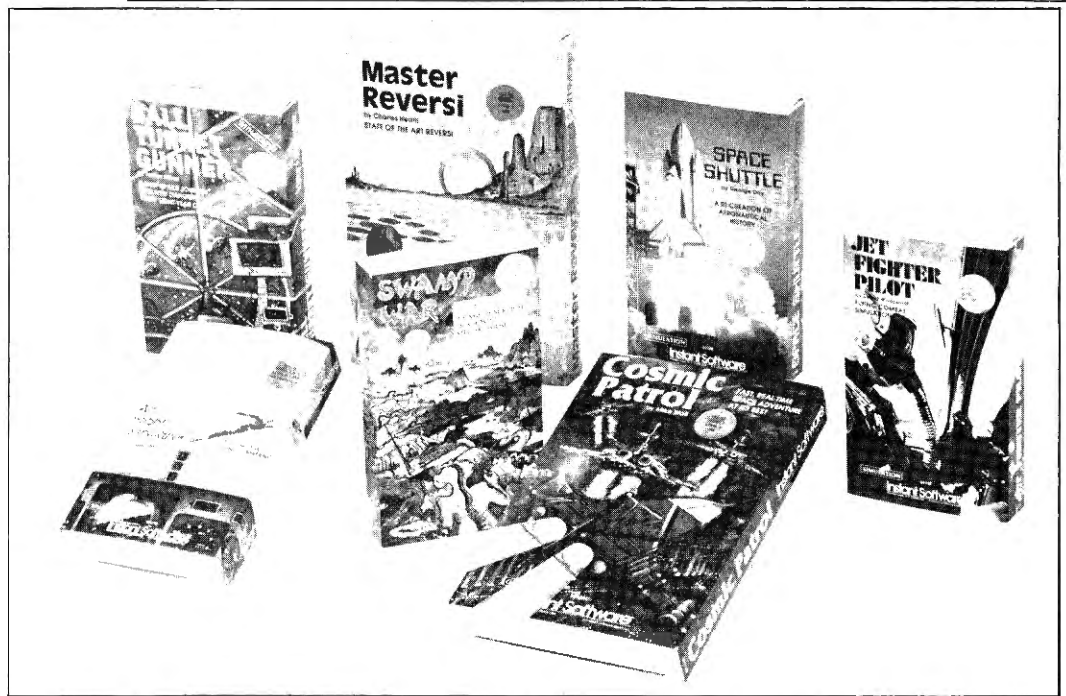
PADDLE FUN

Four action-filled games challenge your prowess. *ALIEN ATTACK FORCE* Destroy the 55 invading flying saucers before they destroy your antimatter gun. *SPACE WARS* Try to disable your friends flying saucers. . . . *HOWITZER* Aim accurately and choose the optimum firing velocity. Destroy the enemy's gun! Apple Disk Applesoft 32K 0163AD \$19.95

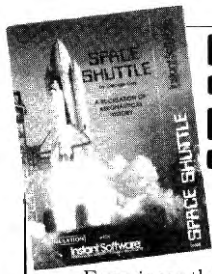


ALIEN ATTACK FORCE

With all of Earth's defenses dead, you are the last vestige of hope for the planet as hundreds of armed invaders make their way to attack. Nine levels of difficulty continue to challenge you as your skills increase. Arcade. Joysticks optional. TRS-80 Tape Mod I and Mod III 16K 0240R \$14.95

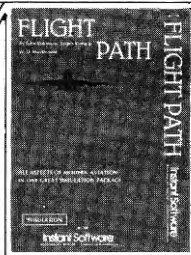


See page 12 for SWAMP WARS and JET FIGHTER PILOT, Page 13 for BALL TURRET GUNNER and MASTER REVERSI, page 14 for AIR FLIGHT SIMULATION, page 15 for COSMIC PATROL and, page 16 for SPACE SHUTTLE.



SPACE SHUTTLE

Experience the Ultimate Flight. Command the next launch of the space shuttle Columbia; its orbit, entry and landing procedures are all in your control. A NASA engineer says this simulation is quite close in design to the one astronauts use for training!
 TRS-80 Tape Mod I & Mod III 16K 0332R \$19.95



FLIGHT PATH

These three tantalizing flight games will whet your appetite for aviation:
MOUNTAIN PILOT Fly over Eagle pass. (See package #0362AD).
PRECISION APPROACH RADAR Land a UFO! (See package #0362AD).
O'HARE Be in charge of the control tower of a busy airport. Direct the speed and approach of 20 planes. The safety of each person aboard depends on your skill! Simulation.
 TRS-80 Tape Mod I and Mod III 16K 0171R \$14.95



KITCHEN SINK

As commander of the castle-in-the-clouds, you must destroy the invading sparrows using everything you have, including the kitchen sink. Plan your strategy wisely: you may shoot, bomb, and ram with maneuverable boats. But your weapons and your time are limited! The perfect fast-action strategy game for those who aren't satisfied with mindless shooting. Arcade. Sound.
 TRS-80 Disk Mod I and Mod III 32K 0386RD \$19.95

AIRMAIL PILOT

Fly your Jenny biplane from Columbus to Chicago before the deadline. You need only avoid running out of gas, being struck by lightning, crashing in a down draft, missing the runway, . . . Challenge your reflexes. Remember, the mail must go through!
 TRS-80 Tape Mod I and Mod III 16K 0106R \$14.95
 T.I. Tape T.I. 99/4 16K 0274TI \$14.95

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Six super-fast arcade games that challenge your skill and stamina. Be a ski racer, a bob sledder, an anti-aircraft gunner and get a choice of three brilliant auto racing programs. Up to 10 people can play! With sound effects option.
 TRS-80 Tape Mod I & Mod III 16K 0082R \$14.95

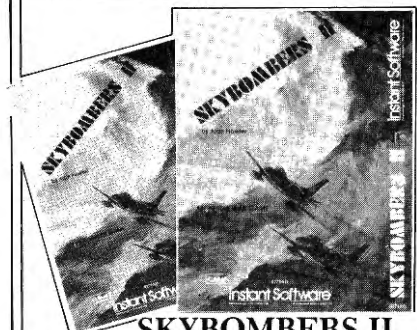
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MISSION-MUD
 (0235RD) . . .

"Grand-kids love it."

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Mission: MUD

Defend the Earth base city by destroying the approaching Mud Monsters and the slimy Mud Patch they inhabit. Mission: Mud is not just another arcade game. Like a chess game in which the pieces have weapons, it combines the challenge of strategy with the excitement of chance. Arcade.
 TRS-80 Disk Mod I and Mod III 32K 0325RD \$19.95



SKYBOMBERS II

Air warfare becomes vivid reality as you and an opponent command fighter bombers against each other. You must first fly over the treacherous mountain that separates your countries before you bomb the enemy blockhouse into oblivion—that is if you're pilot enough to escape enemy fire along the way. Game paddles required. Arcade. Sound.
 Apple II Tape Applesoft and Integer 32K 0183A \$14.95
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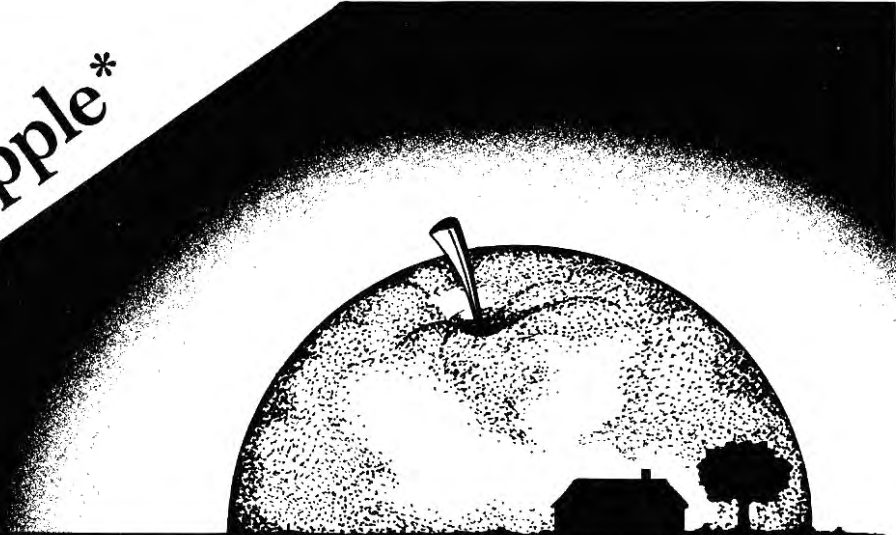
apple fun

Five fun-filled programs provide amusement and challenge for every family member.
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AIR FLIGHT SIMULATION You're flying blind, depending solely on your instrument panel. Watch closely, it's your only clue to your position as you take off, climb, descend, and land in this realistic simulation.
COLORMASTER This brainteaser will sharpen your power of deduction as you attempt to guess the four colors and the sequence chosen by your opponent or the computer.
STAR SHIP ATTACK Defend the orbiting supply satellites from the invading enemy or the planet is doomed!
TRILOGY A fascinating contest of logic, based on the game of tic-tac-toe, using colors and a three-dimensional grid. Compete with a friend or the computer. Arcade.
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JET FIGHTER PILOT Intercept the enemy. (See package #0159R.)
PRECISION APPROACH RADAR Land a UFO! (See package #0362AD.)
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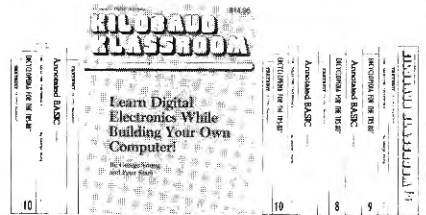
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Makes learning electronics fun and easy. First published as a series in *Kilobaud Microcomputing*, the book combines the learning of essential theory with practical, hands-on experience. The course begins with basic electronic projects and culminates in the construction of your own programmable microcomputer. The direct instructional methods of authors Young & Stark make KILOBAUD KLASROOM a simple way for you to acquire a solid background in digital electronics.

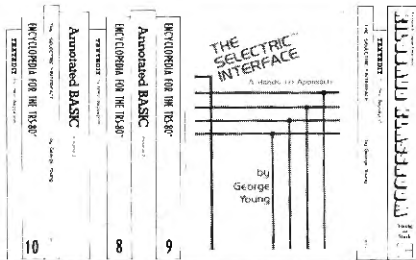
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by Irwin Rappaport

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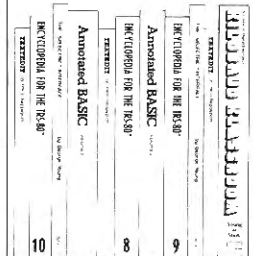
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Disk is manufactured by Instant Software, a division of Wayne Green Inc.

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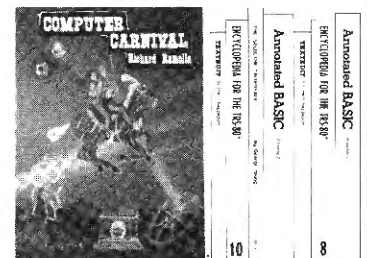
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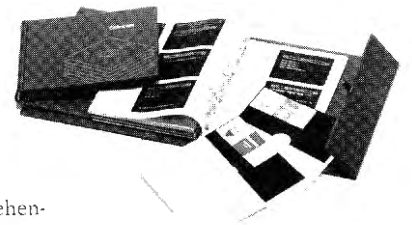
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High-Res Alphanumerics

by Scott Norman

The Color Computer's most attractive feature is the high-resolution graphics capability of the 16K RAM/Extended Color Basic combination. I often plot mathematical functions using PMODE 4, which gives 256 by 192 addressable points on the video display. No built-in way exists to display text in any of the high-resolution modes. Since graphs need titles and labeled axes, I developed the program modules described in this article. Many high-resolution game displays can benefit from the on-screen scoring or alphanumeric prompts these modules provide.

Produce unique character sets in high resolution on a TRS-80 Color Computer with 16K.

Extended Color Basic's versatile Draw command defines my character set. Individual characters that are now string variables can be concatenated into labels by the execute (X) action option of the Draw command. Relative addressing of each character, plus an initial Blank and Move command,

allow you to put the label wherever you like.

Here's an elementary example. Suppose you've defined the uppercase characters A, B, and C as string variables A\$, B\$, C\$. Program line DRAW "BM 50,100; XA\$; XB\$; XC\$;" writes the label ABC on a high-resolution graphics display, starting at the point X = 50, Y = 100.

Program Listing 1 contains the set of uppercase alphabetic characters, numerals, and miscellany I used. I constituted most of the characters in a 5 by 7 resolution element box, but since this is a custom set I've taken a few liberties—M and W are wider, for instance. I also put a proper descender on Q and an upper serif on l, but I encourage anyone using this technique to experiment to generate a pleasing display.

Users of Extended Color Basic will recognize the character definition syntax. If you are unfamiliar with the language, a segment like BM + 5, -5... is a relative addressing command. It means, "Starting from the present screen position, blank the CRT's electron beam and move five units to the right and five units up." You can then

Program Listing 1

```

2 AA$="BM+1,ØU4E2R1F2D4BL3BU2R2BD2BR3"
3 BB$="BM+2,ØU6BL1R3F1D1G1L1R1F1D1G1L3BR7"
4 CC$="BM+5,-5H1L2G1D4F1R2E1BD1BR3"
5 DD$="BM+1,ØU6R2F2D2G2L3BR7"
6 EE$="BM+5,ØL4U6R4BD3BL2L1BD3BR6"
7 FF$="BM+1,ØU6R4BD3BL2L1BD3BR6"
8 GG$="BM+5,-5H1L2G1D4F1R3U2L1R3BR3BD2"
9 HH$="BM+1,ØU6BR4D6BL3BU3R3BR4BD3"
10 II$="BM+5,-6L4R2D6L2R4BR3"
11 JJ$="BM+1,-2D1F1R2E1U5BD6BR3"
12 KK$="BM+1,ØU6D3R1E3G3F3BR3"
13 LL$="BM+1,-6D6R4BR3"
14 MM$="BM+1,ØU6R1F2D1U1E2R1D6BR3"
15 NN$="BM+1,ØU6R1D1F4D1R1U6D6BR3"
16 OO$="BM+5,-1U4H1L2G1D4F1R2BR4"
17 PP$="BM+1,ØU6R3F1D1G1L2BR6BD3"
18 QQ$="BM+5,-1U4H1L2G1D4F1R2F2BE2"

```

Listing 1 continues

The Key Box

Extended Color Basic
Color Computer
16K RAM

```

19 RR$="BM+1,ØU6R3F1D1G1L2R1D1F2BR3"
20 SS$="BM+1,-1F1R2E1H4E1R2F1BD5BR3"
21 TT$="BM+3,ØU6L3R6BR2BD6"
22 UU$="BM+1,-6D5F1R2E1U5BD6BR3"
23 VV$="BM+1,-6D4F2E2U4BD6BR3"
24 WW$="BM+1,-6D6R1E2U1D1F2R1U6D6BR3"
25 XX$="BM+1,ØU1E4U1BL4D1F4D1BR3"
26 YY$="BM+1,-6D1F2D3U3E2U1BD6BR2"
27 ZZ$="BM+1,-6R4D1G4D1R4BR3"
28 BK$="BM+1,ØBR7"
29 PT$="BM+2,ØR1BR2"
30 NR$(1)="BM+2,-4E2D6BR4"
31 NR$(2)="BM+1,-5E1R2F1D1L1G3D1R4BR3"
32 NR$(3)="BM+1,-1F1R2E1U1H1E1U1H1L2G1BD5BR7"
33 NR$(4)="BM+4,ØU6L1G2D1R5BD3BR3"
34 NR$(5)="BM+1,-1F1R2E1U1H1L3U3R5BR3BD6"
35 NR$(6)="BM+5,-6L3G1D4F1R2E1U1H1L2BR6BD3"
36 NR$(7)="BM+1,-6R5D2G4BR7"
37 NR$(8)="BM+1,-1U1E1R2E1U1H1L2G1D1F1R2F1D1G1L2BR6"
38 NR$(9)="BM+1,ØR3E1U4H1L2G1D1F1R2BD3BR4"
39 NR$(Ø)="BM+6,-1U4H1L2G1D4F1R2BR4"
40 MI$="BM+2,-3R3BD3BR2"

```

```

2 )
. ) BASIC Statements of Program Listing 1
. )
40 )

```

```

100 PMODE 4,1: PCLS: SCREEN 1,1
105 LINE (128,Ø)-(128,191),PSET
110 LINE (Ø,96)-(255,96),PSET
115 FOR P=8 TO 248 STEP 6Ø
120 LINE (P,94)-(P,98),PSET
125 NEXT
130 FOR P=46 TO 146 STEP 25
135 LINE (126,P)-(130,P),PSET
140 NEXT
141 DRAW "BM4,8;XTT$;XRR$;XII$;XGG$;XOO$;XNN$;XOO$;
XMM$;XEE$;XTT$;XRR$;XII$;XCC$;"
142 DRAW "BM5,2Ø;XFF$;XUU$;XNN$;XCC$;XTT$;XII$;
XOO$;XNN$;XSS$;"
150 FOR X=-180 TO 180 STEP 5
155 TH=X/57.3: XS=128+.67*X
160 F1=50*SIN(TH)
165 F2=50*COS(TH)
170 PSET(XS,96-F1,1)
175 PSET(XS,96-F2,1)
180 NEXT
185 DRAW "BM188,44;XSS$;XII$;XNN$;XEE$;"
190 DRAW "BM188,154;XCC$;XOO$;XSS$;XII$;XNN$;XEE$;"
195 DRAW "BM174,106;XNR$(9);XNR$(Ø);"
200 DRAW "BM228,106;XNR$(1);XNR$(8);XNR$(Ø);"
205 DRAW "BM2,106;XMI$;XNR$(1);XNR$(8);XNR$(Ø);"
210 DRAW "BM62,106;XMI$;XNR$(9);XNR$(Ø);"
215 DRAW "BM116,49;XNR$(1);"
220 DRAW "BM110,149;XMI$;XNR$(1);"
225 GOTO 225

```

Program Listing 2

draw a character. In the context of these statements, L, R, U, and D are commands for left, right, up, and down, while E, F, G, and H denote 45-degree motions to the northeast, southeast, and so on. Character definitions end with blanked-out motions like BR6, "blank and move six units to the right," to set you up to specify the next character in a string.

You can call the characters anything you please. I denoted the letters as AA\$ and so on in order to reserve one-letter string variable names like A\$ for general use in my programs. I also included a callable blank BK\$, a decimal point PT\$, and a hyphen MI\$. I defined the numerals as elements of a 10-element string variable array NR\$(I) to call them out to construct numeric labels computed within a program rather than being specified at the beginning.

Applications

Unlike data statements, these character definitions must appear in a program before the statements in which they are called. For that reason, I gave the definitions low statement numbers (2-40). If your application requires a large amount of memory for extra video pages, use line 1 to avoid wiping out any of the character definitions. Set up the high-resolution PMODE 4 when you begin plotting.

Program Listing 2 is an application in which the positions and definitions of the alphanumerics are known at the outset and can be specified by the programmer. It plots the sine and cosine functions over one cycle, with a label for each curve, a title for the whole display, and values for a few major points on each axis. Line 100 sets the high-resolution mode, lines 105-140 draw the axes and tic marks, and lines 141-142 write the title Trigonometric Functions in the upper left corner of the screen. The execute action option strings together individual graphics symbols by prefixing their names with X and postfixing with a semicolon. Lines 150-180 perform the actual computations and function plotting (by the slow PSET process in this case). The rest of the program labels the curves and puts numerical values on the tic marks.

The full syntax of the Draw command permits rotating a predefined set of operations in 90-degree increments. In particular, prefixing A3 as in DRAW "A3BM..." results in a character string written vertically upward. You might want to label the vertical axis of a graph this way if you don't want to cock your head 90 degrees to

the left in order to read it! If you use this option, remove it with a prefixed A0 for the next character string that you want to read normally.

If you don't know at the outset what the scale of a graphical axis will be, how can you plot the values calculated within the program? Program Listing 3 demonstrates a fairly simple approach, using the string-variable array. This program calculates the ratio of two numbers entered from the keyboard and displays the quotient in high-resolution mode. Line 65 converts the quotient, Q, to a string and establishes a buffer array BF(I). The elements of BF(I) are the digits of Q. If a particular digit is a decimal point (ASCII code 46), however, then the value 46 is stored in the corresponding element of BF(I) by lines 80-95. Line 100 shifts the display from the low-resolution Color Basic mode in which you entered the numerator and denominator to high-resolution for the output. A starting position 100 units down the left side of the display is established, any leading zero suppressed (line 110), and the elements of BF(I) interrogated one at a time. A value of 46 for any element draws the decimal point; any other value, 0-9, calls up the corresponding high-resolution graphics character. A simplified form of the Draw command concatenates strings with a For...Next loop: DRAW "XNR\$(BF(I));" where you enter only the closing semicolon after you supply an originating position for the string, as in line 105.

Writers of game programs can apply this technique of dissection and reconstruction of numerical strings to alphabetic characters if there is reason to compute alphabetic outputs based on the course of action.

Modifications

You can experiment with the character set defined in Listing 1 and invent your own sets, tailored to your own interests. You can add lowercase letters, Greek letters, and other mathematical symbols. You can add electronic symbols and the common representations of digital logic elements. You might write a Color Computer program to convert a logical expression into a block diagram for electronic realization. Memory usage will limit the imagination you can exercise; for the record, the character set definitions of Listing 1 occupy about 1,700 bytes. ■

Scott Norman can be reached at 8 Doris Road, Framingham, MA 01701.

```
2 )
. ) BASIC Statements of Program Listing 1
. )
40 )
```

```
45 CLS: PRINT "CALCULATE & HI-RES PRINT": PRINT
50 INPUT "NUMERATOR";N
55 PRINT: INPUT "DENOMINATOR";D
60 Q=N/D
65 N$=STR$(Q)
70 L=LEN(N$)
75 DIM BF(L)
80 FOR I=1 TO L
85 A=ASC(MID$(N$,I,1))
90 IF A<>46 THEN BF(I)=VAL(MID$(N$,I,1)) ELSE BF(I)=46
95 NEXT
100 PMODE 4,1: PCLS: SCREEN 1,1
105 DRAW "BM0,100"
110 IF BF(1)=0 THEN 120
115 DRAW "XNR$(BF(1));"
120 FOR I=2 TO L
125 IF BF(I)=46 THEN DRAW "XPT$;" ELSE 135
130 GOTO 140
135 DRAW "XNR$(BF(I));"
140 NEXT
145 GOTO 145
```

Program Listing 3

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Teach Your Computer to Talk

by Richard Seymour

What will your Color Computer's first words be? Here's a step-by-step method in Assembly language to get you and your CC speaking.

The joy of hearing your computer's first words is second only to that of seeing your first program write something intelligent on the terminal.

I will describe a program I use on my Color Computer, but you can adapt the method to any computer. The computer converts a short amount of

speech into a stream of numbers. This is called digitization. When you replay these numbers they recreate sound close to the original. Once you have recorded the original sound in the computer's memory, you can manipulate it for analysis, special effects or to minimize the space required.

The Color Computer contains the hardware necessary for the conversion method I chose. Radio Shack's Skiing game cartridge saying "Get ready, get set" suggested this approach. I will also describe the computer's other digitization possibilities.

Theory

Any sound fed into a microphone consists of a complex electrical signal.

Figure 1 shows an example of such a signal. Classical digitizing methods slice this signal into equal time intervals (Fig. 1b). At the end of each slice the voltage of the signal is measured and stored. The sound is recreated by reproducing those levels at the same intervals.

Two factors affect the sound quality. The first is how well the system can reproduce the tones (frequencies) in the original sound. This is called frequency response. Generally, you can reproduce the original frequencies to any desired accuracy by adjusting the time interval. Shorter intervals give better reproduction (see Figs. 1c and 1d). A rule of thumb is that you must measure twice as fast as the highest frequency you want to reproduce. Short time slices require recording more measurements.

The second factor is the resolution of the signal's voltage level (amplitude or volume). In a digital system the number of steps available between the lowest and highest voltages measured or reproduced describe the voltage

The Key Box

Color Computer
Color Basic
Extended Color Basic
16K RAM
Cassette recorder

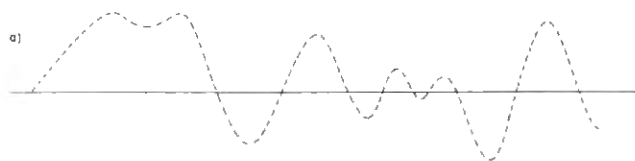


Figure 1a

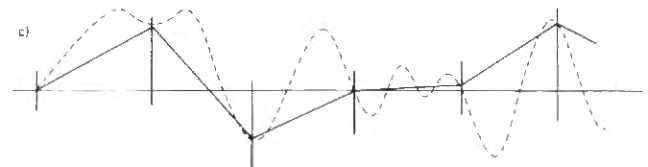


Figure 1c

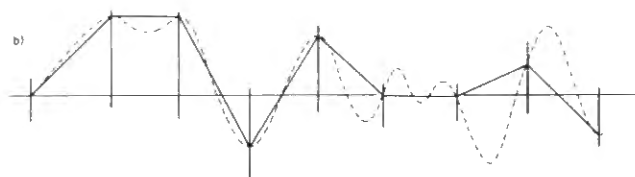


Figure 1b

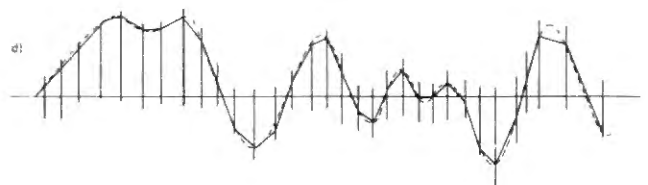


Figure 1d

level. This is normally expressed by the number of data bits required for that number of levels. Therefore, a 6-bit system can provide 64 volume levels. This same number describes the hardware that converts the voltage to a number. Such hardware is called an analog-to-digital converter (ADC) for creating numbers, or a digital-to-analog converter (DAC) for recreating voltages.

The Color Computer's two ways of analyzing incoming voltages are based on the same principle—comparison to an internal reference voltage. One serves the cassette tape input, and com-

parates the signal to zero volts. The other compares joystick input to the output of a 6-bit (64-level) DAC directed by the computer. The computer performs the A/D function by trying different voltages until it finds the closest match to the input voltage.

Why are there two ways? Radio Shack records information on cassette with two distinct tones. This allows recovery by simply measuring the time between the zero-crossings of the recorder's signal. Binary zeros are marked by crossings spaced twice as far apart as binary ones. This is done very quickly. The 6-bit method, which

provides much more information about the input signal, requires more time to measure. When digitizing a rapidly changing signal such as voice or music, that time sets the upper limit on which frequencies can be reliably detected.

My hardware for this project included a 16K Extended Color Basic Color Computer, a 1967 GE Porta-Color tv and a \$25 GE cassette recorder. Just as a \$1,000 stereo receiver would be wasted on \$25 speakers, the quality of the audio path available did not inspire me to attempt ultra high fidelity. I also wanted fast reward for

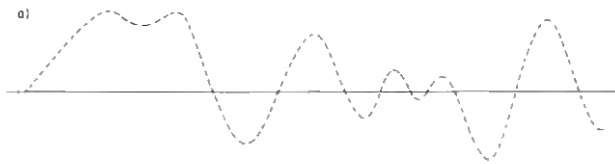


Figure 2a

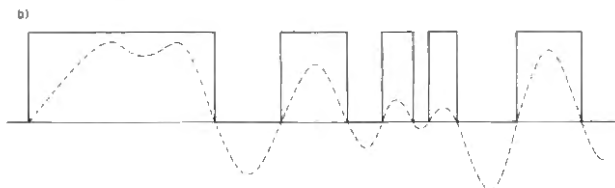


Figure 2b

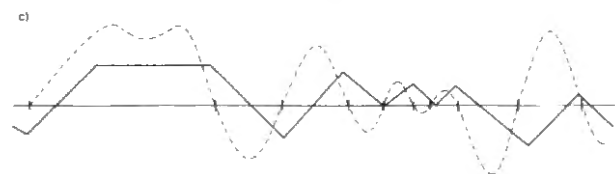


Figure 2c

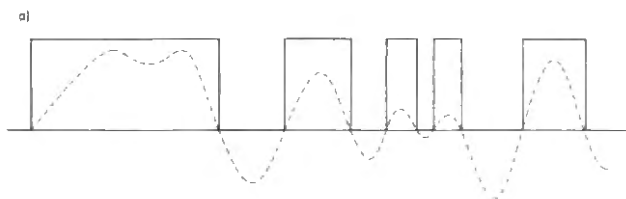


Figure 3a

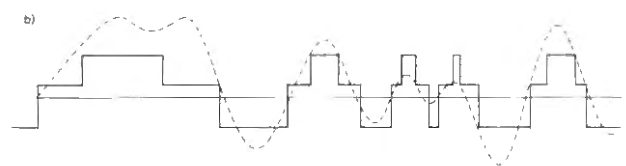


Figure 3b

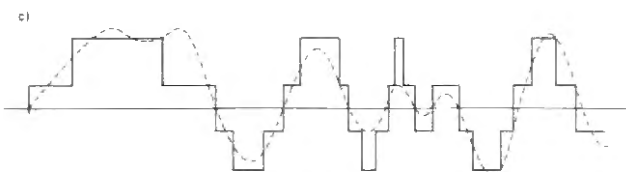


Figure 3c



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my efforts. So I chose to duplicate the cassette tape's input method for its programming simplicity.

Since I was only recording the duration between zero crossings, I decided first to simply send on/off signals back out to the tv set. The computer's single-bit sound system did not work reliably. The 6-bit D/A did work, so I just hit it with a zero or 24 value. Other experiments showed that the absolute values did not matter—only the difference between them. Therefore, the value 24 minus zero sets the volume heard over the speaker. The same result is produced with 30 and 54. I chose 24 by running a joystick-controlled noise program until I found an acceptable value. I encourage you to experiment with these values. Remember to multiply the value you choose by four (shift up 2 bits) to match it to the pins the Color Computer uses for the DAC's input.

Fig. 2 shows the liberties my conversion scheme wreaks upon a sample signal. The original signal (2a) becomes the time blocks (2b) which the computer-to-speaker rounds off to 2c.

Because I use cassette input, I found it easiest to pre-record sample speech. I can exactly reproduce experiments in memory-reduction techniques. Most cassette recorders pass what the microphone hears through the earphone connector while recording, so I use the recorder's microphone to speak directly to the computer. Unplug the computer-to-cassette line from the microphone or auxiliary jack. Leave the earphone line connected. Set the recorder to record and speak into the microphone. You get better quality sound if you use a separate micro-

phone; the one in the recorder picks up a lot of motor noise. The system consists of the tape recorder playing into the normal cassette input, with the reproduced sound playing back through the television speaker.

The program includes three sections: Record, Playback and Basic (which places the other two into memory and interacts with the operator).

Type in the program in Program Listing 1. You may delete all comments in lowercase to save typing. Program Listing 2 is the same program in regular Basic without comments. Program Listing 3 is an Assembly-language listing for the data statements of the Basic programs.

Bookkeeping

For Extended Basic, I put the recorded numbers into the graphic screen area. I watch the data as it comes in and receive a fascinating view of the effect of pauses and noise on the amount of memory used. For regular Basic, I put the storage above the Basic code, behind the cleared area. I put the machine-language part at the top of memory, using Basic's Clear statement to avoid stepping on it with other parts of the program.

One second of speech takes about 2K bytes of memory. Use that number to plan how much memory you want to give to speech storage. I put the table addresses in separate Basic lines to make them easier to find and change.

Recording

The Recording section of the program has four sections. Initialization sets the computer's registers. The "loop while above zero" section times

the positive half of the signals. The "loop while below zero" section times the negative half of every wave. The fourth section checks to see that the program has not run out of storage space.

The Color Computer's heart is a Motorola 6809. It has a variety of internal memories (registers) that you can use to count items or point to other memory locations or both. In this case, I tell the control register to ignore any other disturbances from the outside world (interrupts). This is necessary since I am trying to get accurate timing information by counting the number of times a loop is executed. It would not do to have the computer off somewhere else while my tape played on.

The Color Computer presents the status (zero or one) of the tape input detector as the bottom bit (least significant) of memory location 65312 (FF20). I load the U register with FF20. I load the A register with a one, which I will compare against the status bit to see if it is on or off. Then I load the X register with the starting address of the number storage area. That completes the initialization section.

The program then drops into the "watch while high" section. First it clears the B register, which will serve as the loop counter. Then it adds one to the B register and tests the status bit at FF20. If the bit is still on, the program loops back to the add-one-to-B register instruction. Once the status bit becomes zero, the program falls past the branch-if-not-equal instruction. There it stores the B register count at the address in the X register. That same instruction adds one to the X register, pointing it to the next table location.

```

1 ' TALK for Extended Color Basic
2 ' (c) Richard Seymour aug 1981
5 ' reserve memory and set up entry addresses for machine language
10 CLEAR 200,16200 : MOTOR ON : AUDIO ON : REC=16200 : PLY=16231
15 ' tell extended basic about them, copy the data to the area
20 DEFUSR0=REC : DEFUSR1=PLY : LOC=REC : GOSUB 9900
25 ' tell people how to play
30 PRINT"HOLD RIGHT 'FIRE' BUTTON"
35 PRINT" TO RECORD ANOTHER PIECE"
40 PRINT"HOLD 'BREAK' TO EXIT PROGRAM"
45 ' turn on the sound and wait for a "return"
50 AUDIO ON : INPUT "HIT RETURN TO START CONVERSION";AS
55 ' go to high resolution graphics and select a graphics display
60 PMODE 4,1 : SCREEN 1,1
65 ' perform the "record" subroutine
70 AUDIO ON : A=USR0(0)
75 ' a moment of silence, please
80 FOR I=1 TO 200 : NEXT I
85 ' "Go ahead, Sam. Play it."
90 A=USR1(0)
95 ' look for a struck key or joystick button, rerecord if seen
100 IF (PEEK(&HFF00) AND 1)=0 THEN 50
105 ' just play it again if no buttons were pushed
110 GOTO 80
115 '
9000 ' Record portion of program
9005 DATA 1A, 50, CE, FF, 20, 6E
9009 'table start address follows
9010 DATA 06, 00
9015 ' next line starts at 16200
9020 DATA 86, 01, 5F, 5C, A5, C4, 26, FB, E7, 80
9025 ' next line starts at 16218
9030 DATA 5F, 5C, A5, C4, 27, FB, E7, 80, 8C
9034 'table end address follows
9035 DATA 1D, FC
9040 DATA 25, EB
9045 ' Play starts here (16231)
9050 DATA 1A, 50, CE, FF, 20, 6F, 43
9055 ' next line starts at 16238
9060 DATA CC, F8, 3C, A7, 42, E7, 43, CC, B4, 35, A7, 5D, E7, 5F
9065 ' next line starts at 16252
9069 'table start address follows
9070 DATA 8E, 06, 00
9075 ' next line starts at 16255
9079 'next 60=volume
9080 DATA 86, 60
9085 ' next line starts at 16257
9090 DATA E6, 80, A7, C4, 5A, 26, FB, 4F, E6, 80
9095 ' next line starts at 16267
9100 DATA A7, C4, 5A, 26, FB, 8C
9104 'table end address follows
9105 DATA 1D, FC
9110 ' next line starts at 16275
9115 DATA 25, EA
9120 ' next line starts at 16277
9125 DATA 39 : ' END of subroutine
9900 DATA 1000 : ' flag for end of transfer
9905 ' read value, convert to variable
9910 READ AS : A=VAL("&H"+AS)
9915 ' we're finished if it's over 255 (FF hex)
9920 IF A>255 THEN RETURN
9925 ' otherwise, put it into memory, increment LOC, and get another
9930 POKE LOC,A : LOC=LOC+1 : GOTO 9910
9998 '
9999 END : ' of everything

```

Program Listing 1. Extended Basic Version

Next the program drops into the "watch while low" section. This is just like the "while high" section, except it loops while the bit is zero. Once the bit goes non-zero again, the program moves to another "store B at X" instruction. After that the program checks that X has not risen to the top end of memory space reserved for storage. If X is still below that limit, the program branches back up to the "while high" loop. If X reaches its limit, the program moves from the check section into the Playback program. You could provide an immediate Return here, if you do not want an instant replay.

Playback

You can enter the Playback program directly from Basic, so start by re-initializing any registers you need. Again, the U register points to the hardware control locations in memory. Clear the hardware register controlling the sound source selection to provide access to its direction control register. Then set this to guarantee your choice of the 6-bit DAC. Reset the control register to its normal state, with the sound output enabled. Setting FF1D and FF1F selects the path from the

DAC to tv speaker. Finally, the X register points to the beginning of the sound table.

As the first step of the "send high value" loop, the A register is set with the volume level selected. This is only done at the start of a "send high" section, not within the fast inner loop.

Then the program loads the B register with the recorded loop count fetched from the table (pointed to by the X register, which is incremented after the fetch). The A volume value is sent to the DAC, located at FF20. Subtract one from the B register count. If it has not reached zero, branch back to the send A instruction. When it does reach zero, we proceed to the "send low" section.

As a first step, clear the volume (A) register to zero. Then fill B with the next count from the table. Send A to FF20, decrement B, and check for zero. Loop to the local send A instruction until B goes to zero. Then check that the X register is still within the table's limits. If it is, branch back up to start the "send high" section again. When X reaches or exceeds its limit, the program returns to Basic.

All of the innermost loops in record and playback take exactly the same

time—nine 6809 cycles, or a little more than 11 microseconds in the Color Computer.

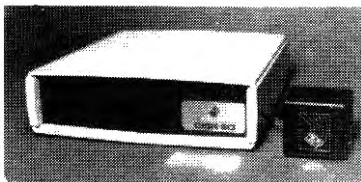
Basic

The Extended Basic program reserves the memory above 16200 for use by the machine-language code. I turn on the tape recorder's motor; the tape-to-speaker sound path allows me to hear the tape before I start the conversion. I set the starting addresses of the record and playback routines into Extended Basic's user-function table. Regular Basic and Extended Basic are incompatible here. In regular Basic, you POKE the starting address of the single USR function to locations 275 and 276 (decimal). Extended Basic does not allow that. Extended Basic requires the DEFUSR0 = ADDRESS convention. A scratch variable LOC points to the location to receive the next byte of machine-language code. I then go to the move-machine-language subroutine.

Lines 9900-9930 read string data values as hexadecimal values, and POKE them into the assigned area. Using hexadecimal data values allows direct use of Motorola's hex reference cards. It works by converting all strings

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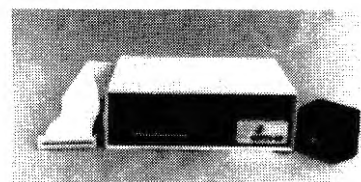
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(such as A9) to the hexadecimal constant form (&HA9) recognized by Extended Basic. This form handled by the VAL function generates the decimal value handed over by POKE. Temporary variable A detects the end of the table. This also catches many missed-comma typing errors in the data list. When the over-255 value planted in 9900 is detected, the machine-language load is stopped, and control returns to the main program section.

The regular Basic version of the program has the same data except for the table addresses. For simplicity, I present the data as decimal numbers.

Now we turn on the tape-to-tv path again, because we can enter statement 50 from below as well (that's line 60 in regular Basic). The programs pause for keyboard input. In Extended Basic the computer automatically goes to Text mode when it hits the Input command. For regular Basic I force the video system back into line with the GOSUB 300 section.

The input statement allows final positioning of the source tape before starting digitization. When you hit return the computer flips to maximum graphics mode to show 6K bytes on the screen. GOSUB 200 in regular Basic does this. Then the Record routine starts.

As the recording progresses, you will see short horizontal lines and rows of dots written or modified on the graphics screen. Each group of eight dots represents one byte of the table. They group into 32 columns. The rightmost bit of each column is the one bit of that count byte. A tone of short counts (or tape hiss) tends to form vertical lines along their zone's right edge. You will see the bytes change as a ripple across each of the 192 lines, from left to right, from top to bottom. When the ripple hits the bottom, the recording section stops, and Playback begins. The computer speaks!

After one pass through Playback, control returns to Basic. At this point I use a loop to cause a slight silent delay, and then enter the Playback routine directly. The computer speaks again!

I then check the fire button on the right joystick. This check can also be satisfied by holding down any key between A and G. If the key (or button) is not hit, I repeat the Playback loop. If the key (or button) is down, I go back for another Record session.

To stop the program, Extended Basic responds to the break key. Regular Basic needs to be told how to restore the text screen, so the program checks

for the left joystick fire button, too. If that button is pushed, GOSUB 300 resets the screen before the program stops. If you break out of the program, you may type GOSUB 300 (even if you can't see it) to get the text screen back. The alternative is to push the reset button.

More and Better

What next? I have tried to lower storage requirements by increasing the loop times. This means each count in the table covers a wider time slice. Higher frequencies will not be seen. Since higher frequencies make lots of table entries in a short time, this trick saves a good deal of memory. I added sections to scan through the data and show graphs of how many entries (channels) contain which counts. This is a rough form of spectrum analyzer.

I have also explored removing or replacing ranges of table entries. If I replace all entries below 16 with one, the speech becomes garbage. But if I replace those same entries with random numbers between one and 16, the speech is almost unchanged.

Loss of the high frequencies affects some words before others. For example, "cold mysterious," when robbed of its high frequencies by cutting below 16 or by loop-lengthening, becomes "cold whoosh." Perhaps you could generate a chart of low-frequency words (like "word") that can be stored efficiently. If the original sound is loud and full of low frequencies, the 6K region can hold more than 10 seconds of speech. Loudness keeps the smaller-level high frequencies from making zero crossings. The low frequencies make each table byte take longer. If you are now recording 500-cycle tones instead of 1,000-cycle tones, each byte holds the loop for twice as long. By having that repeated 6,000 times, the total time spent by the record/playback is more than doubled.

Another obvious step is to improve the volume resolution by using the A/D ability of the computer. This need not be done to the full 6-bit resolution if time is a problem. You can reach the proportional input through either of the joystick inputs.

```

1 ' TALK for Color Computer Regular Basic
2 ' (c) Richard Seymour aug 1981
10 CLEAR 200,8192 : MOTOR ON : AUDIO ON : REC=16200
20 RI=INT( REC/256 ) : R2= REC - RI*256 : PLY=R2 + 31
30 PRINT"HOLD THE RIGHT 'FIRE' BUTTON":PRINT" TO RECORD ANOTHER SECTION"
40 PRINT"HOLD THE LEFT 'FIRE' BUTTON":PRINT" TO EXIT THE PROGRAM"
50 POKE 275,R1 : POKE 276,R2 : LOC=REC : GOSUB 9900
60 GOSUB 300 : AUDIO ON : INPUT "HIT RETURN TO START CONVERSION";AS
70 GOSUB 200 : ' start graphics
80 POKE 276,R2 : A=USR(0)
90 FOR I=1 TO 200 : NEXT I
100 POKE 276,PLY : A=USR(0)
110 A=PEEK(65280) : IF (A AND 1)=0 THEN 60
120 IF (A AND 2)=0 THEN GOSUB 300 : END
130 GO TO 90
200 POKE 65314,249 : POKE 65475,1 : POKE 65477,1 : POKE 65480,1 : POKE 65487,1
210 RETURN
300 POKE 65314,0 : POKE 65474,1 : POKE 65476,1 : POKE 65481,1 : POKE 65486,1
310 RETURN
9000 DATA 26, 80, 206, 255, 32, 142
9005 'table start address follows
9010 DATA 32,0
9020 DATA 134, 1, 95, 92, 165, 196, 38, 251, 231, 128
9030 DATA 95, 92, 165, 196, 39, 251, 231, 128, 140
9035 'table end address follows
9040 DATA 55,252
9050 DATA 37, 235, 26, 80, 206, 255
9060 DATA 32, 111, 67, 204, 249, 60, 167
9070 DATA 66, 231, 67, 204, 180, 53, 167
9080 DATA 93, 231, 95, 142
9085 ' table start address follows
9090 DATA 32, 0
9095 ' the next 96 is the volume
9100 DATA 134, 96
9110 DATA 230, 128, 167, 196, 90, 38, 251
9120 DATA 79, 230, 128, 167, 196, 90, 38, 251, 140
9125 'table end address follows
9130 DATA 55, 252
9140 DATA 37, 234
9150 DATA 57
9900 DATA 1000 : ' flag to stop transfer
9910 READ A
9920 IF A>255 THEN RETURN
9930 POKE LOC,A : LOC=LOC+1 : GOTO 9910
9999 END

```

Program Listing 2. Regular Basic Version

Another area to explore is shaping the output to something smoother than on/off. You can do this by dividing the loop count into quarters. Then send a 12 for the first quarter, 24 for the middle two quarters, and finish with 12 for the last quarter. This would produce the wave in Fig. 3a. By shifting to 16 and 24 for the on cycle, and eight and zero for the off cycle, you should get even smoother sound.

The Color Computer uses a similar technique for the waveform it sends to

the cassette tape, but it reads values from a table stepped through at a constant rate. To achieve the higher frequency it uses every other value from the table. That table can be found starting at location A85C (decimal 43100) in the regular Basic ROM.

Other Computers

This method requires a single input bit driven by your sound source. Like the Color Computer, you can use the cassette inputs of other computers to

do this. If you can drive a peripheral input adapter (PIA) pin from a sound source, you could use it. You cannot connect a normal digital integrated circuit to an alternating signal. When the signal drops below -0.5 volts, it would damage the chip. ■

Richard Seymour (Univ. of Washington, Nuclear Physics Lab, GL-10, Seattle, WA 98195) has been doing hardware and software development and management for 15 years.

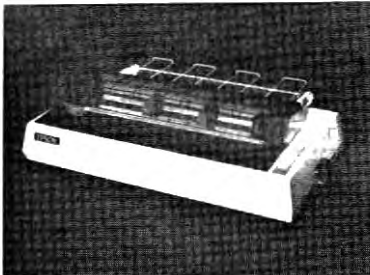
TALK Assembly language routine

Loc	Hex	Source	Comments
Dec	Code	Code	
16200	1A 50	RECORD: ORCC #50	; block FIRQ and IRQ interrupts
16202	CE FF 20	LDU #FF20	; address of cassette input flag
16205	8E 06 00	LDX #0600	; table starting address
16208	86 01	LDA #01	; one bit for cassette flag
16210	5F	HIGH: CLR B	; start loopcount at zero
16211	5C	HLOOP: INC B	; count the loop
16212	A5 C4	BITA ,U	; check 1 bit at FF20
16214	26 FB	BNE HLOOP	; loop if on
16216	E7 80	STB ,X+	; put count in table
16218	5F	CLR B	; reset count to zero
16219	5C	LOW: INC B	; count this loop
16220	A5 C4	BITA ,U	; check the cassette bit
16222	27 FB	BEQ LOW	; loop while off
16224	E7 80	STB ,X+	; put count in table
16226	8C 1D FC	CMPX #1DFC	; table end address
16229	25 EB	BLO HIGH	; keep recording if ok
16231	1A 50	PLAY: ORCC #50	; block FIRQ and IRQ
16233	CE FF 20	LDU #FF20	; address of D/A output
16236	6F 43	CLR 3,U	; clear FF23 register
16238	CC F8 3C	LDD #F83C	; pattern for 6-bit sound
16241	A7 42	STA 2,U	; set the direction register
16243	E7 43	STB 3,U	; set sound out enable
16245	CC B4 35	LDD #B435	; pattern for sound path
16248	A7 5D	STA -3,U	; set the analog switch
16250	E7 5F	STB -1,U	; at FF1D and FF1F
16252	8E 06 00	LDX #0600	; beginning of table
16255	86 60	HIOUT: LDA #60	; volume value (times 4)
16257	E6 80	LDB ,X+	; get next loop count
16259	A7 C4	HILOOP: STA ,U	; turn on D/A
16261	5A	DECB	; downcount B register
16262	26 FB	BNE HILOOP	; until zero
16264	4F	CLRA	; zero volume
16265	E6 80	LDB ,X+	; next table entry
16267	A7 C4	LOLOOP: STA ,U	; turn off D/A
16269	5A	DECB	; down we go
16270	26 FB	BNE LOLOOP	; until run to zero
16272	8C 1D FC	CMPX #1DFC	; at top of table yet?
16275	25 EA	BLO HIOUT	; if not, do more
16277	39	RTS	; otherwise, return to Basic

Program Listing 3. Assembly Language Routine

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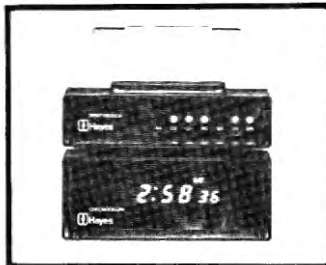


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- ANADEX ADX-9500-P, ADX-9501-P \$1295
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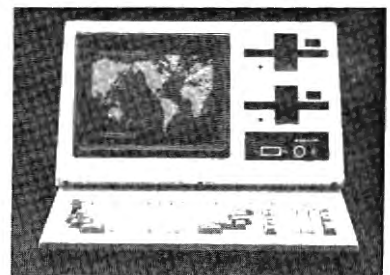


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Five Games for 4K

by James Wood

Don't despair if your Color Computer has only 4K memory—here are Pong, Bingo, Simon, and Hangman clones written to fit your system.

The 4K Color Computer is limited by its small memory, but programs can be developed for it. Here are five games you can play on a 4K or larger Color Computer.

Rocket displays the number of hits, number of rockets, and number of shots at the top of the screen. A rocket (actually a rectangle) moves across the screen at various heights. A base at the lower right corner fires a missile when you press the F key. When you hit the rocket, a graphic explosion results. Make up your own rules; find out how many rockets you can hit with 10 shots or how many of the first 20 rockets you can hit. Adjust the program to fit your rules.

“Here are five games you can play on a 4K or larger Color Computer.”

Pong is similar to the tv pong games. The paddles move continuously if you keep the arrow keys pressed.

For Bingo, you will need markers and bingo cards. The computer generates bingo calls and graphically displays them on a chart. Each number appears on the screen as orange colored but turns red as subsequent numbers are called, so you can easily find the last call or check a winning card.

```

5 'ROCKET
10 'JAMES W. WOOD, 424 N. MISSOURI, ATWOOD, IL, 61913
20 CLS0:PRINT@0,"":PRINT@4,"HITS";:PRINT@27,"SHOTS";:PRINT@13,"R
OCKETS";
30 POKEL530,143:POKE1532,143
40 Z$=CHR$(128)+CHR$(128)+CHR$(128)+CHR$(128)+CHR$(128)
50 F$=CHR$(128)+CHR$(175)+CHR$(175)+CHR$(175)
60 H=H+1:PRINT@8,H;:E=RND(13)*32+32:PRINT@E,F$;
70 F=E
80 PRINT@E,F$;
90 E$=INKEY$
100 IFE$="F" THEN V=V+1:PRINT@23,V;:GOTO120
110 E=E+1:IFE>F+28 THEN 200 ELSE 80
120 FORQ=507 TO 35 STEP -32
130 PRINT@Q,CHR$(255);:PRINT@Q,CHR$(128);
140 E=E+1:IFE>F+28 THEN 200
150 PRINT@E,F$;
160 IFQ=E+1 OR Q=E+2 OR Q=E+3 THEN 170 ELSE 180
170 W=W+1:PRINT@0,W;:GOSUB210:PORTT=1 TO 50:NEXTT:GOTO60
180 NEXTQ
190 E=E+1:GOTO80
200 PRINT@E-1,Z$;:GOTO60
210 FORWW=1 TO 5: SOUND180,1:PRINT@Q-2,CHR$(RND(128)+127)+CHR$(RND(
128)+127)+CHR$(RND(128)+127)+CHR$(RND(128)+127)+CHR$(RND(128)+12
7);:NEXTWW:PRINT@Q-2,Z$;:RETURN
    
```

Program Listing 1

```

5 'PONG
7 'JAMES W. WOOD, 424 N. MISSOURI, ATWOOD, IL, 61913
10 CLS:PRINT:PRINTTAB(13)"PONG":PRINT:PRINT"PLAYER ON LEFT":PRIN
T" USES UP ARROW AND DOWN ARROW":PRINT:PRINT"PLAYER ON RIGHT":P
RINT" RIGHT ARROW IS UP":PRINT" LEFT ARROW IS DOWN":FORTI=1 TO 3
000:NEXTTI
20 XX=RND(9)-1
30 Q=20:A=25:L=25:O=20:CLS0
40 PRINT@66,LL;:PRINT@91,RR;
50 FORY=9 TO 30:SET(0,Y,XX):SET(63,Y,XX):NEXTY
60 C=1:K=1:PRINT@76,"PONG";
70 FORJ=20 TO 25:SET(7,J,XX):SET(56,J,XX):NEXTJ
80 FORX=1 TO 62:SET(X,9,XX):SET(X,30,XX):NEXTX
90 Y=10:X=RND(40)+10
100 SET(X,Y,XX)
110 FORJ=1 TO 2:NEXTJ:RESET(X,Y)
120 IFPEEK(344)=247 THEN GOSUB350
130 IFPEEK(343)=247 THEN GOSUB370
140 IFPEEK(341)=247 THEN GOSUB390
150 IFPEEK(342)=247 THEN GOSUB410
160 X=X+C
170 Y=Y+K
    
```

Program Listing 2

Listing 2 continues

The Key Box

Color Computer
4K RAM
Color Basic or Extended Color Basic

Listing 2 continued

```
180 IFY<30ANDY>9THEN220
190 IFX>58THEN300
200 IFX<6THEN280
210 IFPOINT(X,Y) THEN260
220 IFX>58THEN300
230 IFX<5THEN280
240 IFPOINT(X,Y) THEN270
250 GOTO100
260 SOUND100,1:K=-K:GOTO170
270 SOUND200,1:C=-C:GOTO160
280 SOUND20,5:RR=RR+1:PRINT@91,RR;:IFRR=15THEN320
290 GOTO90
300 SOUND20,5:LL=LL+1:PRINT@66,LL;:IFLL=15THEN320
310 GOTO90
320 PRINT@485,"PLAY AGAIN":KIS=INKEY$
330 B$=INKEY$:IFB$="" THEN330
340 IFB$="Y" THENRUNELSEIFB$="N" THENENDEELSE330
350 IFO<11THENRETURN
360 RESET(56,L):O=O-1:L=L-1:SET(56,O,XX):RETURN
370 IFL>28THENRETURN
380 RESET(56,O):O=O+1:L=L+1:SET(56,L,XX):RETURN
390 IFQ<11THENRETURN
400 RESET(7,A):Q=Q-1:A=A-1:SET(7,Q,XX):RETURN
410 IFA>28THENRETURN
420 RESET(7,Q):Q=Q+1:A=A+1:SET(7,A,XX):RETURN
```

```
5 'BINGO
7 'JAMES W. WOOD, 424 N. MISSOURI, ATWOOD, IL, 61913
10 CLS:PRINT@200,"BINGO":PRINT:PRINT" PRESS <ENTER> FOR NEXT C
ALL.":PRINT:PRINT"PRESS <Z> IF READY FOR NEXT GAME"
20 PRINT@420,"PRESS <ENTER> TO CONTINUE"
30 A$=INKEY$:IFA$="" THEN30
40 CLS0:PRINT@4,"B";:PRINT@9,"I";:PRINT@14,"N";:PRINT@19,"G";:PR
INT@24,"O";
50 FORC=1TO15:PRINT@32*C,C;:PRINT@32*C+5,C+15;:PRINT@32*C+10,C+3
0;:PRINT@32*C+15,C+45;:PRINT@32*C+20,C+60;:NEXTC
60 FORC=35TO291STEP32:PRINT@C,CHR$(143);:NEXTC
70 DIMB(75)
80 A=RND(75):IFB(A)=1THEN80
90 B(A)=1
100 IFA<=15THENP=4+32*A:PRINT@P,CHR$(255);:GOTO150
110 IFA<=30THENP=9+32*(A-15):PRINT@P,CHR$(255);:GOTO150
120 IFA<=45THENP=14+32*(A-30):PRINT@P,CHR$(255);:GOTO150
130 IFA<=60THENP=19+32*(A-45):PRINT@P,CHR$(255);:GOTO150
140 P=24+32*(A-60):PRINT@P,CHR$(255);
150 K$=INKEY$
160 KK=KK+1:IFKK=75THEN210
170 A$=INKEY$:IFA$="" THEN170
180 IFA$="Z" THENRUNELSEIFASC(A$)=13THEN190ELSE170
190 PRINT@P,CHR$(191);
200 GOTO80
210 CLS:PRINT@194,"YOU USED ALL THE SPACES!!!"
```

Program Listing 3

Program Listing 4

```
5 'REREPEAT
7 'JAMES W. WOOD, 424 N. MISSOURI, ATWOOD, IL, 61913
10 CLS
20 PRINT@230,"REPEAT!!!":INPUT" HOW MANY CAN YOU REPEAT";M
30 IFM>50THENPRINT"SORRY, I CAN ONLY GIVE FIFTY":PRINT@281,"
";:GOTO20
40 IFM<1THENPRINT"DON'T BE SILLY";:PRINT@281," ";:GOTO20
45 PRINT@416," USE THE ARROWS TO REPEAT THE PATTERNS OF LIGHT
!!!";
46 FORD=1TO1500:NEXTD
50 DIMQ(50):CLS0:FORB=1TO4:FORA=1TO5:A$(B)=A$(B)+CHR$(127+16*B):
NEXTA,B
60 FORW=1TO50:Q(W)=RND(4):NEXTW
70 E=E+1:IFE=M+1THENCLS0:FORI=1TO30:SOUNDRND(150)+50,1:PRINT@RND
(500),A$(RND(4));:NEXTI:GOTO250
80 FORF=1TOE:FORD=1TO100:NEXTD
90 CLS0:FORD=1TO100:NEXTD:ONQ(F)GOSUB210,220,230,240
100 NEXTF:FORD=1TO100:NEXTD:CLS0
110 FORF=1TOE:Z=0:CLS0
```

Listing 4 continues

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Rerepeat is an imitation of Simon. Colored squares at the top, bottom, and sides of the screen flash a pattern that you must repeat using the up, down, left, and right arrows. First re-

“Colored squares at the top, bottom, and sides of the screen flash a pattern. . .”

peat one square, then the same one plus another, and so on. If you successfully repeat the pattern, a wild graphics display appears on the screen.

Hangman makes you guess the letters in a word in an attempt to save the little man from the rope. You can change the words in the data lines or add more. Be sure to change the 72 in line 70 to the total number of words in your data lines. ■

James Wood (424 N. Missouri, Atwood, IL 61913) is the coach for a high-school scholastic team.

Listing 4 continued

```

120 A$=INKEY$
130 A$=INKEY$:IFA$=""THEN130
140 IFA$=CHR$(94)ANDQ(F)=1THENGOSUB210:Z=1
150 IFA$=CHR$(8)ANDQ(F)=2THENGOSUB220:Z=1
160 IFA$=CHR$(9)ANDQ(F)=3THENGOSUB230:Z=1
170 IFA$=CHR$(10)ANDQ(F)=4THENGOSUB240:Z=1
180 IFZ=0THENFORV=1TO5:SOUND5,5:NEXTV:FORF=1TOE:ONQ(F)GOSUB210,2
20,230,240:FORD=1TO100:NEXTD:CLS0:NEXTF:GOTO250
190 NEXTF
200 GOTO70
210 FORC=13TO77STEP32:PRINT@C,A$(1);:NEXTC:SOUND147,2:RETURN
220 FORC=193TO257STEP32:PRINT@C,A$(2);:NEXTC:SOUND159,2:RETURN
230 FORC=218TO282STEP32:PRINT@C,A$(3);:NEXTC:SOUND170,2:RETURN
240 FORC=429TO493STEP32:PRINT@C,A$(4);:NEXTC:SOUND176,2:RETURN
250 CLS:PRINT@230,"PLAY AGAIN? (Y/N)"
260 B$=INKEY$:IFB$="Y"THENRUNELSEIFB$="N"THENENDELSE260

```

```

10 'HANGMAN
20 'JAMES W. WOOD,424 N. MISSOURI,ATWOOD, IL, 61913
30 CLS:DIMA$(30):FORA=1TO14:BL$=BL$+CHR$(128):NEXTA:FORA=201TO48
9STEP32:PRINT@A,BL$;:NEXTA
40 PRINT@235,CHR$(159)+CHR$(156)+CHR$(156)+CHR$(158)+CHR$(156)+C
HR$(156)+CHR$(157)+CHR$(156);
50 PRINT@267,CHR$(159)+CHR$(128)+CHR$(150);
60 PRINT@299,CHR$(159)+CHR$(150);:FORA=331TO491STEP32:PRINT@A,CH
R$(159);:NEXTA
70 T=ROUND(72):FORY=1TOT:READA$:NEXTY
80 B=LEN(A$):FORQ=1TOB:A$(Q)=MID$(A$,Q,1):NEXTQ
90 PRINT@96,"LETTERS USED,";:FORA=1TOB:PRINT@38+A,"-";:NEXTA
100 PRINT@160,"WHAT LETTER?";
110 PRINT@172," ";
120 IK$=INKEY$
130 B$=INKEY$:IFB$=""ORB$=CHR$(13)THEN130
140 PRINT@172,B$;:FORTI=1TO40:NEXTTI
150 FORQ=1TOB:IFB$=A$(Q)THENPRINT@Q+38,B$;:SOUND150,1
160 NEXTQ
170 FORQ=1TOB:IFB$<>A$(Q)THENNEXTQ:G=G+1:SOUND5,1:ON G GOSUB 210
,220,230,240,250,260,270,280,290,300
180 PRINT@W+110,B$;:W=W+1
190 FORQ=1TOB:IFCHR$(PEEK(1062+Q))=A$(Q)ORPEEK(1062+Q)=64+ASC(A$(
Q))THENNEXTQ:FORT=1TO10:PRINT@12,"CORRECT";:FORTT=1TO10:NEXTTT:
PRINT@12," ";:SOUND150,1:FORTT=1TO10:NEXTTT:NEXTT:RUN
200 GOTO100
210 PRINT@272,CHR$(158)+CHR$(159)+CHR$(157);:PRINT@304,CHR$(157)
+CHR$(159)+CHR$(158);:RETURN
220 PRINT@336,CHR$(143)+CHR$(143)+CHR$(143);:PRINT@368,CHR$(143)
+CHR$(143)+CHR$(143);:PRINT@400,CHR$(175)+CHR$(175)+CHR$(175);:P
RINT@432,CHR$(172)+CHR$(172)+CHR$(172);:RETURN
230 PRINT@432,CHR$(175);:PRINT@464,CHR$(175);:RETURN
240 PRINT@434,CHR$(175);:PRINT@466,CHR$(175);:RETURN
250 PRINT@335,CHR$(142);:PRINT@367,CHR$(138);:RETURN
260 PRINT@339,CHR$(141);:PRINT@371,CHR$(133);:RETURN
270 PRINT@399,CHR$(158);:RETURN
280 PRINT@403,CHR$(157);:RETURN
290 PRINT@495,CHR$(177)+CHR$(183);:RETURN
300 PRINT@498,CHR$(187)+CHR$(178);
310 PRINT@0," THE WORD IS ";CHR$(34);A$;CHR$(34):SOUND89,8:SET(3
3,17,2):SOUND89,8:RESET(33,17):SOUND89,4:SET(36,17,2):SOUND89,8:
RESET(36,17):SOUND117,8:SET(33,17,2):SOUND108,4:RESET(33,17):SOU
ND108,8:SET(36,17,2):SOUND89,4:RESET(36,17):SOUND89,8
320 SET(36,17,2):SOUND78,4:SET(33,17,2):SOUND89,8:RUN
330 DATAABLE,ABOUT,ACCIDENT,BABY,BALANCE,BED
340 DATACARE,CHANGE,CONTAINER,DAUGHTER,DELIVER,DISAPPOINTED
350 DATAEAT,EMPTY,ENERGY,FIGURE,FAST,FRUIT
360 DATAGATHER,GRACEFUL,GRANDFATHER,HANDKERCHIEF,HELLO,HUNGRY
370 DATAIODINE,ICE,INVENT,JACKET,JET,JUNGLE
380 DATAKANGAROO,KINGDOM,KINDERGARTEN
390 DATALADDER,LATER,LADY
400 DATAMONEY,MATCH,MARRY
410 DATANOthing,NEW,NARROW
420 DATAOCTOPUS,OATMEAL,ONLY
430 DATAPACKAGE,PARTY,PALACE
440 DATAQUARTER,QUESTION,QUEEN
450 DATARACE,READY,REASON
460 DATASAD,SAILBOAT,SAT
470 DATATALL,TEACHER,TEASE
480 DATAUGLY,UNDERSTAND,VACUUM
490 DATAVACATION,VAPE,VACUUM
500 DATAWADE,WAGON,WALL
510 DATAXYLOPHONE,ZEBRA,ZIPPER

```

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Program Listing 5

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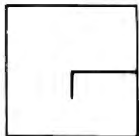
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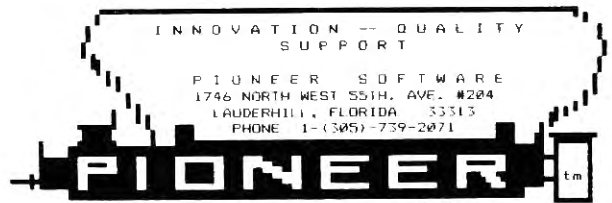
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Reconcile with Color

by David Dacus

You don't need a Model II, CP/M, and a general ledger program to balance your checkbook. Just run this routine on your CC with 32K.

If keeping track of finances gets you down, try this program. It contains a comprehensive financial management package associated with the check register, and it performs the following tasks:

- Enters transactions
- Edits transactions
- Reconciles your bank statement
- Searches for checks to a specific payee
- Searches for a series of checks
- Lists all checks in the file to a printer
- Shows the current bank balance
- Searches for checks written during a

specific month

- Searches for checks written for a specific category
- Exits the program with no file save
- Records all checks to disk and exits

This program was written for a 32K Color Computer with Radio Shack Disk Basic, and it uses all the available memory in the 32K. With one page of graphics reserved when the program is running (PCLEAR 1—the smallest amount reservable with disk operational) and with all arrays dimensioned, 202 bytes are free. You can

modify the program to operate on a 16K Color Computer or a TRS-80 Model I, II, or III. Suggestions for modifications and a discussion of some of the Color Computer's commands appear in the conclusion.

The program keeps track of all checks written on your account by asking you to enter five data items for each check. The program accepts credits and deposits as well as checks and debits. The current balance is maintained with each entry; this is useful if you have two checkbooks for the same account.

Another useful function is the search by category. This function is priceless at income-tax time.

Reconcile saves time when the monthly bank statement arrives. You can reconcile savings and checking accounts in 15 to 20 minutes; it takes two to three hours by hand.

Algorithms

The Enter subroutine (lines 260–410) lets you enter new checks, deposits, credits, and debits. The program asks you to enter a check by entering five data items separated by commas. Enter the data in the following order: check number, up to six digits; payee name, up to 16 characters; the amount of the check, up to nine characters; the month the check was written, three characters (e.g., JAN); and the category of the expenditure, up to 16 characters.

Any entry that adds money to the account must be entered as category Deposit. The automatic balance function searches the category of an entry for the value Deposit. If the category is Depos-

Program Listing

```

10 REM CHECK REGISTER
20 REM COPYRIGHT 1982 BY DAVID M. DACUS, 1670 VALENCIA, LAS CRUC
ES, NM 88001
25 GOTO 2005
30 CLEAR 7000
40 CLS:PRINT@0,STRING$(64,165):INPUT"IS THIS A NEW FILE (Y OR N)
";A$:PRINT@128,STRING$(32,165)
50 DIM FL$(80),T(250),A(250)
60 DIM NAM$(250),CHK$(250),AMT$(250),MON$(251),CAT$(250),RECS(25
0)
70 IF A$="Y" THEN INPUT "WHAT IS THE NAME FOR YOUR NEW DAT
A FILE?";FL$:N = 0:GOTO 200
80 INPUT "WHAT IS THE NAME OF YOUR CURRENT DATA FILE?";FL
$:PRINT STRINGS(32,165);:PRINT"LOADING DATA"
90 OPEN "D", #1, FL$, 64
100 N = N + 1
110 GET #1, N
120 INPUT #1, CHK$(N),AMT$(N),RECS(N),NAM$(N),MON$(N),CAT$(N)
130 A(N) = VAL(AMT$(N))
140 IF LOF(1) <> N THEN 100
150 CLOSE #1
160 FOR D = 1 TO N
170 IF CAT$(D) <> "DEPOSIT" THEN 190
180 T(D) = T(D-1) + A(D):NEXT D:GOTO 200
190 T(D) = T(D-1) - A(D):NEXT D
200 CLS:PRINT@0,STRING$(32,175)
210 PRINT@ 32,"**TO RECOVER FROM ERROR WITHOUT LOSING DATA ENTER
GOTO 200**"
    
```

Listing continues

The Key Box

**Color Computer
32K
Extended Color Basic
Color TRSDOS, 1 disk drive**

```

220 PRINT @ 96, STRINGS(32,175):PRINT @ 128, "SELECT A FUNCTION.
ENTER A NUMBER":PRINT @ 160, STRINGS(32,175)
230 PRINT @ 192, "1. ENTER", "2. EDIT", "3. RECONCILE", "4. PAYEE", "5. C
HECK #", "6. LIST", "7. BALANCE", "8. MONTH", "9. CATEGORY", "10. QUIT", "1
1. EXIT - SAVE FILE":PRINT @ 384, STRINGS(32,175)
240 INPUT "PLEASE ENTER A #";B:IF B < 1 OR B > 11 THEN FOR B = 1
TO 200:PRINT "PLEASE ENTER A # BETWEEN 1 & 11":NEXT B:GOTO 200
250 ON B GOTO 260,420,600,990,1230,1360,1460,1490,1650,2000,1940
260 FOR D = N + 1 TO 250:CLS:PRINT@0,STRINGS(32,169):PRINT@32, "
** ENTER ANY MONEY ADDED TO THE ACCOUNT AS CATEGORY - DEPOSIT **
":PRINT@96,STRINGS(32,169)
270 PRINT@128, "LAST CHECK ENTERED WAS ";CHK$(N):PRINT@160,STRIN
G$(32,169)
280 PRINT@192, "ENTER CHECK DATA SEPARATED BY ,S (6)/(16)/ (9)
/ (3) / (16)  CHK#,NAME,AMOUNT,MONTH,CATEGORY":PRINT@288,STRIN
G$(32,169)
290 INPUT CHK$(D),NAM$(D),AMT$(D),MON$(D),CAT$(D):A(D) = VAL(AMT
$(D)):IF N <= 1 THEN 350
300 FOR E = 1 TO N:IF CHK$(D) <> CHK$(E) THEN NEXT E:GOTO 350
310 CLS:PRINT@0,STRINGS(224,246);"CHECK NUMBER ";CHK$(D);" HAS B
EEN ENTERED ALREADY"
320 PRINT"CHECK NUMBER ";CHK$(D);" IS":PRINT CHK$(E) " "NAM$(E) "
"AMT$(E) " "MON$(E) " "CAT$(E)
330 INPUT "DO YOU WANT TO 1.RETURN TO INPUT 2.RETURN TO MAIN MEN
U"; B
340 IF B = 1 THEN 260 ELSE GOTO 200
350 N = D:IF CAT$(D) <> "DEPOSIT" THEN 370
360 T(D) = T(D-1) + A(D):GOTO 380
370 T(D) = T(D-1) - A(D)
380 CLS:PRINT@0,STRINGS(32,169);"THERE ARE NOW";N;"CHECKS IN THE
FILE.THE LIMIT IS 250 CHECKS":PRINT@96,STRINGS(32,169)
390 PRINT"THE CURRENT BALANCE IS ":PRINTUSING"***$##,####.##";T(
D):PRINT@224,STRINGS(32,169)
400 INPUT "ARE YOU THROUGH ENTERING (Y/N)";X$:IF X$ <> "N" THEN
200
410 NEXT D:GOTO200
420 CLS:PRINT@0,STRINGS(160,181);:INPUT "ENTER CHECK # FOR EDIT"
;X$:CLS:PRINT@0,STRINGS(32,181);
430 PRINT @ 32, "CHK#,NAME,AMOUNT,MONTH,CATEGORY":PRINT@64,STRIN
G$(32,181);
440 FOR D = 1 TO N:IF X$ <> CHK$(D) THEN NEXT D
450 PRINT CHK$(D) " "NAM$(D) " "AMT$(D) " "MON$(D) " "CAT$(D):PRINT@
192,STRINGS(32,181);
460 PRINT@224,"WHICH OF THE ITEMS IS INCORRECT ";"1.CHECK #","2.
NAME","3.AMOUNT","4.MONTH","5.CATEGORY","6.ALL ARE RIGHT":INPUT
B:CLS:PRINT@0,STRINGS(32,181);
470 ON B GOTO 480,490,500,550,560,590
480 INPUT "ENTER CORRECT CHECK #";CHK$(D):GOTO570
490 INPUT "ENTER CORRECT NAME";NAM$(D):GOTO570
500 INPUT "ENTER CORRECT AMOUNT";AMT$(D):A(D) = VAL(AMT$(D))
510 FOR E = D TO N:IF CAT$(E) <> "DEPOSIT" THEN 530
520 T(E) = T(E-1) + A(E):NEXT E:GOTO 540
530 T(E) = T(E-1) - A(E):NEXT E
540 PRINT"THE CORRECT BALANCE IS":PRINT USING "***$##,####.##";T(
N):PRINT@128,STRINGS(32,181);:GOTO 570
550 INPUT"ENTER CORRECT MONTH";MON$(D):GOTO 570
560 INPUT"ENTER CORRECT CATEGORY";CAT$(D)
570 PRINT @ 224,CHK$(D) " "NAM$(D) " "AMT$(D) " "MON$(D) " "CAT$(D) :
PRINT@288,STRINGS(32,181);
580 PRINT@320,;:INPUT "IS THE ENTRY CORRECT(Y/N)";X$:IF X$ = "N"
THEN CLS:GOTO 450
590 PRINT@288,STRINGS(32,181);:INPUT "DO YOU WANT TO EDIT AGAIN(
Y/N)";X$:IF X$ = "Y" THEN 420 ELSE 200
600 CLS:PRINT@0,STRINGS(32,185);"ENTER# OF CHECK TO BE RECONCILE
D":INPUT "CHECK # ";X$
610 PRINT@96,STRINGS(32,185);"CHK#,NAME,AMOUNT,MONTH,CATEGORY ";
STRINGS(32,185)
620 FOR D = 1 TO N:IF X$ <> CHK$(D) THEN NEXT D
630 PRINT@192,CHK$(D) " "NAM$(D) " "AMT$(D) " "MON$(D) " "CAT$(D):PR
INT@256,STRINGS(32,185)
640 PRINT"DOES THE COMPUTER ENTRY MATCH YOUR CHECK ",", "1.YES",
"2.NO","3.DO NOT RECONCILE":INPUT "#";REC$(D)
650 IF VAL(REC$(D)) <> 2 THEN 790
660 CLS:PRINT@0,STRINGS(32,185);CHK$(D) " "NAM$(D) " "AMT$(D) " "MO
N$(D) " "CAT$(D)
670 PRINT@96,STRINGS(32,185);"WHICH OF THE ITEMS IS INCORRECT ";
"1.CHECK #","2.NAME","3.AMOUNT","4.MONTH","5.CATEGORY","6.ALL AR
E RIGHT":INPUT B:PRINT@288,STRINGS(32,185);
680 ON B GOTO 690,700,710,750,760,790
690 INPUT "ENTER THE CORRECT CHECK #";CHK$(D):GOTO770
700 INPUT "ENTER THE CORRECT NAME";NAM$(D):GOTO770
710 INPUT "ENTER THE CORRECT AMOUNT";AMT$(D):A(D) = VAL(AMT$(D))
720 FOR E = D TO N:IF CAT$(E) <> "DEPOSIT" THEN 740
730 T(E) = T(E-1) + A(E):NEXT E:GOTO770
740 T(E) = T(E-1) - A(E):NEXT E:GOTO 770

```

Listing continues

it, the amount is added to the account. All other entries are subtracted from the account.

Enter's algorithm prevents you from entering two checks by the same check number. If two checks are entered by the same number, you can never reach the second check to reconcile it. If you need to enter two checks with the same number, label one with a trailing alpha character (e.g., 1459 and 1459A).

Each time you enter a check you are asked if you want to enter another check or return to the main menu. The default value is return to the main menu, and if you press enter without entering a response, the main menu appears.

Edit (lines 420-590) allows you to change any data item entered for a check. When you enter a check number, the current data for that check displays and you are offered six choices. Options 1-5 let you change one of the five data entries. Option 6 lets you say that the data is fine. This option is offered in case you select the wrong check number for edit.

If you select option 6, you do not need to change any value. You are asked if you want to edit another check or return to the main menu. If you change a data entry, the new check displays and you are asked if it is correct. If you answer yes, the program asks if you wish to enter another check for edit. If the check is not correct, it asks which data item you wish to change. When the data item changed is the amount, the balance of the account is updated.

Reconcile (lines 600-980) is the heart of the checkbook portion of the program. This algorithm keeps track of each check that has been returned with your monthly bank statement, so you know which checks have cleared the bank and which have not.

The function asks for a check number to be reconciled. When you enter the number, the data stored for the entered check is displayed to the screen and you are asked if the data matches the check you hold in your hand. If you enter 1 (yes) the check is flagged as reconciled and will not be listed as an outstanding check. If you enter 2 (no) you are sent to an edit subroutine and asked which data item is incorrect.

This subroutine works in the same manner as the Edit function. After you have corrected the data you are again asked if the data matches the check. If you respond with a 1 or 2, the procedures just discussed are repeated. Option 3 is "do not reconcile." This

option allows you to skip functions 1 and 2 if you have entered an erroneous check number or do not wish to reconcile the check.

After you have completed option 1, 2, or 3, you are asked if you want to enter another check, list all outstanding checks, or return to the main menu. If you request to enter another check, repeat the above procedure. If you ask to return to the main menu, you exit the reconcile algorithm.

If you ask to list all outstanding checks, you are offered two options. You can have all outstanding checks listed on the printer or on the screen. Once you have selected either a printout or CRT listing, you are asked for the closing balance of the current bank statement. All five data items are listed for each outstanding check, followed by a list of the total value for the outstanding checks and a list of the value of outstanding deposits. The reconciled balance is also listed.

The Payee function (lines 990-1220) lists all checks to a specified payee. You are first presented with the option of listing all payees. The payees may either be listed to the CRT or to the printer. If you have written checks to a large number of payees, you may experience a BS error. The unique-payees array is dimensioned to hold 80 payees (FIL\$(80) in line 50). After the payees have been listed, or if you select no listing, you are asked to name the payee you want listed. You can then select between listing all checks to the payee to either the printer or the CRT.

The Check # function (lines 1230-1350) lets you list a series of checks searched by check number. You are asked to input the first and last number for the search, separated by a comma.

List (lines 1360-1450) sends a list of all checks in the file to the printer. At the end of the check list, the current bank balance is printed.

The Balance function (lines 1460-1480) lists the current balance to the screen.

Month (lines 1490-1640) lists all checks written within a single month.

Category (lines 1650-1930) automatically provides a list of categories and then asks you to select a category for Search.

The Quit function (line 2000) exits the program without saving any transactions done before the exit.

The Exit-Save File function (lines 1940-2000) saves all check data to the disk file named when you enter the program, and then exits the program. You

Listing continued

```

750 INPUT "ENTER THE CORRECT MONTH";MON$(D):GOTO770
760 INPUT "ENTER THE CORRECT CATEGORY";CAT$(D)
770 CLS:PRINT@0,STRING$(32,185);"THE CURRENT BALANCE IS":PRINT U
SING"*##,###.##";T(N):PRINT@96,STRING$(32,185)
780 PRINT@128,CHK$(D) "NAM$(D) "AMT$(D) "MON$(D) "CAT$(D):PR
INT@192,STRING$(32,185);:INPUT "IS THE CHECK DATA CORRECT";X$:IF
X$ = "N" THEN 660 ELSE GOTO640
790 PRINT@256,STRING$(32,185);:PRINT "DO YOU WANT TO ",,"1.ENTER
ANOTHER CHECK","2.LIST ALL CHECKS OUTSTANDING","3.ENTER ANOTHER
FUNCTION";STRING$(41,32);:INPUT E
800 ON E GOTO 600,810,200
810 CLS:PRINT@224,STRING$(32,185):INPUT"DO YOU WANT (1)HARDCOPY,
OR (2)CRT LISTING OF OUTSTANDING CHECKS?";F:INPUT"ENTER C
LOSING BALANCE FROM STATEMENT";S1:K=0:H=0:IF F = 2 THEN 910
820 PRINT "LISTING OUTSTANDING CHECKS":PRINT#-2,"****LIST OF OUT
STANDING CHECKS*";CHR$(10);CHR$(10)
830 PRINT#-2,"CHECK #","MONTH","NAME","AMOUNT","CATEGORY"
840 FOR D = 1 TO N
850 IF VAL(REC$(D)) <> 1 THEN PRINT #,-2,CHK$(D),MON$(D),NAM$(D)
,AMT$(D),CAT$(D):IF CAT$(D) = "DEPOSIT" THEN 860 ELSE H = H + A(
D)
860 IF VAL(REC$(D)) <> 1 AND CAT$(D) = "DEPOSIT" THEN K = K + A(
D)
870 NEXT D:PRINT #,-2,CHR$(10);CHR$(10);"THE TOTAL VALUE OF OUTS
TANDING CHECKS IS $"H
880 IF K > 0 THEN PRINT #,-2,CHR$(10);"THE TOTAL VALUE OF OUTSTA
NDING DEPOSITS IS $"K
890 S1=S1+K:S1=S1-H:PRINT#-2,CHR$(10);CHR$(10);"* RECONCILED BAL
ANCE=";S1
900 GOTO200
910 PRINT"CHK#,NAME,AMOUNT,CATEGORY":FOR D = 1 TO N
920 IF VAL(REC$(D)) <> 1 THEN PRINT CHK$(D) "NAM$(D) "AMT$(D) "
CAT$(D) ELSE 940
930 IF CAT$(D) <> "DEPOSIT" THEN H = H + A(D) ELSE K = K + A(D)
940 NEXT D
950 PRINT"THE TOTAL VALUE OF OUTSTANDING CHECKS IS: "H
960 IF K > 0 THEN PRINT "THE VALUE OF OUTSTANDING DEPOSIT
S IS "K
970 S1=S1+K:S1=S1-H:PRINT"RECONCILED BALANCE="S1
980 INPUT "PRESS ENTER TO RETURN";X$:GOTO 200
990 CLS:PRINT@0,STRING$(32,201):INPUT "DO YOU NEED A LIST OF PAY
EES";X$:IF X$ = "Y" THEN INPUT "HARDCOPY (Y/N)";X1$:GOSUB 1120:I
F X1$ <> "Y" THEN INPUT "ARE YOU FINISHED READING";X$:CLS ELSE C
LS
1000 PRINT@0,STRING$(32,201);:INPUT "ENTER PAYEE TO BE SOUGHT
";X$:PRINT@128,STRING$(32,201);:INPUT "DO YOU WANT HARD COPY(
ENTER 1)";E:IF E <> 1 THEN 1080
1010 CLS:PRINT@0,STRING$(160,201):PRINT"PRINTING PAYEE LISTING"
1020 PRINT#-2, "PAYEE - "X$,CHR$(10),CHR$(10)
1030 PRINT#-2, "CHECK #","MONTH","AMOUNT","CATEGORY",CHR$(10):X1
= 0:FOR D = 1 TO N
1040 IF X$ <> NAM$(D) THEN 1060
1050 PRINT#-2, CHK$(D),MON$(D),AMT$(D),CAT$(D):X1 = X1 + VAL(AMT
$(D))
1060 NEXT D
1070 PRINT#-2, CHR$(10),CHR$(10);"THE TOTAL PAID TO ";X$;" IS ";
X1:GOTO 200
1080 CLS:PRINT "CHECK#,MONTH,AMOUNT,CATEGORY"
1090 X1 = 0:FOR D = 1 TO N:IF X$ <> NAM$(D) THEN 1110
1100 PRINT CHK$(D) "MON$(D) "AMT$(D) "CAT$(D):X1 = X1 + VAL(A
MT$(D))
1110 NEXT D:PRINT"*** THE TOTAL PAID TO ",X$;" IS";X1:INPUT "ARE
YOU THROUGH READING";X$:GOTO200
1120 E = 1:X1 = 0:FIL$ = ""
1130 FOR D = 1 TO N
1140 FOR X = 1 TO E
1150 IF FIL$(X) = NAM$(D) THEN 1210
1160 NEXT X
1170 IF X1$ = "Y" THEN PRINT#-2, NAM$(D),:GOTO 1190
1180 PRINT NAM$(D),
1190 FIL$(E) = NAM$(D)
1200 E = E + 1
1210 NEXT D
1220 RETURN
1230 CLS:PRINT@ 128, STRING$(32,246):INPUT "PLEASE ENTER FIRST A
ND LAST CHECK NUMBER FOR SEARCH (F,L) ";X$,X1$
1240 CLS:PRINT@ 128,STRING$(32,246):INPUT "DO YOU WANT HARDCOPY(
Y/N)";X2$:IF X2$ <>"Y" THEN 1310
1250 CLS:PRINT@ 128,STRING$(32,246);"PRINTING CHECK SERIES"
1260 PRINT#-2, "LISTING OF ALL CHECKS NUMBERED BETWEEN ";X$;" A
ND ";X1$;CHR$(10);CHR$(10)
1270 PRINT#-2, "CHECK #","PAYEE","AMOUNT","MONTH","CATEGORY";CHR
$(10)
1280 FOR D = 1 TO N:IF VAL(CHK$(D)) < VAL(X$) OR VAL(CHK$(D)) >
VAL(X1$) THEN NEXT D:GOTO200

```

Listing continues

are also asked if you intend to exit. If you do not answer Y you are returned to the main menu.

I use this option to back up my check files. I keep two disks current with my checks. When I exit saving the file to disk, I tell the computer I do not want to exit. Then, I switch disks and re-exit, saving my file, and copying data to my back-up disk.

These functions should meet most of the needs for financial transactions for a family or small business, but the program is easy to tailor to your own needs.

To adapt the program for a 16K machine, reduce the number of checks stored per file to 50 or 75. You may also want to eliminate some of the functions, such as Edit (Reconcile has an edit function anyway), Payee, Check #, and Month.

Those of you who don't have a Color Computer will have to reformat the displays, because the Color Computer has a display of 14 lines of 32 characters rather than 16 of 64 or 24 of 80. All the PRINT@ commands, except those of PRINT@0, must be recalculated. PRINT STRING\$(X,Y) prints a string of X characters of ASCII code Y. The Y values in this program are block color graphics, which can be replaced on the Models I, II, and III by the block-graphic characters for these machines.

The disk commands in lines 90 and 1940 open a direct (random access) file with a limit of 64 characters per entry. The other computers require appropriate random-access file commands and format statements. The Color Computer has no DEFINT command. Some arrays can be converted to integers to save memory. The PRINT #-2 command of Color Basic is the equivalent of LPRINT. The Print Using format "***###,###.##" specifies two decimal places with commas inserted every three numbers, a floating dollar sign, and fill from the left with asterisks. Color Basic doesn't allow the defining of a format variable. If your computer lets you define a format, you don't have to repeat the format each place it is used.

The program is long, but it should make your financial management tasks easier. The program also makes use of some unusual features of the Color Computer that you may find useful in your programming efforts. ■

David Dacus (1670 Valencia, Las Cruces, NM 88001) is an Operations Research Analyst for the U.S. Army Training and Doctrine Command Systems Analysis Activity at White Sands Missile Range, NM.

Listing continued

```

1290 PRINT#-2, CHK$(D),NAM$(D),AMT$(D),MON$(D),CAT$(D)
1300 NEXT D:GOTO 200
1310 CLS:PRINT"LIST OF CHECKS ";X$ TO ";X1$
1320 PRINT "CHK#,NAME,AMOUNT,MONTH,CATEGORY"
1330 FOR D = 1 TO N:IF VAL(CHK$(D)) < VAL(X$) OR VAL(CHK$(D)) >
VAL(X1$) THEN NEXT D:GOTO 1350
1340 PRINT CHK$(D) " "NAM$(D) " "AMT$(D) " "MON$(D) " "CAT$(D):NEXT
D
1350 INPUT "ARE YOU THROUGH WITH THE LIST";X$:GOTO 200
1360 CLS:PRINT@0,STRING$(192,134);"PRINTING A LIST OF ALL CHECKS
IN THE FILE":PRINTSTRING$(192,134)
1370 PRINT#-2,"LIST OF ALL CHECKS"
1380 PRINT#-2,CHR$(10)
1390 PRINT #-2, "CHECK #","MONTH","NAME","AMOUNT","CATEGORY"
1400 FOR D = 1 TO N
1410 PRINT #-2, CHK$(D),MON$(D),NAM$(D),AMT$(D),CAT$(D)
1420 NEXT D
1430 FOR D = 1 TO 3:PRINT #-2,CHR$(10):NEXT D
1440 PRINT#-2,"CURRENT BALANCE IS: ";:PRINT#-2, USING "***##,##
##.##";T(N)
1450 GOTO 200
1460 CLS:PRINT@0,STRING$(192,172);
1470 PRINT"CURRENT BALANCE IS:":PRINTUSING "***##,###.##";T(N)
:PRINT@256,STRING$(160,172);
1480 INPUT"READY TO RETURN";X$:GOTO200
1490 CLS:PRINT@0,STRING$(32,206);:INPUT"ENTER MONTH FOR FILE SEA
RCH";A$:PRINT@96,STRING$(32,206);
1500 INPUT"DO YOU WANT HARDCOPY(ENTER 1)";E:IF E<<1 THEN1580
1510 PRINT@192,STRING$(32,206);"PRINTING CHECKS FOR "A$:PRINT#-2
, "***** ";A$;" *****";CHR$(10);CHR$(10)
1520 PRINT#-2,"CHECK #","NAME","AMOUNT","CATEGORY"
1530 PRINT#-2,CHR$(10)
1540 FOR D = 1 TO N
1550 IF A$ <> MON$(D) THEN 1570
1560 PRINT #-2, CHK$(D),NAM$(D),AMT$(D),CAT$(D)
1570 NEXT D:GOTO 200
1580 CLS:PRINT@0,STRING$(32,206);
1590 PRINT"CHECK #, NAME, AMOUNT, CATEGORY"
1600 FOR D = 1 TO N
1610 IF A$ <> MON$(D) THEN NEXT D:GOTO 1640
1620 PRINT CHK$(D);" ";NAM$(D);" ";AMT$(D);" ";CAT$(D)
1630 NEXT D
1640 INPUT "READY TO RETURN";A$:GOTO 200
1650 GOSUB 1840
1660 CLS:PRINT@0,STRING$(32,239);:INPUT"ENTER CATEGORY FOR FILE
SEARCH ?";Z$
1670 PRINT@96,STRING$(32,239);
1680 INPUT"DO YOU WANT HARDCOPY(ENTER 1)";E:IF E<<1 THEN 1780
1690 PRINT@192,STRING$(32,239);"PRINTING CHECKS IN CATEGORY
";Z$:PRINT#-2,"CATEGORY - "Z$
1700 PRINT #-2, CHR$(10);"CHECK #","MONTH","NAME","AMOUNT";CHR$(
10)
1710 FOR D = 1 TO N
1720 IF Z$ <> CAT$(D) THEN 1750
1730 PRINT #-2,CHK$(D),MON$(D),NAM$(D),AMT$(D)
1740 X1 = X1 + VAL(AMT$(D))
1750 NEXT D
1760 PRINT#-2, CHR$(10);CHR$(10);CHR$(10);"THE TOTAL EXPENDITURE
S FOR CATEGORY ";Z$;" IS " X1
1770 GOTO 200
1780 CLS:PRINT@0,STRING$(32,239);:PRINT"CHECK #, MONTH, NAME, AM
OUNT"
1790 FOR D = 1 TO N
1800 IFZ$<>CAT$(D) THEN 1820
1810 PRINT CHK$(D) " "MON$(D) " "NAM$(D) " "AMT$(D)
1820 NEXT D
1830 INPUT "READY TO RETURN";Z$:GOTO 200
1840 CLS:E=1:X1 = 0:FIL$ = ""
1850 FOR D = 1 TO N
1860 FOR X = 1 TO E
1870 IF FIL$(X) = CAT$(D) THEN 1920
1880 NEXT X
1890 PRINT CAT$(D),
1900 FIL$(E) = CAT$(D)
1910 E = E + 1
1920 NEXT D
1930 INPUT "ARE YOU THROUGH READING";X1$:RETURN
1940 OPEN "D", #1, FLS, 64
1950 FOR I = 1 TO N
1960 WRITE #1, CHK$(I),AMT$(I),REC$(I),NAM$(I),MON$(I),CAT$(I)
1970 PUT #1, I
1980 NEXT I
1990 CLOSE #1
2000 CLS:PRINT@0,STRING$(224,246);:INPUT"ARE YOU SURE YOU WANT T
O EXIT";X$:IF X$ <> "Y" THEN 200 ELSE END
2005 PCLEAR 1:GOTO 30

```

Expanded Color Capabilities

by James Wood

According to the *Going Ahead With Extended Color Basic* manual, the Color Computer can display only certain colors on the screen at one time. In the high-resolution modes you can have black and green; black and buff; red, blue, green, and yellow; or cyan, ma-

genta, orange, and buff. But, I wanted several colors on a black background. After experimenting, I obtained these colors. I don't know why it works, but I can tell you how to put green, red, blue, and black in the same picture (great colors for a space game).

The Color Computer can now display green, blue, red, and black on the screen at one time.

8	creates strings for numbers to display number of hits
10	clears screen, prevents FC error first time rock is erased
20	resets timer
30	dimensions array for ship and dust
50	draws ship
60	creates dust for explosion
70	paints ship
80	part of ship
90	changes colors
100	places ship into array
110	places dust into array
120	clears graphics and shows new graphics screen
130	reads joysticks
140	used with line 240
150	changes joystick reading to even numbers to prevent distorted ship image (necessary due to switching PMODEs)
160	places ship array onto screen
170	reads joysticks
180	displays laser blast and sound if joystick button is pressed
190	determines if rock has been hit, sounds explosion
200	delay to leave rock on screen long enough to hit (if you're fast)
210	erases rock
220	determines position for next rock
230	puts rock on screen
240	erases old ship position only if joysticks have moved (prevents flicker of motionless ship)
260	determines if number of hits equals 10, places number of hits on screen, prints time elapsed after 10 ships destroyed

Table 1. Line Descriptions

Type in and run the Red, Green, Blue, Black demo, which starts at line 295. Lines 300-330 use PMODE 3,1 and SCREEN 1,0 to create red, blue, and yellow boxes on a green background. After the For loop in line 340, the monitor is changed by PMODE 4,1:SCREEN1,1. The red changes to green, blue to red, yellow to blue, and green to black.

You could use these colors to create a space ship as well as some rocks to blow up. In the Space Rocks program, a red and blue ship shoots green laser blasts at red and blue rocks against a black sky. The rocks explode into green, red, and blue dust. The right joystick controls the up, down, left, and right movement of the space ship. Depressing the fire button creates a laser blast.

The program has one minor problem. The ship points to the right and shoots to the right. If a rock is on your left, you can still blow it up by shooting to the right. This problem will give you something with which to experiment. ■

James Wood can be reached at 424 N. Missouri, Atwood, IL 61913.

Program Listing

```

5 'SPACE ROCKS
7 'JAMES W. WOOD, 424 N. MISSOURI, ATWOOD, IL, 61913
8 A$(1)="D10":A$(2)="R5D5L5D5R5":A$(3)="R5D5L5R5D5L5":A$(4)="D5R
5U5D10":A$(5)="R5L5D5R5D5L5":A$(6)="R5L5D10R5U5L5":A$(7)="R5D10"
:A$(8)="R5D10L5U10D5R5":A$(9)="R5D5L5U5R5D10"
10 U=3:V=3:CLS0
20 TIMER=0
    
```

Listing continued

The Key Box

**Color Computer
16K RAM
Extended Color Basic
One Joystick**

Listing continued

```

30 DIMW(20,10),E(10,10)
40 PMODE3,1:PCLS
50 DRAW"BM0,0R4F4R8F4L20U8"
60 FORT=1TO20:PSET(RND(10)+100,RND(10)+100,RND(3)+1):NEXTT
70 PAINT(3,4),3,4
80 FORX=10TO14:PSET(X,6,2):NEXTX
90 PMODE4,1
100 GET(0,0)-(20,10),W
110 GET(100,100)-(110,110),E
120 PCLS:SCREEN1,1
130 A=JOYSTK(0):B=JOYSTK(1)
140 A1=A:B1=B
150 A=INT(A/2)*2:B=INT(B/2)*2
160 PUT(A*4,B*3)-(A*4+20,B*3+10),W
170 AA=JOYSTK(0):BB=JOYSTK(1)
180 P=PEEK(65280):IFP=126ORP=254THENPLAY"O4V3L255BCB":LINE(A*4+
22,B*3+8)-(255,B*3+8),PSET:LINE(A*4+22,B*3+8)-(255,B*3+8),PRESET
:GOTO190ELSE200
190 IFABS((B*3+8)-V)<=3THENPUT(U-5,V-5)-(U+5,V+5),E:PLAY"O2L100V
31GECA":LINE(U-10,V-10)-(U+10,V+10),PRESET,BF:NH=NH+1:GOSUB260:G
OTO220
200 JW=JW+1:IFJW=6THENJW=0:GOTO210ELSE240
210 LINE(U-3,V-3)-(U+3,V+3),PRESET,BF
220 U=RND(100)+150:V=RND(170)+10
230 CIRCLE(U,V),3
240 IF AA<>A1 OR BB<>B1 THENLINE(A*4,B*3)-(A*4+22,B*3+10),PRESET
,BF:GOTO130
250 GOTO170
260 IFNH=10THENPRINT@192,INT(TIMER/60);"SECONDS FOR 10 HITS"ELSE
LINE(0,180)-(6,190),PRESET,BF:DRAW"BM1,180"+AS(NH):RETURN
290 END
295 'RED, GREEN, BLUE, BLACK DEMO
298 'JAMES W. WOOD, 424 N. MISSOURI, ATWOOD, IL, 61913
300 PMODE3,1:PCLS:SCREEN1,0
310 LINE(20,20)-(80,80),PSET,BF
320 COLOR3,1:LINE(80,80)-(140,140),PSET,BF
330 COLOR2,1:LINE(140,140)-(190,190),PSET,BF
340 FORTT=1TO500:NEXTTT
350 PMODE4,1:SCREEN1,1
360 GOTO360

```

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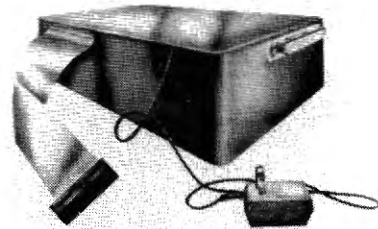
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80 Index, 1980-1982

Many of you have asked for it, and here it is: a cumulative, annotated, cross-referenced *80 Micro* article index through October 1982. (Look for the rest of 1982 in the January issue). We've even included references for Debugs!

The index is divided into the following categories: Business, Education, Games, General, Graphics, Hardware,

Home/Hobby, Programming Techniques, Science/Math, Tutorials, and Utilities. Reviews are listed in a section of their own. The articles are sorted by title.

The computer the article was written for is listed in parentheses at the end of the annotation. If no computer appears, it is a general article that applies to all TRS-80s.

You will notice that most are listed as Model I articles. Many of these programs will run on a Model III, but we could not test them all to be sure. Also, it is often easy to convert Basic programs from one TRS-80 to another.

If you do not have the issue that has the article you want, many back issues are still available. Look for an order form elsewhere in this magazine. ■

1980

BUSINESS

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Accountant's Aid	Sheats	6/80:130		Produce columnar work sheets. (Model I)
Business Programming	Clarke	5/80:78		See Tutorials.
Doctor Your Records	Muehlig	9/80:162		One doctor's bookkeeping program. (Model I)
Down the Road	Vick	9/80:212		Stock and sales plan to maximize profit. (Model I)
Get the Whole Story	Blechman	7/80:62	9/80:14	Computerize your Amway business. (Model I)
Investment Analysis	Sparks	3/80		Use sophisticated financial techniques to analyze possible investments. (Model I)
Livestock Management	Noti	10/80:106		How farmers use computers to keep track of herd management.
Office Computer, The	Valle	12/80:109		Set up your computer to handle common chores of a business.
Printer's Apprentice	Barnes	3/20:22		Give printing estimates on the computer. (Model I)

EDUCATION

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Braille	Bruey	1/80:52		Generate Braille on an impact printer adjusted for a heavy impression. (Model I)
Computer Education	Chartier/Goldner	7/80:44		Computer-ed class at the Fort King Middle School.
Fraction Tutor	Orr	1/80:80		Teach fractions to children. (Model I)
Hey... You in the Corner	South	11/80:186		Educational games. (Model I)
Kidstuff	Keen/Dischert	9/80:124		Pick out shapes on screen. (Model I)
Math Flash	Barbarelo	9/80:158	12/80:18	Simulation of math flashcards on screen. (Model I)
More Night School	Lopez	4/80:45		Another report on Loyola University's computer education course.
Music Note Recognition	McClung	9/80:182		Program that teaches you how to read music. (Model I)
Night School	Lopez	1/80:41		University of Loyola uses 25 Model Is in computer education course. (Model I)
Preschool Math	Hastings	4/80:77		Teach math to young children. (Model I)
Quiz Master	Eckert	6/80:148		Store questions and answers on disk. (Model I)

GAMES

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
4K Intelligence	Lopez	3/80:55		Artificial intelligence in Level 1. (Model I)
Asteroid Adventure	Perry/Taylor	10/80:212		4K arcade space game. (Model I)
Ball Box	Lewis	4/80:60		Based on Pong Squor. (Model I)
Code Cracker	Morgan	8/80:110		Generate codes for one or two players to decipher. (Model I)
Computer Monopoly	Adams	11/80:83		Computer simulation of the board game. (Model I)
Game of Life, The	Kitsz	6/80:38	8/80:16	Based on British mathematician John Conway's game, in Assembly language. (Model I)
Heartbeat Away, A	Morey	8/80:76		Simulation for being President of U.S. (Model I)
Life in the Fast Lane	Kepner/Grace	8/80:62		Basic/Assembly game of Life. (Model I)
Ping-Pong	Moehlis	9/80:216		Hit the bouncing dot. (Model I)
Puzzler	Morgan	10/80:198		Find the hidden word. (Model I)
Rock, Scissors, Paper	Harris	4/80:116		An old standard computerized in 4K. (Model I)
Slot Machine	Fason	8/80:84		Casino simulation. (Model I)
Starfighter	Ferrera	8/80:59		Space arcade game for 4K. (Model I)
Swords and Sorcery II	Adams	8/80:42	10/80:14	Adventure game. (Model I)
Third Dimension, The	Dillehay	7/80:152	4/81:22	Tic-Tac-Toe-like game. (Model I)
True or False?	Krutch	6/80:116		Guessing game with artificial-intelligence techniques employed. (Model I)
U-Boat	Borrmann	8/80:68		Sink subs and learn matrix handling. (Model I)
Westward Ho!	Herold	10/80:148		Simulation of a westward trek by pioneers. (Model I)

GENERAL

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Computer Bulletin Boards	Cambron	5/80:110		All about bulletin boards and how to access them.
Confessions of a Computer Derelict	Kornfeld	4/80:30		Humor
Courts Smashed	Kitsz	10/82:55		Software Copyright and the courts.
Copyright?				
Dealer's Experience, A	DeFonzo	4/80:98		RS dealer experience.
EDTASM Index	Kepner	6/80:124		A cross-referenced index for the RS E/A manual.
Electronic Networks	Robertson	11/80:62		Computers and networking.
How the Gamesman Began	Robertson	7/80:48		Scott Adams profile.
I Ching	Scarpelli	4/80:123		Calculate life's changes on the TRS-80. (Model I)
In the Beginning	Herro	7/80:78		One man's experience with the TRS-80. (Model I)
On the Radio	Hastings	8/80:86		Do a broadcast log on the TRS-80. (Model I)
Owner's Tale, An	Dilbeck	5/80:107		Why I bought my microcomputer.
Part-time Consultant	Morin	3/80:79		How to be a computer consultant.
Put-N	O'Brien	5/80:46		A list of structured statements to build a language around.
Radio Shack vs. Competition	Busch	11/80:109		TRS-80 compared to other computers.
Table of Contents, The	Thurlow	11/80:234		Outline for Scripsit instruction tapes.
Tally with an 80	Graham/Haller	11/80:114		Computerize election returns. (Model I)
Tandy Story, The	Brown	1/80:28		Short history of the Tandy/Radio Shack Corporation.
The Bottom Shelf	Shuford	2/80:36		Profile of a software company.

GRAPHICS

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Adventures in Roseland	Joffe	6/80:62	8/80:16	Use J = a SIN X to draw a three-leaved rose. (Model I)
Basic Drawing	Gorsky	7/80:140		Draw on the screen and save your work. (Model I)
Beginner's Formatting	Keller	7/80:108		See Tutorials.
Beyond Blackjack	Thorsen	1/80:60		See Programming Techniques.
CAL81	Strazzarino	12/80:128		See Home/Hobby
Compu-Sketch	Hendricks	12/80:255		Short Basic program to draw on the screen. (Model I)
Curve Plotter	Cecil	7/80:130		Draw curved graphics in Basic. (Model I)
Doodle Bug	Bishop	6/80:72	8/80:16	Doodle on your screen with eight direction keys. (Model I)

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Double-size Graphics	Thiel	6/80:106		How to get around CHR\$(23) and keep your graphics. (Model I)
Graphics Coder, The	Racine	8/80:160		See Utilities.
Images	Gorsky	11/80:220		Draw radial lines on the screen. (Model I)
Inside-out Debugging	Ogren	11/80:222		See Tutorials.
Kaleidopen	Nicholas	6/80:78		Display kaleidoscope-like graphics on the screen. (Model I)
Random Walker	Strazzarino	11/80:179		Randomly generated graphics on the screen. (Model I)
Real-time Graphics	Zidonis	6/80:82		Use PEEK and POKE in game simulations. (Model I)
Seasons Greetings	Vann	12/80:112	3/81:14	Generate greeting cards on your screen. (Model I)
Simple Graphics	Hommel	7/80:76		Draw designs with arrow keys in 4K. (Model I)
Super Graphics	Moyer	10/80:202	1/81:28	Fast animation using the Print graphics method. (Model I)

HARDWARE

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
300-baud Terminal	Loos	8/80:136		Use unused ICs in the TRS-80 to make it a half-duplex terminal. (Model I)
Babybug Keypad	Kitsz	3/80:88		Hex keypad to use with machine code. (Model I)
Box It In	Zalnerunas	3/80:132		Build a box to hold wires and keyboard. (Model I)
Build a Light Pen	Holder	4/80:38	6/80:12	(Model I)
Build Your Own Port	Hawkes/Reese	9/80:116		Build a parallel port using the 8255 PPI chip. (Model I)
Cassette Problems	Stoner/Barker	1/80:62		See Tutorials.
Cassette Problems II	Stoner/Barker	2/80:54		Build the Data Dubber, which regenerates original CSAVE pulses. (Model I)
Caveat Emptor	Parris	10/80:122		Trials and errors of homebrew interfacing. (Model I)
Cheap CLOAD Fix	King	1/80:132	4/80:27	Device to block unwanted noise on CLOADs. (Model I)
Cheap Video	Fowler/Murray	8/80:116		Interface a tv to your computer. (Model I)
CLOAD Micrometer	Thiel	5/80:84		Device to monitor load level.
CTR- 41 Modifications	Hinrichs	4/80:110		Mods for a better recorder. (Model I)
Destick Your Relay	Lukoff	5/80:74		Mod to prevent relay from sticking on the cassette recorder.
Disaster Saver	Brooks	7/80:156		Power interlock to prevent garbaged disk files. (Model I)
DVM Interface for the 80	Casper/Freedman	10/80:156		Hook up a digital voltmeter to the TRS-80. (Model I)
Faster, Faster	Kitsz	2/80:50		Program speedup device. (Model I)
Fuse Fix	Winter	6/80:154		Put an external fuse on your power supply. (Model I)
H14, Meet the TRS-80	Friesen	10/80:118		Interface Heathkit printer to TRS-80. (Model I)
Homebrew Interface, A	Vince	3/80:96		Real-time interface for home climate control, etc. (Model I)
Homebrew Memory	Ragucci	5/80:70		Extra memory with no expansion interface. (Model I)
Homebrew TRS-80	Steele	11/80:146		Build your own TRS-80 from scratch. (Model I)
I/O Ports Plus	Harron	3/80:120		Interface to turn on any memory location for control or monitor use. (Model I)
Interfacing the NEC Spinwriter	Kunzman	10/80:144		Get the NEC printer to work at 1,200 baud. (Model I)
Joystick City	Suter	12/80:186		Interface joysticks via the cassette I/O port. (Model I)
Level II to Model 33	Colby	1/80:70	3/81:14	Interface Model 33 Teletype to TRS-80.
Look, a Super Snubber	Martel	11/80:216		Protect cassette's relay from high voltage across its contact when turned off.
Lowercase and Uppercase	Stoner/Barker	3/80:72		Build a lowercase mod. (Model I)
LPRINT "Cheap"	Blechman	2/80:100		Using a serial printer with TRS232/Formatter. (Model I)
Mem Size...20K?	Stanley	11/80:116	5/81:22	Add 4K to 16K. (Model I)
Mork & Mindy Monitor	Jackson	4/80:58		Use tv as a computer monitor. (Model I)
PR- 40 Printer Interface	Hise	8/80:152		Connect an SWTPC printer to a TRS-80. (Model I)
Regulate It!	Klungle	3/80:113		Build a voltage regulator.
Relay Assistant	Jahns	7/80:112		Circuit to prevent recorder on/off control from welding in the close position.

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Relay Protection	Richardson	1/80:78		Build a protection device for your cassette relay. (Model I)
Reverse Video	Kitsz	4/80:54	5/80:28	Build a reverse-video device. (Model I)
Selectric Hardcopy	Bickerton	9/80:102	11/80:22	Interface a TRS-80 and a Selectric typewriter. (Model I)
Serial Clank on the Print Simple Interface	O'Brien Mullin	10/80:194 2/80:94	4/81:22	Interfacing serial printers via the RS-232. (Model I) Interface switches using one chip and eight resistors. (Model I)
Teletype Interface	Noeth	6/80:142		Interface a Model 33 with no modification to the CPU. (Model I)
Teletype Interface	Commander	9/80:84		Instructions and driver program to interface a TTY to your computer. (Model I)
Testing 1, 2, 3	Nelson	6/80:136		Interface your computer with a test measuring system. (Model I)
TTY Interface	Rumbolt	7/80:144		Use a TTY as a printer. (Model I)
Turn-on	Nestor	12/80:208		Automatically turn on the RS line printer with a relay and software control. (Model I)
Two Basics Better than One	Erickson	10/80:182		Mod for Level I and Level II in the same machine. (Model I)
Two Different Worlds	Eckert	7/80:116		A/D converter using the AD570 and AD582 chips. (Model I)
Video Tune-up	Miller	2/80:62		Eliminate fuzzy edges and make monitor electrically safe. (Model I)

HOME/HOBBY

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Bout with the IRS, A CAL81	Blechman Strazzarino	9/80:58 12/80:128	4/81:22	How a TRS-80 can help in an IRS audit. (Model I) Print out personalized calendar with graphics. (Model I)
Carpool	McCahan	5/80:62		Program to organize a carpool. (Model I)
Cold Comfort	Keen/Laughlin	10/80:176		Heating and insulation-analysis program. (Model I)
Decisions, Decisions	Walton	1/80:56		Basic program to aid in decision making. (Model I)
Duty Roster	Straw	3/80:127		Keep track of who's in charge of what for club or church functions. (Model I)
Fixer, The	Ashley	11/80:90		Program to keep photographer's darkroom organized. (Model I)
Graph Plotter	King	3/80:130		Plot how much you spend each month. (Model I)
Gregorian Converter	Borrmann	12/80:260		Convert Gregorian dates to Julian. (Model I)
Household Accountant	Andresen	2/80:114	4/80:27	Keep family expense records. (Model I)
IRS-80	McNeil	3/80:42		Keep tax records. (Model I)
Itinerary	Gorsky	4/80:95		Keep track of travel arrangements. (Model I)
Magazine Index	Klungle	4/80:114	2/81:31	Keep track of up to 300 articles in 16K. (Model I)
Merry TRSMAS	Taylor	1/80:32		Display Christmas greetings on TRS-80. (Model I)
Mind Your As and Ps	Leonard	9/80:174		Compile grocery lists in 16K. (Model I)
Model Conversion	Blackburn	5/80:128		Work out model measurements. (Model I)
Passing the Plate	Riekers	2/80:70		Keep track of Sunday church donations. (Model I)
Reference Library Index	Morgan	9/80:146		Keep track of articles in 16K. (Model I)
Soundex Codes	Hodge	3/80:138		Class similar-sounding names together for easier genealogical research. (Model I)
Tout I	Wilson	1/80:90		Horse-racing analysis program. (Model I)
Video Titler	Rotzien	4/80:121		Generate captions for video productions. (Model I)
Your Personal Calendar	Colsher	11/80:132		Put important dates, etc. on your 16K one-disk system. (Model I)

PROGRAMMING TECHNIQUES

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Adventures in Roseland	Joffe	6/80:62		See Graphics
Beyond Blackjack	Thorsen	1/80:60		Learning Level I Basic graphics techniques. (Model I)
Cheap Trills with T-Bug	Joffe	11/80:168		How to get sound in machine code. (Model I)
Cutting & Splicing Basic	Nottingham	5/80:134		Reorder programs via block movement.
Display Formatting	Joffe	6/80:134		Techniques for a tidy screen display. (Model I)
Doodle Bug	Bishop	6/80:72		See Graphics.

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Free Format Search	Riekers	5/80:94		See Utilities.
Get Serious	Pape	10/80:93		Using the RST instruction. (Model I)
Hidden Codes/ Missing Chip	O'Connor	1/80:93		Use commands the RS manuals don't mention. (Model I)
INKEY\$	Himler	4/80:103		Enhance computer/user interaction. (Model I)
Keyboard Interrogation	Yarbrough/Vesteen	6/80:140		Use PEEK to directly access keyboard memory. (Model I)
Long and the Short of It	Bole	11/80:180		Format RS Quick Printer output for screen dumps of game displays. (Model I)
Merry TRSMAS	Taylor	1/80:32		See Home/Hobby.
Multiple USRs	Ventimiglia	4/80:80		Get up to 10 USR subroutines. (Model I)
Music Maestro!	Pape	1/80:36		Machine-language and Basic tone-generating routines. (Model I)
Now It's Time for . . . Name That Routine	Cornell	12/80:160		Use mnemonics for Basic functions call, with Assembly-language listing. (Model I)
Of Two-Dimensional Arrays	Conhaim	11/80:160		How to use two-dimensional arrays. (Model I)
Randomness	Carpenter	6/80:65		Use bargraphs to see how RND works in a program. (Model I)
Rom Routines	Thielke	2/80:106	10/80:14	Use Microsoft ROMs for programming shortcuts. (Model I)
Smart Programs	Lovy	11/80:202		Write programs with self-modifying code. (Model I)
Soundex Codes	Hodge	3/80:138		See Home/Hobby
Stringy Machine Code	Grimes	9/80:152		String-packing techniques with Basic program. (Model I)
Super Graphics	Moyer	10/80:202		See Graphics.
U-Boat	Borrmann	8/80:68		See Games.
Useful USR(0) Function	Kepner	10/80:100		Ways to imbed and use USR(0) in programs. (Model I)
Variations on a Theme	Bullitt	9/80:188		Use Print to print lines. (Model I)

SCIENCE/MATH

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Biorhythms	Holthausen	3/80:117		Get a numerical indication of daily biorhythms. (Model I)
Divine Proportions	Cecil	9/80:170		Generate figures to study aesthetics. (Model I)
Equations	Joffe	3/80:84		Algebraic equation solutions.
Genotype	Rauber	10/80:188		Program to estimate risk of having children with defects for parents with genetic problems. (Model I)
Linear Meter Design	Thibodeau	7/80:58		Program to calculate values for linear dials. (Model I)
Oh No! Calculus	Joffe	1/80:114		Calculus demystified.
Process Control	Hoffman	2/80:104		Prevent problems caused by over-adjustment of a process containing random errors. (Model I)
Real Roots	Daniels	7/80:166		Compute square roots in Level 1 Basic fast. (Model I)
Root Routines	Gerald	2/80:73		Solve algebraic equations. (Model I)
Telepathy	Warren	1/80:54		Computer-simulated Zener cards to test for ESP. (Model I)

TUTORIALS

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Article Called Intrepid	Gorsky	9/80:178		How coding works—cryptography on the computer. (Model I)
Assembly-language Trainer	Colsher	6/80:118		Assembly-language program that shows the result of most machine instructions. (Any Z80 computer)
Basic Switchyard, The	Perkins	7/80:52		How the Basic interpreter works.
Beginner's Formatting	Keller	7/80:108		Put graphics where you want them. (Model I)
BINAX KIBUFF	Blair	9/80:187		ROM routines not listed in your manual. (Model I)
Break Disable	Rastin	4/80:128	6/80:12	Software to prevent unwanted breaks. (Model I)
Business Programming	Clarke	5/80:78		How to write a business program.
Cassette Problems	Stoner/Barker	1/80:62		Reasons why a cassette won't load and possible solutions. (Model I)
Disk Files	O'Brien	7/80:88		Use random and sequential access on your disk system. (Model I)

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Disk Primer, A	O'Brien	1/80:130		How disk drives work and what they can do.
EDTASM on Disk	Butler	1/80:120	5/80:28	Convert RS E/A from tape to disk. (Model I)
Equations	Joffe	3/80:84		See Science/Math.
Floppy PIMS	Herman	2/80:80		Convert SCELBI Personal Information Management System to run on Disk Basic. (Model I)
Get T-Bug High	Rappaport	1/80:118	3/80:13	Move T-Bug to higher memory. (Model I)
Graphic Sort	de Zoysa	8/80:166		Graphic depiction of how the computer sorts. (Model I)
Inside Level I	Meushaw	6/80:96		Make better use of Level I. (Model I)
Inside the ROMs	Stock	3/80:94		Using built-in Assembly-language subroutines. (Model I)
Inside- out Debugging	Ogren	11/80:222		Graphics techniques to get game figures on screen. (Model I)
Into the 80s, Pt. I	Sinclair	9/80:50		Pointers for beginners. (Model I)
Into the 80s, Pt. II	Sinclair	10/80:68		String variables, Clear command, Input tips. (Model I)
Into the 80s, Pt. III	Sinclair	11/80:70		If... Then... Else, Clearing methods, and more explained. (Model I)
Into the 80s, Pt. IV	Sinclair	12/80:82		Storing variables, dimensioning, loading strings, matrices, cutting strings, and more. (Model I)
Keyboard Information	Levy	1/80:138		Use INKEY\$ more efficiently. (Model I)
Machine-code USR	McDonald	8/80:178		Incorporate machine code into Basic programs. (Model I)
Manipulative Wizard, A	Adams	12/80:94		How to handle array management. (Model I)
Modification Update	Richards	7/80:84		Things you can do to modify your computer. (Model I)
My Way	Meushaw	9/80:138		Self-help routines to let the computer help solve your computing problems. (Model I)
Mysteries of Level II ROM	Griswold	12/80:147	4/81:22	Jump addresses, compression codes, variable storage formats, etc. of Level II ROMs. (Model I)
"Next" Trap, The	Borrmann	9/80:208	11/80:22	Avoid the ?NF error message. (Model I)
Oh No! Calculus	Joffe	1/80:114		See Science/Math.
Pascal I & II	Monsour	5/80:38		A look at two commercial Pascal interpreters. (Model I)
Printer Calibration	Rexrode	9/80:94		Ways to ensure your labels or paper is properly aligned before you print.
Pulling Strings Together II	Adams	10/80:76		A look at string management instructions. (Model I)
Pulling Strings Together I	Adams	9/80:62		How to manipulate string data. (Model I)
Punch Out Your Disks	Taylor	10/82:140		Get double-sided disks with a paper punch.
RELOCATE with PEEK	Rappaport	2/80:88		Move machine-code programs around using a Basic program. (Model I)
POKE				
Saving Money	Acres	7/80:110		Buy mail order and install yourself.
Smart Programs	Lovy	11/80:202		See Programming Techniques.
Towards Machine Language	Joffe	8/80:144	12/80:18	How to begin learning machine language.

UTILITIES

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Append It!	Gerald	2/80:82		Add Basic statements to your program from cassette. (Model I)
Assemble It Yourself	Koch	12/80:212		Modify EDTASM to run without disk or cassette, and to use the editor as a WP. (Model I)
AutoPOKE	Kump	8/80:132		Load machine-language routines with a Basic routine. (Model I)
Babybeep	Kitsz	4/80:68		Machine-language sound routine. (Model I)
Babybug I	Kitsz	2/80:42	4/80:27	Machine-code monitor. (Model I)
Babyroot	Kitsz	5/80:76		Find defective memory locations. (Model I)
Backup/Display	Lindley	5/80:96		Assembly-language program to back up tapes and display contents in ASCII and hex. (Model I)
Basic Basic Renumbering	Orjeff	1/80:82		150-byte renumbering program. (Model I)
Basic Terminal	Noreault	4/80:133		Turn the TRS-80 into an intelligent terminal. (Model I)

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Basic Word Processor	Hinrichs	5/80:50		WP in Basic. (Model I)
Beyond Shell Metzner	Walker	9/80:192		Basic sort routine. (Model I)
Buffer Analysis	Chambers	6/80:132		Display buffer contents in hex, ASCII, or decimal. (Model I)
Cassette File	Tallman	8/80:174		Use the first program on the tape to keep track of the others. (Model I)
CLOAD Assembly Language	Baker	6/80:146		CLOAD Assembly-language Level I programs. (Model I)
CLOAD Machine Language	Schimelman	2/80:68		Modify your machine-language monitor. (Model I)
CLOAD Monitor	Whaland	5/80:86		Get a graphic display when CLOADing Level I or II. (Model I)
Compac	Romanchik	12/80:198		Assembly-language subroutines to speed up I/O programming. (Model I)
Competition's Cursor, The	Bishop	9/80:210		Get a flashing cursor in Level II Basic. (Model I)
Compress It!	Powers	2/80:118		Take out remark statements. (Model I)
Cross Reference	Camp	11/80:128		Basic program that builds cross reference of machine-language calls and jumps. (Model I)
Custom EDTASM	Blair	8/80:122	11/80:22 1/81:28	Assembly-language printer driver for EDTASM. (Model I)
Decwriter Driver	Beauchamp	6/80:111		I/O driver to interface DEC LA-34 terminal to a TRS-80, in Assembly language. (Model I)
Deflower Your Debug	Walter	9/80:196		Access previously inaccessible memory locations. (Model II)
Delay Loop	Joffe	9/80:168		Delay or timing loops for Assembly-language programs. (Model I)
Disk File Protection	Keen/Dischert	8/80:164		Protect disk files from being overwritten. (Model I)
Disk Index	Cheshire	2/80:124		Keep list of programs on file. (Model I)
Displaced Programs	Moehlis	7/80:158		Move machine-language programs to high memory and save them to disk. (Model I)
Document Those Variables	Noel	9/80:88	2/81:12	Program that lists variables and tells what they represent. (Model I)
Doodle Bug	Bishop	6/80:72		See Graphics.
DOS Machine-code Loading Techniques	Turner	11/80:208		Keep routines in high memory from conflicting with each other. (Model I)
Dvorak Keyboard, The	Boyd	12/80:66		Program to convert your keyboard from Qwerty to Dvorak format. (Model I)
Etch-A-Screen	Shrum	5/80:116		Design video layouts for use in programs. (Model I)
Extra Errors	Moses	3/80:125		Add error messages. (Model I)
Extra Variables	Clark	1/80:134		Get extra variables in Level I. (Model I)
FASTDOS	Neher	5/80:114		Modify TRSDOS for more speed. (Model I)
Format 40	Adams	7/80:162	10/80:14	Basic printout format routine. (Model I)
Fractional Input	Cecil	5/80:142		Use fractions instead of decimals in input statements. (Model I)
Free Format Search	Rickers	5/80:94		Search a data base character by character. (Model I)
Free Space	Cornell	9/80:68		Load this utility that deletes spaces, line feeds, and remarks into the input buffer. (Model I)
Graphics Coder, The	Racine	8/80:160		Generate a video-display worksheet to compute proper graphics POKE locations. (Model I)
Heathkit Interface	Kunk	7/80:114		Increase the speed of the Heathkit H14 printer with software. (Model I)
Hex Display	Campbell	6/80:88		Convert hex to decimal. (Model I)
Holiday Cheer	Kerr	12/80:132	4/81:22	Address list and letter-writing program in Basic. (Model I)
Input with Insight	Decker	10/80:138		Get around the limitations of the Input command. (Model I)
Invisible Password	Conley	8/80:107		Hide your passwords on disk systems with NEWDOS. (Model I)
KBFIX Fix	Andreasen	4/80:108		Move KBFIX in memory with a Basic program. (Model I)

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Keyword List Plus	Decker	12/80:263		Routine to print keyword table with starting addresses (Model I)
KWIC Index	Sparks	3/80:60	5/80:28 6/80:12	Find articles with this technique. (Model I)
Less Is More	Winterbauer	12/80:259		Short Assembly-language print routine. (Model I)
Level II to Level I	Wolf	4/80:62		Convert Level II object tapes to Level I CLOADable format. (Model I)
Listen to Your Keyboard	Domuret	1/80:109		Debounce program with audio feedback on keystrokes. (Model I)
Lowercase with Strings Attached	Chepko	8/80:121		Program to generate lowercase. (Model I)
LPRINT Formatter	McCormick	2/80:120		Format printouts. (Model I)
LPRINT Routines	Werner	3/80:105		Print out data from the screen. (Model I)
LPVIDEO	Powers	5/80:136		Assembly-language program to print out screen contents. (Model I)
MACROPOKE Monitor	Suter	4/80:90		Incorporate machine-code routines in Basic programs. (Model I)
Memory Dump	Joffe	5/80:144		Look at memory via PEEK. (Model I)
Memory Sizer	Decker	10/80:114		Set memory size from Basic. (Model I)
Menu List Selection Subroutine	Rowlett	11/80:195		Select menu items by number. (Model I)
Mix Your Own PIMS	Busch	11/80:212		Add a directory to Scelbi's Personal Information Management System. (Model I)
Music Maestro!	Pape	1/80:36	4/80:27	See Programming Techniques.
New Restored	Fordham	1/80:84		Recover programs after typing New and restore to anywhere you like with these Assembly-language routines. (Model I)
Pencil RS-232 Driver	Kinsey	8/80:170		Use Electric Pencil and a printer through the RS-232C interface. (Model I)
Position Display	Frost	9/80:150		Display titles in programs or have a message stand out, draw borders. (Model I)
Pow—Bang—Zap—(Crash)	Brandolini	11/80:230		Assembly-language sound routine that uses cassette I/O port. (Model I)
Progdata	Kelley	5/80:126		Edit Assembly/Basic programs. (Model I)
QWIKDISK	Nazarian	9/80:206		Software patch to cut track access time in half. (Model I)
Relocate with PEEK POKE	Rappaport	2/80:88		See Tutorials.
Restore Data Pointer Control	Cecil	12/80:257		Set data pointer to a place other than the start of the data list. (Model I)
Resurrect It!	Quindry	11/80:206		Recover Basic programs lost due to errors in Basic or object-code programming. (Model I)
Scatterplot	Genqvese	7/80:128		Use the Pearson Product-Moment correlation to examine one variable as a function of another. (Model I)
Screen Editor	Colsher	3/80:122		Document your programs in Level I. (Model I)
Screenprint	Frankenberg	5/80:152	8/80:16 9/80:14	Screendump by pressing I, J, and K simultaneously. (Model I)
Service Tape	Flatley	4/80:106		Load a collection of utility programs with one command. (Model I)
Slash Zero	Richardson	8/80:108		Assembly-language routine to print out all zeros with a slash. (Model I)
Slow Scroll	Lewis	9/80:202		Video driver mod to slow scrolling. (Model I)
Smart Terminal	Shirley	1/80:104		Assembly-language program to make your TRS-80 an intelligent terminal for a larger system. (Model I)
Software Lock	Kelleher	8/80:118		Limit access to machine-code routines. (Model I)
Sort 80K in 6K!	Fitchhorn	1/80:102	3/80:13	Use disk random access to sort more data than fits in memory. (Model I)
Sound X	Baker	7/80:136		Machine-language sound routine. (Model I)
Spool and Despool	Gentry	3/80:46		Print files while running another program. (Model I)
Super Sound	Morr	5/80:130		Assembly-language sound-generating routine using cassette recorder. (Model I)

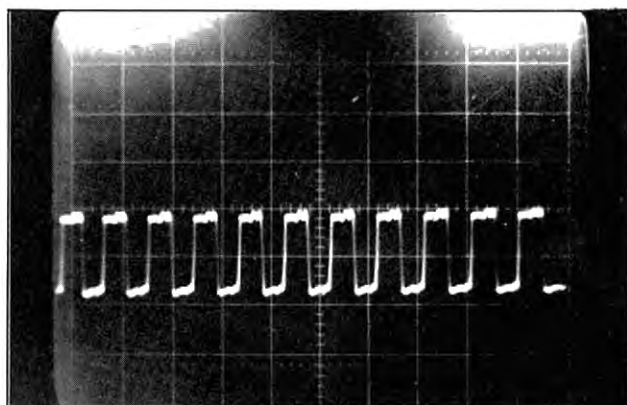
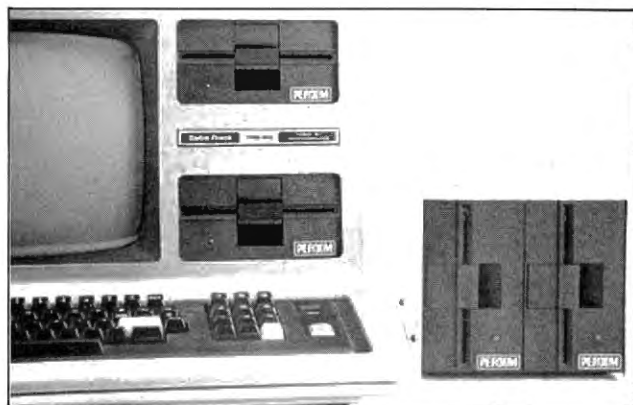
<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
T-Bug and Then Some	Paxton	11/80:172		Add Clear, Dump, and Shift commands to T-Bug. (Model I)
T-Bug for II	Curtis	4/80:84		Shorten Level II T-Bug and customize it. (Model I)
Take Me Beyond Your Leader	McTernan	10/80:210		Move cassette past leader to oxide. (Model I)
Tape Librarian	Herold	8/80:100		Keep track of your tapes. (Model I)
TCopy	Stevens	7/80:160		Copy tapes with source or object code in one step. (Model I)
Test Your Memory	Chepko	3/80:80		Test program for new memory chips. (Model I)
Tinycomp	Bohlke	5/80:44		Basic program to compile into Assembly language. (Model I)
Triple Play for T-Bug	Johnson	10/80:207	5/80:22	Put T-Bug into three different memory locations. (Model I)
T Tape	Stevens	1/80:122		Analyze and adjust cassettes for better CLOADS. (Model I)
Uni-key	Archer	9/80:76		Enter Basic keywords in one stroke. (Model I)
Up and Down	Parris	11/80:177		Rerecord any 500-baud tape without fumbling with sound levels. (Model I)
Variable Scroll	Coisher	10/80:134		Get a screen display of variables used at any time. (Model I)
Versatile Input	Wilde	9/80:98		Routine for easy, elegant data input. (Model I)
Walking Words	Borrmann	9/80:173		Move words across the screen, left to right. (Model I)
Whazit?	Penny	3/80:115		Identify System and Basic tapes. (Model I)
White	Commander	7/80:94		Command to fool interpreter into executing your own commands. (Model I)
Winking Cursor	Lovy	1/80:68		Give input statements a winking cursor or graphics block. (Model I)
You Can Call It... Ray	Kornfeld	11/80:226		Read disk directories, number programs, and run them in one keystroke. (Model I)

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BUSINESS

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
After the Goldrush	Frost	1/81:120		Calculate value of your precious metals. (Model I)
Analytic Inventory Management	Harper	12/81:314		Organize your inventory management. (Model I)
By Appointment Only	Busch	3/81:152		Appointment-tracking program. (Model I)
Dollars and Sense	Andrews	5/81:216		See Utilities.
Exponential Forecasting	Gorney	4/81:266		Forecast demand for your products. (Model I)
General Ledger	Conhaim	5/81:222	7/81:20	General ledger program for 32K and disks. (Model I)
House Detective, The	Cominio	11/81:160		Real estate information library. (Model I)
How to Buy & Sell Houses	Whitman	5/81:103		Program to figure wraparound mortgages. (Model I)
Income Averaging—1980	Grothman	3/81:136		Program to aid in figuring your taxes with income averaging. (Model I)
Investment du Jour	Honess	11/81:190	3/82:18	A look at the basic aspects of a business package.
Investment Property Analysis	Sparks	11/81:144		Estimate income from rental property. (Model I)
Landlord	Tuohy	2/81:154		Evaluate potential real estate investments. (Model I)
Line Up!	Anderson	3/81:174		Simulate waiting lines to study check-out counter efficiency. (Model I)
Loan Wrangler	Jensen	3/81:240		Loan calculator program. (Model I)
Micros—Business or Pleasure	Latamore	7/81:90		How Tandy is pushing the TRS-80 as a business machine.
Mind Your Own Business	Glau	3/81:200		Assembly time-cost analysis program. (Model I)
Paper Mountain	Wierenga	11/81:118		See Education.
Pacemaker, The	Tinis	11/81:220		Assembly time-cost analysis program. (Model I)

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Punch Out	Conroy	2/81:198		Program to aid tallying of time cards. (Model I)
Software Broker, The	Harper	6/81:268	10/81:19	Seven-program investment-analysis package. (Model I)
Some Fundamentals	Tune	2/81:216		Use the TRS-80 as an effective business computer. (Model I)
State of the Union	Reid	11/81:321		Financial trend monitor for credit unions. (Model I)
Take a Letter	Mullin	8/81:290		See Utilities.
Tenant Tracker	Kwascha	11/81:138	4/82:26	Computerize your rental records. (Model I)
Ups and Downs of Graphs	Foley	11/81:176		See Graphics.



EDUCATION

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Alternate Course, Pt. I	Duffin	8/81:180	12/81:28	Programs to teach data processing and alleviate computerphobia. (Model I)
Alternate Course, Pt. II	Duffin	9/81:204		See Part I.
Alternate Course, Pt. III	Duffin	10/81:180	3/82:22	See Part I.
Alternate Course, Pt. IV	Duffin	11/81:274		See Part I.
Analogies	Spencer	9/81:328		Analogy-quiz program. (Model I)
Calling All Teachers	Hedden	11/81:306		Package for teachers' record keeping. (Model I)
Classroom Computing	Droegemueller/Bell	2/81:78		How a school started a computer-education course.
Classroom Doodles	Rosenberg	2/81:86		Graphic program to encourage problem solving and Use Electric Pencil to build a foreign-language dictionary. (Model I)
Foreign-language	Robinson	5/81:219		
Green Register, The	LaBorde	8/81:214		Program to keep student records. (Model I)
Math Derby	Duffin	9/81:244		Math game to teach the basics. (Model I)
Notes from the Classroom	von Kaenel	2/81:96		Tips on introducing computers to the classroom.
Paper Mountain	Wierenga	11/81:118		Program to keep school personnel records. (Model II)
Programming for Education, Pt. I	Weintraub	2/81:68		Things you should know about writing educational software.
Pogramming for Education, Pt. II	Weintraub	4/81:144		How to go about writing test programs.
Programs for the Handicapped	Nowak/Muswick	10/81:141		Programs handicapped children can use to learn. (Model I)
Project Local	Petrakos	2/81:74		CAI as it is done at one school.
Quiz	Olsen	8/81:188		Use the computer to test students. (Model I)
Rushing Toward Courseware	Petrakos	4/81:74		How computerized instruction is affecting the classroom.
Specific Heat	Fetchko	12/81:220		Program to help students learn how to find the specific heat in chemistry lab. (Model I)
Teacher Mod	Fish	9/81:272		Modify ISI's teacher program for networking. (Model I)
Vocabulary Builder	Zimmerman	2/81:226		Program to aid learning a foreign vocabulary. (Model I)
Walls of Jericho, The	McNichols	9/81:292		Teach the Bible with this program. (Model I)

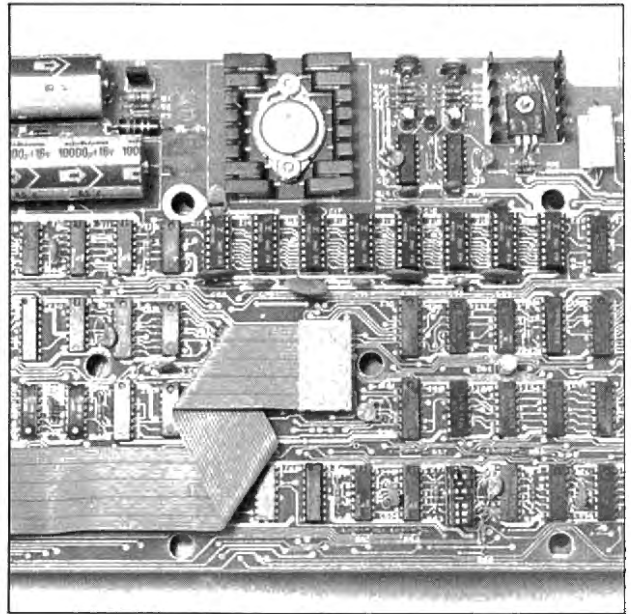
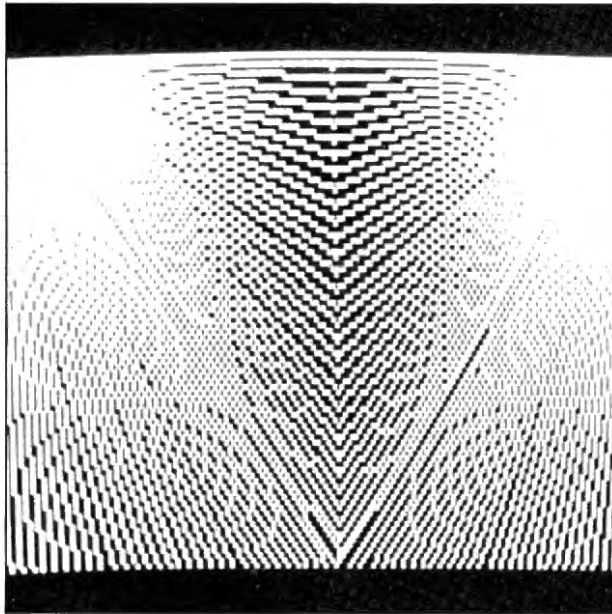
GAMES

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Boa	Myers	5/81:294		Two-player graphic game of survival. (Model I)
Capture the Computer	Fisher	12/81:176		Computer version of the game of Tag. (Model I)
Chess Tutor, The	Dowd	12/81:154	3/82:18 4/82:24	Let the computer teach you chess. (Model I)
Color Concentration	Wrye	12/81:298		Like the tv show. (CC)
Colorful Maneuvers	Wood	11/81:328		Outmaneuver a friend. (CC)
Compukala	Moller	3/81:278		Computer version of the game of Kala. (Model I)
Dessert Solitaire	Ratke	12/81:226		Based on the board game. (Model I)
Digits for Fun	Wirth	8/81:304		Math Puzzle. (Model I)
Dot Game, The	Welcher	4/81:210		Simple game to connect the dots. (Model I)
Formula 80	Sprague	8/81:122		Race sports cars on your screen. (Model I)
Frankenstein	Nicholas	8/81:92		Three word games in one. (Model I)
Let's Get Rude!	Ramella	12/81:142		Removal game with pejorative prompts. (Model I)
Level II Black Box	Jones	7/81:217		Find the contents of The Black Box. (Model I)
Lunar Lander Revisited	Beringer	6/81:244		Another version of an old standard. (Model I)
Magic Cube, The	York	12/81:346		Simulation of the Rubik's Cube. (Model I)
Magic Trick, The	Busch	9/81:300		Party game. (Model I)
Master Mind	Hope	10/81:122		Computer version of game, using AI techniques. (Model I)
Math Derby	Duffin	9/81:244		See Education.
Micro-basketball	Weindorf	3/81:118		Computer basketball game for 16K. (Model I)
Micro-Yahtzee	Johnson	10/81:302		Computer dice game. (Model I)
Simon	McGlumphy	8/81:112		Computer simulation of Simon in 4K. (Model I)
Simul-80—a Weird Game	Kitsz	4/81:154		Game that simulates what happens inside a microprocessor. (Model I)
Space Empires	Smith	8/81:106	5/82:26	Strategy space game. (Model I/III)
Space Potatoes	Brumme/Abel	8/81:102		Shoot down cosmic spuds. (Model I)
Star Colony	Beringer	10/81:334		Colonize and explore the star system. (Model I)
Star Guard	Beringer	8/81:116		Three-dimensional space game. (Model I)
Startrek 4.0	Commander	8/81:86	1/82:24	Classic Star Trek space game. (Model I/III)
Subdestry	Cominio	6/81:186		Arcade-style battle game. (Model I)
Supermaze	Batie	6/81:160	9/81:16	Maze game, using arrays. (Model I)
Tank	Rice	8/81:104		Arcade game for preschoolers. (Model I)
This Ain't No Party!	Fason	4/81:179		Party game that interviews guests. (Model I)
Walk on the Monster Side	Latamore	8/81:84		Short history of games and game development.
Writers of a Lost Art	Albino	12/81:290		See Tutorials.

GENERAL

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
80 Interview with Kornfeld/Roach	Robertson	3/81:82		Two interviews, one with Lew Kornfeld and one with John Roach, both of Tandy.
80 Limited, The	Latamore	12/81:128		How a TRS-80 runs a model train setup.
Between the Lines	McTernan	3/81:216		Level II manual errata fixed, with thoughts on the rest of it.
Color Computer First Impression	Kilmon	8/81:286		Thoughts on the "new" computer.
Computerization/Workplace	Brown	11/81:110		How the Computer Revolution is affecting the management/labor relationship.
Date Maker, The	Grosse	8/81:274		Julian-to-Gregorian date converter. (Model I)
Digital Delivery	Latamore	11/81:112		Future of electronic mail.
Dragnetnetwork	Kennedy	6/81:122		How a police department set up a network with microcomputers.
Field Guide to Computerists	Doherty	5/81:208		Humor piece on different types of computer users.
Getting Involved	Batty	7/81:179		Looking back on how one got started with micros.
It's All Robotese to Me	Gesamte	9/81:101		Humor—a robot glossary.
Just a Matter of Time	Busch	3/81:196		Thoughts on using a micro to save money around the home.
Lenny's Story	Busch	12/81:384		Humor piece on virtues of making back-ups.

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Queue Theory	Neibauer	12/81:368		Simulate a gas line. (Model I)
Realm of Science Fiction	Robertson	10/81:136		A look at AI in science fiction.
Unexpurgated Version, The	Busch	4/81:178		Humor piece on the "real" definitions of some computer terms.
User's Groups	staff	11/81:272		A list of TRS-80 user's groups.



GRAPHICS

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
80 Cartoon Capers	DeVigili	9/81:320	12/81:28	Generate cartoons on the screen. (Model I)
Advanced Graphics Techniques, Pt. I	Boothe	4/81:116		Use disk commands without disks to get graphic printouts. (Model I)
Advanced Graphics Techniques, Pt. II	Boothe	5/81:119		See Part I.
Advanced Graphics Techniques, Pt. III	Boothe	6/81:68		Manipulate three-dimensional objects on screen. (Model I)
Banner Banter	Vann	2/81:128		Print out large-letter banners on the Quick Printer (Model I)
Can Computing Be Art?	Conroy	2/81:122		Reproduce pictures with characters on a printer. (Model I)
Classroom Doodles	Rosenberg	2/81:86		See Education.
Color by Percom	Kalinowski	1/81:68		Use Percom's Electric Crayon to get color on the Model I.
Curve Plotter	Zimmerman/Stanley	9/81:256		See Science/Math.
Doodlebug	McKenna	1/81:208		Draw on the screen from the keyboard. (Model I)
Perspective on Cubes, A	Gerhardt	1/81:182		How to program computer to draw cubes. (Model I)
Picture This	Keen/Dischert	9/81:214		Animation via string packing. (Model I)
POKE A, Color Com- puter	Esposito	12/81:362		Access graphics modes in the CC.
Rotation	Yelling	9/81:154		See Programming Techniques.
Tiger with Dots, A	Somers	6/81:96		Control matrix print-head needles through software on the IDS 440. (Model I)
Title Graphics	Kalinowski	9/81:302		Get flashy titles on the screen for your programs. (Model I)
Turn of the Screw	Boothe	4/81:117		Three-dimensional, rotating graphics for printer and video. (Model I)
Unlocking the Graphic Code	Weintraub	6/81:147		Relationships between graphic elements and their ASCII character codes. (Model I)
Ups and Downs of Graphs	Foley	11/81:176		Generate graphs. (Model I)

HARDWARE

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
80 Appliance Control	Lewart	3/81:230		Build a circuit to control home appliances with software-generated tones. (Model I)
Alternate Source, An	Conner	5/81:254		Battery-charger-based power supply.
Another Noise Maker	Erb	12/81:312		Sound synthesizer. (Model I)
Audio Interface	Batie	1/81:172		Cassette dubbing, aural and video load monitoring, debounce, and more with this device. (Model I)
Baudot LPRINT	Rister	11/81:314	2/82:28	Interface the Teletype Model 15 to the TRS-80. (Model I)
Cruise Control	Waltjen/Placido	12/81:320		Auto-adjusting speed-up mod. (Model I)
Eye-80	Hawkes/Reese	6/81:140		Photo cell interface that will allow a Model I to detect objects and speed and direction.
Gold-plated 80, A	Martin	12/81:302		Gold plate your contacts.
Hang Person	Hilton	10/81:320		Hangman with sound. (Model I)
Hard and Soft Printware	Sinclair	10/81:234		Build a printer interface. (Model I)
Hardwire the RS-232	DeJarnette	5/81:202		Solder the RS-232 in place.
High-Density Graphics Interface, Pt. I	Murray/Fowler	4/81:134		Get 192-by-96 resolution on your monitor. (Model I)
High-Density Graphics Interface, Pt. II	Murray/Fowler	5/81:80	10/:81:19	See Part I.
Inverse Video	Smith	5/81:176		Build a device to print characters in black on white. (Model I)
Joysticks for the Model I	DiNunzio	6/81:157	10/81:23	Build a two-joystick interface.
Last CLOAD Fix, The	Stanley	7/81:171		Build your own X2X CLOAD fix. (Model I)
Lightning Strikes Twice	Fowler/Murray	7/81:184		Build a permanent transient suppressor.
Lower Cost Lowercase	Van Praag	4/81:228		Lowercase Mod and KB fix. (Model I)
Spare-time Generator, The	Mehesan	5/81:264		Quick sort utility for name lists. (Model I)
Split and Splice	Mills	9/81:228		Split up Basic programs, convert Level I to II, merge together again. (Model I)
Spooler, The	Gault	12/81:222	3/82:18	Use your computer while the printer prints. (Model I)
Superlist	Jones	11/81:333		Get more readable listings. (Model I)
T-Bug III	Kleinfelter	11/81:390		Convert Model I T-Bug to Model III.
Take a Letter	Mullin	8/81:290	12:81:26	Letter-writing program. (Model I)
Take T-Bug Higher	Stanley	5/81:284		Move T-Bug to high memory. (Model I)
Tale of Two Drivers, A	Blair	10/81:326		Printer patches for Level II Basic and NEWDOS. (Model I)
Terminal Plus	Gorsky	1/81:226		Assembly-language terminal program for 48K disk systems. (Model I)
Through-boot	Smith	10/81:312		Initial program loader for TRSDOS. (Model I)
TRS-80 Disassembler	Wuebker	8/81:240		Read bits in ROM and convert them to Z80 mnemonic instructions. (Model I)
UC/LC Fix	Thurlow	8/81:260		Get INKEY\$ working properly with the RS lowercase mod. (Model I)
Underscoring Scripsit	Iseli	6/81:246		Underline in Scripsit. (Model I)
Variable Lister, The	Webster	7/81:259		List variables. (Model I)
Voice Synthesizer	Hall	10/81:146		Program to generate words on the RS Voice Synthesizer. (Model I)
Weak Link	Denholtz	10/81:360		Strengthen NEWDOS80's Chain command. (Model I)
Where Have All the GOTOs Gone	Borrmann	3/81:236	6/81:16	Program that lists line numbers with specific instructions. (Model I)
Wherzit—Keyword Index	Fox	4/81:252	9/81:16	Indexing program that searches by title. (Model I)
Write Stuff, The	Barnes	12/81:390	3/82:22	Assembly-language word processor. (Model I)
ZBug... Super Debug Monitor	Harrell	1/81:130	4/81:22	An Assembly-language monitor for 16K. (Model I)

HOME/HOBBY

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Auto Mentor, The	Sparks	5/81:87	7/81:20 8/81:16	Program to aid in buying a car. (Model I)

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Being of Sound Algorithm	Weinberg	8/81:136		Write your will on your TRS-80. (Model I)
Cadet—The Decision Maker	Albino	10/81:298		Program to aid in making decisions. (Model I)
City Accessibility Calculation	Todd	12/81:310		Find out which city is most convenient for all group members to meet in. (Model I)
COINS	Lloyd	12/81:134		Catalog your coin collection. (Model I)
Computer Cantos	Griffiths	3/81:154		Computer-generated poetry. (Model I)
Computerized Complaint	Gillig	5/81:276		Send out complaint letters via computer. (Model I)
Dancin! A Disco Primer	Modla	5/81:194		Generate disco dance steps on screen. (Model I)
Dollar Down, A	Martin	5/81:113		Evaluate financing plan for a new or used car. (Model I)
Endorse It	Welcher	4/81:214		Basic check-writing program. (Model I)
Equine Equation Evaluation	Herold	9/81:262		Horse-racing program. (Model I)
Family Relationships	Horwitz	8/81:192		Genealogy program. (Model I)
Fat City	Busch	10/81:274		Freezer inventory program. (Model I)
Final Notice, The	Atkins	2/81:200		Personal payment scheduling program. (Model I)
Firestream	Gille	10/81:316		Calculate correct water pressure for fire hoses. (Model I)
Hold That Pose	Ebert	8/81:248		Photo and slide-indexing program. (Model I)
Home Buyer's Helper, The	Stinson	5/81:99	4/82:26	Estimate what it will cost you to buy a home. (Model I)
Hoops	Cornwell	10/81:184		Program to keep basketball statistics. (Model I)
House Plant Index, The	Chipman	12/81:116		Keep the vital statistics of your house plants on the computer. (Model I)
Lifespan	Wailand	9/81:252	12/81:28	Program that estimates your lifespan based on your lifestyle. (Model I)
Loan Sharp	Atkins	10/81:338		Figure interest on the Pocket Computer.
Mileage Manager, The	Frink	6/81:236		Keep track of the gas consumption of your car. (Model I)
Morse Resource, Pt. I	Joffe	8/81:150		Software to help you send Morse code. (Model I)
Morse Resource, Pt. II	Joffe	9/81:130		See Part I.
Nag Analysis	Crosby	7/81:243		Horse-handicapping program. (PC)
Philatelist's Friend, The	Castor	12/81:108	5/82:26	Catalog your stamp collection. (Model I)
Pocket Full of Chips	Dolan	12/81:230		Several common calculation programs. (PC)
Procedures Pricing	Keller	12/81:252		Keep track of the cost of living. (Model I/III)
Quick Riff on Synthesizer	Keen/Dischert	7/81:294		ARPs, Moogs, and TRS-80s.
Real Rules of 78s, The	Conhaim	7/81:289		Figure early loan repayment. (Model I)
Rule of 78s, The	Conhaim	6/81:296		Figure rates on early payment of loans. (Model I)
Runner's Logbook, The	Vose	12/81:100		Keep a log of running times and distances. (Model I/III)
Second Sourcing	Tinis	11/81:348		See Hardware.
Secret Ballot	Busch	9/81:286		Use your computer as a ballot box. (Model I)
Sharp Marketing	Atkins	12/81:150		Supermarket program. (PC)
Shoplist	Smith	3/81:274		Shopping-list program. (Model I)
Shopper's Aid	Maninger	12/81:172		Shoplist program. (PC)
Two Cents Worth	Clayton	4/81:192		Program to evaluate old pennies. (Model I)
Watt's It All About?	Hubert	3/81:219	6/81:16	Home electrical utility monitor program. (Model I)
Worldly Goods	Fail	10/81:220		Keep inventory of your belongings. (Model I)

PROGRAMMING TECHNIQUES

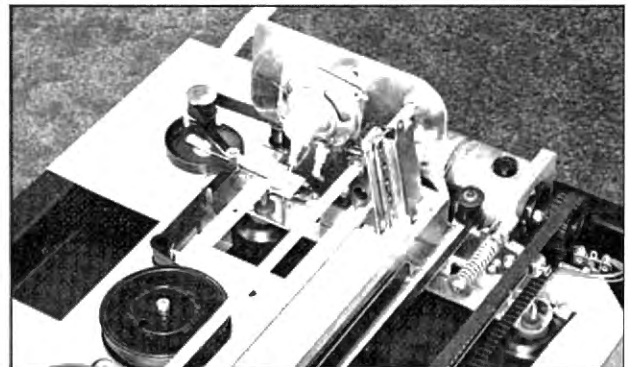
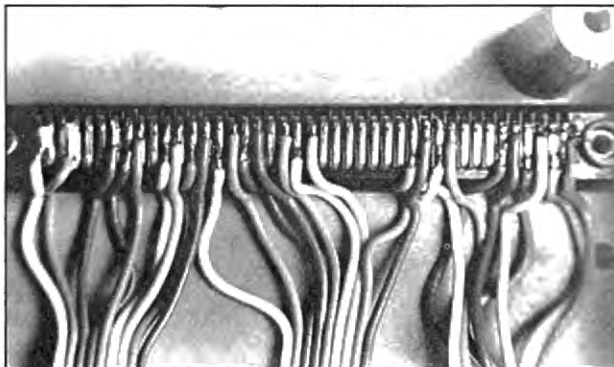
<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
All About Program Files	Barnard	10/81:258		Use program files with small DBMs on cassette. (Model I)
All About Sorts, Pt. I	Gorney	8/81:208		See Tutorials.
Bascal	Metzler	9/81:334		Get a hybrid Basic/Pascal programming language.
Be a Super USR!	Alford	8/81:254		Ways to use USR calls. (Model I)
Chain Command Implementation	Pape	11/81:250		Program chain and edit programs and continue execution. (Model I)
Debug with GOTO	Pape	10/81:249		Save what's in memory when your program crashes.
Delete and Save	Langston	9/81:240		Delete lines and stay in the program. (Model I)

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Do Not Enter	Weintraub	3/81:104		Use INKEY\$ and eliminate prompts in programs. (Model I)
Doing Two Things at Once	Gorsky	3/81:178		Using interrupts in your programs. (Model I)
Efficient Cassette I/O	Sabin	1/81:218		How to better handle cassette data files. (Model I)
Erudite Arrays	Barnes	9/81:226		Use one array as a series of arrays in Level I. (Model I)
FOR My NEXT Trick . . .	MacLean	12/81:380		See Tutorials.
Formatted Screen Input	Byrnes	10/81:350		Easier way for data entry. (Model I)
Get Organized	Lesley	12/81:398		Organize your programming methods.
High-speed Sorts	Robson	9/81:220		Sort in machine language. (Model I)
How to Handle Those Random Files	Knecht	7/81:271		See Tutorials.
In Praise of Outlines	Drew	11/81:204		Outline your programs before you write them.
Loops and Arrays	Wein	4/81:246		Combine loops and arrays in your programs.
Multi-statement	Keen/Dischert	10/81:296		Using multi-statement lines in programs.
New Words for Basic	Neibauer	9/81:170		Simulate commands not in Level II Basic.
Not-So-Random Numbers	Zeigler	5/81:246		Generate random sequences using Poisson, exponential, or normal distributions. (Model I)
On Embedding Data	Adams	6/81:294		Tips on using Read . . . Data . . . Restore.
Pascal Dream, The	Krutch	6/81:174		Pascal as compared to Basic.
Perspective on Cubes, A	Gerhardt	1/81:182		See Graphics.
Picture This	Keen/Dischert	9/81:214		See Graphics.
Plan of the Page, The	MacLean	1/81:222		Improve your video page layouts for Level I. (Model I)
POKE A, Color Computer	Esposito	12/81:362		See Graphics.
Program Chaining and Local Variable Definitions in Basic	Brown	6/81:255	10/81:22	Chaining, variable storage and preservation, and string storage tips.
Programming with Voice Synthesizers	Werner	8/81:208		See Tutorials.
RAM Squeeze	Adams	8/81:230		Space-saving methods. (Model I)
Regression and Correlation	Honess	7/81:254		Using regression and correlation for forecasting.
Rotation	Yellin	9/81:154		How to rotate 3-D figures. (Model I)
Simple Syllogisms	Hoffman	10/81:132		AI techniques for theorem-proving programs. (Model I)
Slice & Dice Basic	Schneider	9/81:322		Write self-modifying Basic code.
Thoughts on For . . . Next	Amyx	10/81:354		Ways to use the loop.
Three's Not a Crowd	Mawdsley	8/81:292		Program with utilities in memory. (Model I)
Title Graphics	Kalinowski	9/81:302		See Graphics.
Undocumented Instructions	Cameron	7/81:296		Split sometimes unused 16-bit index registers in half. (Model I)
USR Usery	Freese	12/81:248		Put Variables and \$ in USR calls. (Model I)
Vital Statistics	Honess	8/81:194	12/81:26	Build a program to summarize and display descriptive data value characteristics. (Model I)
Wild Glitch Hunting	Warren	3/81:186		Finding the more subtle bugs in your program.

SCIENCE/MATH

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
And Now Artificial Intelligence	Nelson	10/81:108		Some techniques used in AI research.
Applications in Real Time	Genet	6/81:127		How a Model I runs the night shift at an observatory.
Artificial Intelligence at MIT	Vose	10/81:118		A look at current research.
Artificial Intelligence—Technology and the Search for Self	Brown	10/81:103		State of the art of artificial intelligence research.
Curve Plotter	Zimmerman/Stanley	9/81:256		Graph math functions. (Model I)
Digits for Fun	Pirth	8/81:304		See Games.
Dome Time	Nickell	5/81:182		Analysis program for geodesic dome design.

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Function Plotter	Graue	2/81:126		(Model I) Graph any function. (Model I)
Molality Crunching	Suder	2/81:194		Use atomic masses in practical problems on the computer. (Model I)
Number Cruncher	Barbarelo	1/81:232		Data reduction program for statistical studies. (Model I)
On the Average	Gorney	5/81:292		Program to figure mean, midrange, mode values in averaging. (Model I)
Pocket Stats	Atkins	11/81:392		Median-length statistics program. (PC)
Population Estimation	Solomon	2/81:152		Analysis program based on Lincoln-Peterson techniques. (Model I)
Sheer Lunacy	Harris	12/81:386		Get a graphic representation of the moon for any point in time. (Model I)
Simple Syllogisms	Hoffman	10/81:132		See Programming Techniques.
Solar Altitude Plotter	Rea	8/81:294		Track the Sun's position. (Model I)
Specific Heat	Fetchko	12/81:220		See Education.
Sunrise...Sunset	Skramstad	10/81:272		Calculate time and place of sunset/sunrise. (Model I)



TUTORIALS

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Adventures in Modemland	Blechman	10/81:264		Using TRS-80 with a modem. (Model I)
All About Program Files	Barnard	10/81:258		See Programming Techniques.
All About Sorts, Pt. I	Gorney	8/81:208	12/81:28 1/82:24	Choosing the correct sort method. (Model I)
All About Sorts, Pt. II	Gorney	9/81:148	1/82:24	See Part I.
Bascal	Metzler	9/81:334		See Programming Techniques.
Basic Difference, The	Blechman	10/81:290		Converting Model I programs to Model III.
Be a Super USR!	Alford	8/81:254		See Programming Techniques.
Be a Super User	Joffe	2/81:166		How to use USR. (Model I)
Better Documentation	Ferber	3/81:209		How to develop a trainer module for program users. (Model I)
Buyer's Guide to Printers	staff	6/81:84		Available printers compared.
Buyer's Guide: Peripheral	staff	12/81:183		What's available in peripherals for the TRS-80.
Clear N	Salsbury	9/81:312		What Clear N does. (Model I)
CLOAD Is Just a Five-Letter Word	Kitsz	1/81:114		Problems and solutions to CLOAD woes. (Model I)
Cobol: Ready and Waiting	Bradley	7/81:116		An introduction to Cobol.
Color Computer, The	Martel/Nicholas	6/81:202	9/81:16	A look at the CC's capabilities.
Coming to Terms	Fugate	7/81:112		Some common computer buzzwords defined.
Compile, Interpret, Assemble	Faulk	2/81:224		How the compiler, interpreter, and assembler work.
Conversion, The	Woeger	12/81:324		Hands-on approach to converting from a Basic to Assembly-language program.
Cost-effective Word Processor	Hewin	4/81:222		Putting together a cheap word-processing system.

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Datacom Decisions	Derfler	8/81:262		How to start your data communications system.
Disk DOSSier	Commander	3/81:68		What a DOS is; how TRSDOS works.
Disk to Tape	Hocking	3/81:250		Thought about using cassettes after getting disks.
Fast Clock DOS	Domuret	4/81:240		Speed up your DOS when you speed up your hardware. (Model I)
Fast Round-up, A	McComb	11/81:184		Choosing a word processor.
First Look at Forth, A	Krutch	7/81:162		Introduction to Forth.
Floppy Tales	Keener	2/81:220		How to use the Extaron Stringy Floppy for data storage. (Model I)
FOR My NEXT Trick . . .	MacLean	12/81:380		Uses of the For . . . Next loop.
Freebie, The	Adams	12/81:304		How to take 150 bytes out of reserved RAM on cassette systems. (Model I)
Going Pro	Moss	9/81:242		Tips on programming for money.
How to Handle Those Random Files		Knecht	7/81:271	Make efficient use of random-access disk files. (Model I)
Idiot's Guide to AL, Pt. I	Montgomery	5/81:168		Beginner's guide to Assembly-language programming. (Model I)
Idiot's Guide to AL, Pt. II	Montgomery	6/81:112		See Part I.
In Command	Rutledge	11/81:300		Stay in the Command mode. (Model I)
In Praise of Outlines	Drew	11/81:204		See Programming Techniques.
Ins and Outs of Edit, The	Schrader	12/81:358		Notes on using the Edit utility. (Model I)
Into the 80s, Pt V	Sinclair	1/81:100		Using math on the computer. (Model I)
Into the 80s, Pt. VI	Sinclair	2/81:100		Producing a menu, using subroutines, and more. (Model I)
Into the 80s, Pt. VII	Sinclair	3/81:92		Program construction, using variables, PEEK and POKE, and more. (Model I)
Join the Pascal Parade	Grothman	7/81:146		Introduction to Pascal.
Keep it in the Black	Johnston	5/81:188		Reink printer ribbons.
Keyboard Incantations	Robnett	11/81:352		Mysteries of the TRS-80 keyboard. (Model I)
Language Quest '81	Vose	7/81:96		What a computer language is and how they work.
Level II Utilities/Mod III	Bigelow	9/81:182		Modify machine-language subroutines for the Model III.
LLIST for Level I	Ogden	7/81:251		How to get Level I printouts from Level II. (Model I)
Macroprocessor for Basic	Olmstead	8/81:156		Using macros in logical programming.
Macroprocessor for Basic Pt. III	Olmstead	9/81:142		Why most compilers fail, and how to change that.
Macroprocessor for Basic Pt. IV	Olmstead	10/81:228		What the Metabasic compiler is.
Macroprocessor for Basic Pt. V	Olmstead	11/81:243		See Part IV.
Macroprocessor for Basic Pt. VI	Olmstead	12/81:206		See Part IV.
Memories Are Made of This	Randall	5/81:146	9/81:16	RAM/ROM explored with memory test routines. (Model I)
Model II Q and A	Yager	6/81:197		Common questions about Model II answered.
Modify Tiny Pascal for Disk	Harrell	7/81:154	12/81:26	How to make changes to put RS Tiny Pascal on disk. (Model I)
On Modems	Brown	1/81:98		Basic information on modems.
Pilot—Language of CAI	Hawkins	7/81:122		Introduction to Pilot.
Programming for Education	Weintraub	2/81:68		See Education.
Programming with Voice Synthesizers	Werner	8/81:208		Techniques for programming voices. (Model I)
Random Tricks	Perkins	2/81:168		Why Z80 random number sequences are somewhat predictable.
Regression and Correlation	Honess	7/81:254		See Programming Techniques.
Shadow Knows, The	Romkey	3/81:244		What some of the undocumented RAM areas hold. (Model I)
Short and Sweet	Gundlach	3/81:272		One line instructions that are useful. (Model I)
Smart Answers	Williams	4/81:298	3/82:24	Answer computer prompts in hex. (Model I)

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Soft Characters	Moulton	10/81:285		Get six more characters from the RS generator ROM. (Model I)
Speedset	Winings	5/81:258		Calibrate your drive speed.
To Err Is...Forbidden, Pt. I	Adams	6/81:108		What the error messages the TRS-80 gives mean. (Model I)
To Err Is...Forbidden, Pt. II	Adams	7/81:291		How to use error traps.
USR Usery	Freese	12/81:248		See Programming Techniques.
Writers of a Lost Art	Albino	12/81:290		Write your own adventure games.

UTILITIES

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
80 Black Book	McGlumphy	12/81:278		Find ROM addresses fast. (Model I)
80 to RS-232 to TI-810	Herman	8/81:164		Software to interface the TI-810 printer to the TRS-80 via the RS-232. (Model I)
Auto Edit	Rollins	2/81:144	5/81:22	Find out where the current line pointer is located and simplify editing. (Model I)
Auto-key	Ghan	10/81:242		Define strings in Basic and execute USR commands to enter character from keyboard. (Model I)
Babydub	Kitsz	3/81:210		Copy most cassette programs under 16K with greater volume variation. (Model I)
Base Conversions	Yclvington	9/81:186		Convert number bases in Assembly language. (Model I)
Basic Disassembler, A	Delfine	7/81:244	2/82:28	Generate Assembly listings of machine code and examine Level II PROMs. (Model I)
Basic Shorthand	Radin	8/81:282		Enter Basic keywords with one keystroke. (Model I)
Basic—Enhanced Again	Goodwin	11/81:384		Twelve new commands for Level II Basic. (Model I)
Block That Cursor	Balewski	4/81:297	7/81:20	Turn the winking cursor into a block cursor. (Model I)
Building Bridges	Mueller	10/81:306		Move AIDS III's fields to or from Special Delivery's fields. (Model I)
Captran	Gorsky	6/81:192		Convert uppercase text files to upper/lowercase. (Model I)
Cheater Poker	Davies	12/81:356		Data-generating utility that is easy to use. (Model I)
Check Writer	Tzinberg	4/81:261		Patch for check-writing programs to produce professional-looking results. (Model I)
Clock Boot	Boehmke	2/81:112		Put the TRSDOS clock back on time after a reboot. (Model I)
Command File Modifier	Crawford	8/81:278		Create new command files or modify existing ones. (Model I)
Compare	Everett	4/81:271		Double check accuracy of ASCII disk dumps. (Model I)
Comprs	Barker	5/81:270		Machine-language routine to remove remarks and spaces from Basic programs. (Model I)
Constant Alternatives	Hand	3/81:225		Use decimal, hex, and octal constants in Level II Basic. (Model I)
Copyit	Balewski	10/81:370		Eliminate retyping duplicate data statements in programs. (Model I)
Copykill	Kelly	6/81:224		Copy or kill dozens of programs with one command. (Model I)
Crossdos	Means	10/81:288		Convert TRSDOS to CP/M. (Model I)
Crossref	Ewart	1/81:212		Get a variable cross-reference listing. (Model I)
Customized Commands	Rupert	11/81:292		Add merge and other commands to Level II Basic. (Model I)
Datafix	Barnard	10/81:358		Translate two or more keypad periods into a word or other punctuation. (Model I)
Datagen	Lewart	8/81:168		Get data statements from machine language to Basic. (Model I)
Dateline 80	Press	9/81:333		Create Basic data statements from object-code disk files. (Model I)
DB to LII Converter, The	Mumford	1/81:200		Convert Disk Basic to Level II. (Model I)

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Death Wish, The	Smith	12/81:262		Program that generates machine-language data statements as it self-destructs. (Model I)
Dexterous Data Entry	Shuken	12/81:280		Menu-generating routine. (Model I)
Direct Statement in File	Fitchhorn	5/81:190		Retrieve programs from disk after the "direct statement in file" error. (Model I)
Dirprog	Egbert	8/81:270		Disk directory program. (Model I)
Disk Auto-Menu, The	Hewin	6/81:178		Run and list programs from the menu. (Model I)
Disk Index	Schilling	8/81:268		Keep track of all your directory listings. (Model I)
Dollars and Sense	Andrews	5/81:216		Generate formatted input commands in business software. (Model I)
Driven Printer, A	Mueller	11/81:164		Assembly-language driver for the Centronics interface. (Model I)
El Cheapo Packer	Browne	3/81:168		Routine to pack two lines together or break one line in two. (Model I)
Emterm	Mills	10/81:156		Terminal program to use with ESI Lynx modem. (Model I)
Encoder, The	Cain	5/81:234		Convert hex into blocks of Basic that POKE hex back into proper memory locations. (Model I)
Enhance Your Level II Basic	Spencer	7/81:202		Assembly-language listing to add functions to Level II. (Model I)
Everyman's Mod II WP	Kilroy	7/81:226	10/81:22	A Basic word processor. (Model II)
EZ Wider	Chepko	3/81:247		Set printer character width and line length. (Model I)
Fast Edit	Illk	2/81:218		Juggle utilities to save time in reloading them. (Model I)
Find It Fast!	Yelvington	3/81:180		String-search for Basic programs. (Model I)
Flexible Scroller, The	Myers	5/81:204		Get segmented screen scrolls. (Model I)
Floppy Fixer	Beebe	12/81:326		Look anywhere on your disk and modify its contents. (Model I)
Full Error	Keairns	10/81:340		Get full error messages instead of abbreviations. (Model I)
Get High on Histograms	Lovy	1/81:211		Bar-graph generator. (Model I)
Head Bright	Hesse	9/81:327		Head-cleaning program. (Model I)
Hex Converter	Malone	5/81:244		Take hex off number base conversions. (Model I)
High-speed Data Tapes	Glosser	7/81:280	11/81:16	A quick string-array tape subroutine. (Model I)
II the Dump	Faber	12/81:236		Machine-language screen-dump routine. (Model II)
KBEEPFIX Revisited	Whitehead	3/81:270	6/81:16	Modify KBEEPFIX (2/80:14) for disk-based systems. (Model I)
KILDOS Is Here	Soltysik	6/81:265		Eliminate DOS from the disk to free space. (Model I and NEWDOS)
Know-It-All	Sehmer	5/81:288		List variables and lines in which they are used. (Model I)
Letter Counter	Atkins	3/81:192		Analyze text by tallying frequency of letters. (Model I)
Line Loss	Borrmann	5/81:283		Save the line lost to answering prompts. (Model I)
Listprog	Riffel	10/81:374		Improve your program listing's appearance. (Model I)
Logger, The	Kelly	12/81:374		Keep track of your programs. (Model I)
LPRINT Formatter II	Tzinberg	2/81:214		Print professional-looking listings. (Model I/III)
Memory Expander, The	Kenealy	9/81:174		Space saver that deletes spaces and remarks. (Model I)
Memory Window	Merkey	10/81:364		Machine-code subroutine to dump memory onto the screen. (Model I)
Merge for Level II	Dalesandry	11/81:284		Put a Merge utility on Level II cassette Basic. (Model I)
Mergers	Lloyd	12/81:238		Run RS's Mail List program in 48K. (Model I)
Modifying EDTASM+	Rhode	10/81:344		Store source and object code on disk. (Model I)
Never Ready	Balewski	7/81:199		Routine to change the Ready prompt. (Model I)
Newbug	Marks	11/81:368		Fifteen new commands for T-Bug. (Model I)
No Forwarding Address	Thiel	3/81:160		Protect your programs from tampering. (Model I)
Now You See It	Borrmann	2/81:236		Save and restore screen contents in 24 bytes or less. (Model I)
On Error...Fix	Richardson	9/81:250		Routine that detects and repairs errors. (Model I)

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
One-wheel Drive	Keen/Pezzuto	5/81:256		Copy utility for one disk drive. (Model I)
Paper Tiger Screenprinter	Lewart	2/81:138		Get screendumps of graphic display with the IDS 440 printer. (Model I)
Patching Across	Koch	9/81:282	12/81:26	Use Model I Scripsit on the Model III.
Pauper's Processor	Osburn	3/81:232		Simple Basic word processor. (Model I)
Purge	Ligori	6/81:219		Purge utility for disk. (Model I)
Ready—For the Model II?	Barbarelllo	12/81:260		Make your programs novice-proof. (Model II)
Rename	Busch	9/81:317		Get a rename utility on NEWDOS. (Model I)
Sans Disks	Hunter	4/81:186		Data-base management on cassette with fast loading and saving techniques. (Model I)
Sargon Saver, The	Quindry	5/81:272		Save Sargon in mid-game and play later. (Model I)
Sargon Saver, Pt. II	Quindry	12/81:348	4/82:26	A better way to save Sargon to tape. (Model I)
Scrip Patch	Allred	3/81:222		Go from Scripsit to DOS without losing text. (Model I)
Scripsit—Sans Serif	Cochrell	11/81:172		Use your printer's special features from Scripsit. (Model I)
Sentry, The	Rastin	12/81:242		Time-saving shift-entry utility. (Model I)
Serial Printing/EDTASM+	Cohen	9/81:276		Driver to get serial printouts using EDTASM+. (Model I)
Shift Lock	Hambel	5/81:260		Assembly-language subroutine for shift reversal. (Model I)
Simplezap	Safford	11/81:360		Inspect your disk sectors. (Model I)
Single-drive File Copy	Gorsky	3/81:191		Copy utility for TRSDOS and one drive. (Model I)
Soft Tach	North	6/81:232		Display the rotational speed of your disk drives. (Model I)

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BUSINESS

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Autotrak	Lloyd	10/82:203		Keep track of maintenance records for a fleet of vehicles. (Model I/III)
CC—Color Computer or Chamber of Commerce	Adcock	3/82:210		Using the Color Computer as a business machine.
Discriminating Pallets	Eaton	1/82:98		Plot prices for increasing material costs. (Model I)
Financial Wizard	Perelman	5/82:326		Figure compound interest, annuity, and amortization. (Model II)
High Finance	Byrne	10/82:324		Program to use with all-saver savings accounts. (Model I/III)
Industry Saver	Leichtman	10/82:156		How a TRS-80 improved production-line efficiency.
Invoice	Hackman	10/82:342		Organize your billing procedures. (Model I/III)
One Twelfth of a Misery	Krapf	4/82:298		Loan-amortization program. (Model I)
Order Form	Wright	9/82:270		Produce custom-designed forms. (Model I/III)
Phonfind	Eldridge	6/82:358		See Home/Hobby.
Pocket Portfolio	Dethlefsen	1/82:94		Investment-analysis program. (PC)
Portal-to-Portal Report	Keneipp	6/82:300		Keep track of air miles traveled. (Model I)
Production Learning Curve	Jeffrey	10/82:316		Program to track production costs per unit. (Model III)
Profit Prognosticator	Nottingham	2/82:268		Estimate business profits. (Model III)
Questions, Questions, Questions	Rutledge	1/82:102		Tabulate and average survey results for a business. (Model I/III)
QuickCalc	Leafstand	10/82:114		VisiCalc clone. (Model I/III)
Rule of 300	Zimmerman/Conrad	1/82:116		Figure interest payments on loans. (Model I/III)
Spanning of Mod II Disks	Keen/Dischert	1/82:110		See Programming Techniques.
Survey	Wells	6/82:248		Telemarketing program. (Model I/III)

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Tax Relief for the Rich	Perelman	3/82:176		Figure taxes after the Economic Recovery Act. (Model II)
Trade Wins, The	Finkelstein	2/82:238		Stock Market simulator. (Model I/III)



EDUCATION

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
80 in the Apple, An	Radin	2/82:68		About a teacher in NYC using 80s in the classroom.
Anything Jodi Can Do...	Tallman	2/82:60		Code game written by 9-year old and comments from her dad on teaching kids to program. (Model I)
BIPED	Leichtman	4/82:112		Story on a program using micros to train handicapped people.
CIE—Computers in Education	Radin	6/82:254		How a school district uses computers.
Classroom Crystal Ball	Keough	2/82:94		The future of computers and education, and how programmers should view educational software.
Computer Etch-a-sketch	Mustico	2/82:70		See Programming Techniques.
Do Not Pass	Wood	6/82:352		Teach road signs in driver-education class. (CC)
Dynamic Item Scheduling	Wyckoff	5/82:316		Write educational programs that interest and teach students. (CC)
Earth to Class, Listen Up	Fish	2/82:120		Classroom networking. (Model I)
Elementary, My Dear Primate	Vanderburgh	2/82:256		Use randomly generated text to study language synthesis. (Model I)
Extra-terrestrial	Wells	2/82:112		Program to teach the solar system. (Model I)
Fret No More!	Louis	5/82:164		Learn how to play the guitar with your 80. (Model I)
Future in Miniature, The	Mello	2/82:53		The micro in the classroom.
Grade Book	Pugsley	3/82:184		Keep students' grades on the computer. (Model I)
King Komputer	Allison	4/82:302		Program to teach kids how to read a ruler. (Model I/III)
Learning the Elements	Wood	2/82:116		Program to teach chemical elements. (Model I/III)
Making More Possible	Leichtman	2/82:128		How micros help the handicapped.
Moby Dick Touch	Brown	9/82:139		Learn touch typing. (Model I/III)
Typing Tutor				
OJT	Tymon	6/82:326		Program to build your own educational programs from. (Model I)
Put Them to the Test	Davis	2/82:104		Program that generates quizzes. (Model I/III)
Roll Call	Henderson	2/82:100		Using computers to keep track of student records.
RS-80Tay, Aysay Hatway?	Stratton	2/82:142		Program to teach a foreign language. (Model I)
Ten-key Tutor, The	Knogle	2/82:192		Program to teach typing on the ten-key pad. (Model I)
Time to Make 'em Sweat	Hawkes	5/82:332		Generate multiple-choice, true-false, short-answer, or completion tests. (Model I)
To Comma, or Not to Comma	Perron	2/82:82		Punctuation-teaching program. (Model I)
Vocabulary Test	Kalkstein	4/82:294		Match a word with a definition. (Model I)
You Light Up My Life	Wood	3/82:330		Teach the physics of light. (CC)

GAMES

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Acrostic Generator	Falk	8/82:240		Create puzzles. (Model I/III)
Alien Attack	Perry	8/82:282		Arcade game, with joysticks. (CC)
Amazing Cardoni II	O'Connor	8/82:302		Card trick. (Model I/III)
Assignment 46	Albino	8/82:66		Adventure game. (Model I)
Birthday Party	Zuckerbraun	10/82:262		Games for kids' birthday parties. (Model I)
Casino Slot Machine	Balewski	8/82:222		Simulate a Las Vegas slot machine. (Model I)
Color Breakaway	Grossbach	8/82:268		One-on-one hockey simulation. (CC)
Color Maze	White	8/82:188		Maze game. (CC)
Color Reversi	Ledger	3/82:90		Reversi on the Color Computer.
Computer Repeat	Fontenot	4/82:222	9/82:32	Memory game. (Model I)
Conquest of Memory Alpha	Myers	8/82:254		Colonize the universe. (Model I/III)
Cram	Brothers	8/82:234		Draw the line without going back or into it. (Model I/III)
Cube-80	Washington	8/82:106	10/82:30	Rubik's Cube on the computer. (Model I/III)
Enter the Dragon	Hadlock	8/82:248		Kung-fu adventure. (Model I/III)
Flip-a-piece	Cominio	3/82:252		Othello-like game. (Model III)
Fortran Puzzler	Yehle	6/82:227		Figure out the secret code. (Model I)
Four in One Plus Another	Becker	8/82:202	10/82:31	Four games and a utility for the CC.
Game of Kalah, The	Victor	8/82:132		Similar to Reversi. (Model I)
Game of Sim, The	Radin	9/82:276		Similar to tic-tac-toe. (Model I/III)
Intellectual Somnambulism	Keller	8/82:296		Arcade game. (Model I)
Kings and Catapults	Adams	2/82:232	9/82:32	Two feudal kings battle it out. (Model I/III)
Loco Motion	Ridgway	8/82:286		One-player to align objects into a pattern. (Model I)
Martian Missile Attack	Gillen	1/82:265		Save cities, destroy Martians. (Model I)
Master Muses, The	Heath	8/82:186		See Tutorials.
Micro Puzzle Box	Moews	1/82:302	3/82:28	Put the numbers in the right order in a grid. (Model I)
Naval Wars	Byrnes	8/82:114		Battleship with two computers. (Model I/III)
Outdoor Computer Games?	Adams	8/82:80		Play spy vs. spy outdoors with your computer. (Model I/III)
Pitty Pat	Barnes	8/82:270		Variation of draw poker. (Model I/III)
Save All Humans	Boothe	3/82:154		Save people from flying saucers. (Model I/III)
Save Our Ship	Hawkins	8/82:174		Star Trek adventure. (Model I/III)
Ski Slalom	Commander	8/82:112		Hit the slopes on the 80. (Model I/III)
Space Chase	Gillen	5/82:292	10/82:30	Arcade space game. (Model I)
Space Duel	Edick	8/82:260		Arcade game. (Model I/III, CC)
Square Game	Kanach	8/82:264		Merlin-like game. (CC)
Stanley	Black	8/82:300		Out stare your VDT. (Model I)
Sub Destroy, Model II Style	Steele	8/82:212		Arcade game for the Model II.
Subchaser!	Steiner	3/82:106		Avoid depth charges and learn graphics techniques. (CC)
Subs 'n Choppers	Gillen	8/82:216		Arcade game, subs vs. choppers. (Model I)
Tee for Six	Bevington	8/82:156		Tee-jumping board games for the computer. (Model I/III)
Termites	Weindorf	8/82:274		Eat through the wood, but remember where the knots are. (Model I/III)
Thru the Asteroids	Fugate	8/82:280		Find your way through the asteroid belt and land safely. (Model I/III)
Tumblin' Dice	Bobo	2/82:166		Based on Boggle. (Model I)
You Light Up My Grid	McGlumphly	6/82:330		Light all the squares but the center one. (Model I)

GENERAL

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Basic Misinterpreter	Busch	4/82:86		Humor—change Basic keywords to misspelled words. (Model I)
Bob Rosen—A Colorful Story	Leichtman	6/82:174		Personality piece on Bob Rosen.

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Broadening the TRS-80 Horizons	Busch	3/82:298		Thoughts on expanding your system.
Celluloid CPUs	Nadeau	5/82:98		Micros in the movies.
CompuServe, MicroNet and the TRS-80	Maguire	1/82:74		TRS-80 users and CompuServe.
Computer Creationists	Rose	5/82:80		How micros are used in sound studios.
Confessions of a Microholic	Keller	5/82:320		One user's life after buying a TRS-80.
Dateline: Sri Lanka	Mello	4/82:128		Personality piece on David Busch.
Divine Dementia	Nadeau	5/82:176		Personality piece on Dennis Kitsz.
Dream Team	Wangness	2/82:196		Put together an ideal team with this program. (Model I)
Gabby the Space Cowbum	Ramella	5/82:322		This space cowboy won't shut up. (Model I)
Graphics King, The	Frann	8/82:120		Personality piece on Leo Christopherson.
Jake's Wampeters	Mello	3/82:162		Profile on Jake Commander.
Kryha Cipher Machine	Deavours	5/82:272		Use Tiny Pascal in cryptology. (Model I)
Little Byte Music, A	Levine	5/82:128		History of digitally synthesized music.
Night on the Town, A	Gunn	4/82:124		Humor—take your computer out on a date.
Northern Lights	Latamore	5/82:104		How a sculptor uses a micro to plan his designs.
Ohio Electronic News Experiment	Chidsey	6/82:100		Progress report on the Tiffin, OH, newspaper's electronic news experiment.
Out of Thin Error	Adcock	5/82:258		Humor—what error messages "really" mean.
Philly Phiasco	Gunn	5/82:140		Commentary on the Philadelphia Computer in the Arts Symposium.
Radio Shack vs. IBM	Van Ghent	3/82:168		Model II compared to the IBM 5150.
ROM Bibliography	Secord	4/82:76		Annotated list of literature on the ROM. (Model I/III)
Shopping with Uncle Sam	Stolker	10/82:88		A look at the Federal DP Expo in Washington, DC.
Terminal Case, A	Latamore	1/81:66		A look at the Canadian videotext system, Telidon.
TRON: Man in the Computer	Mello	8/82:124		Piece on the movie, Tron.
Vexed by the Void	Resnick	4/82:262		An alien's view of TRS-80 users—humor.
Videotext for the Masses	Nadeau	1/82:60		What videotext means to the home computerist.
When the Postman Doesn't Ring	Averill	3/82:308		Thoughts on mail order.

GRAPHICS

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
3-D Graphics	Fogelin	3/82:138		Get 3-D geometric shapes on the screen. (Model I/III)
Alpha-graphics	Basch	1/82:190		See Programming Techniques.
Back to the Drawing Board	Rappaport	3/82:120		See Utilities.
CC on Parade, Pt. I	Barden	10/82:82		Using graphics on the CC.
Color from a Model II?	Ward/Deninger	3/82:240		Use the DMP-3 digital plotter to get color graphics. (Model II)
Colorful Computer, Pt. I	Miller	8/82:94		Twenty-one graphics programs. (CC)
Colorful Computer, Pt. II	Miller	9/82:152		See Part I.
Colorful Computer, Pt. III	Miller	10/82:254		See Part I.
Computer Etch-a-sketch	Mustico	2/82:70		See Programming Techniques.
Conversion	Osborne	9/82:238		Bob Boothe's graphics on the CC.
Different Perspective	Nielsen	5/82:242		Use shadows to gain perspective in graphics. (Model I)
Editor's Choice, The Is a Rose in Color/ a Rose?	Gesamte/Commander Green	3/82:78 3/82:142	6/82:26	Graphic patterns. (CC) Earlier 80 Micro graphics programs converted to the CC.
Joystick Paintbrush	Sprouse	9/82:230		Draw on the screen with joysticks. (CC)
Mirror Imagining	Boothe	3/82:112		Plot spheres, paraboloids, and other high-resolution shapes for the Epson. (Model I)
Paper Graphics	Rosenberg	3/82:270		See Utilities.
Pictures at a Mod II Exhibition	Baker	3/82:280	6/82:26	Bob Boothe's techniques on a Model II.

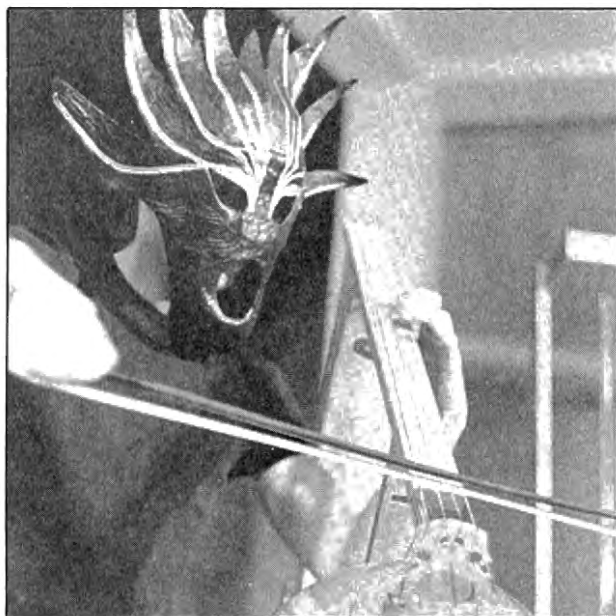
Polar Generator	Webb	2/82:204		See Programming Techniques.
Random Picture Generator	Swarts	2/82:194		Let the computer be the artist. (Model I)
Shady Characters	Ramella	3/82:258	6/82:26	Get silhouette printouts. (Model I)
Smooth Graphics	Goodman	3/82:304		See Programming Techniques.
Spiromania, Pt. I	Commander	5/82:88		Draw spirographs on the Color Computer.
Spiromania, Pt. II	Commander	6/82:106		See Part I.
Sublime Simulations	Keough	4/82:258		How computer simulation/modeling works.
Super Banner	Balewski	5/82:282		Print out banners on a Centronics 737. (Model I)
When Black Is White	Tache	3/82:294		Reverse graphic printouts. (Model I/III)

HARDWARE

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Bare-bones Communicator	Hart	6/82:128		Get a communications system without the expansion interface or RS-232 adapter, with software. (Model I)
Battery Back-up	Batie	2/82:126		Build a battery back-up unit.
Building an M-80	Hawkes/Reese	3/82:172		Build a single-board microprocessor with the Z80.
Cheaper Upgrade	Tucker	9/82:186		Install the Extended Color Basic ROM yourself. (CC)
Color Computer Upgrade	Murphy	3/82:102		Go from 4K to 16K. (CC)
Color from a Model II?	Ward/Deninger	3/82:240		See Graphics.
Computerized Engraving	Joffe	5/82:318		Drive a pantograph with your 80. (Model III)
Cybernetics and Jelly Beans	Davids	10/82:190		Build a robot to detect jelly beans. (Model I)
Digital Doodles	Sehmer	1/82:244	9/82:30	Build a graphics plotter. (Model I)
Do-it-yourself Disks	Schaefer	1/82:172		Install your own disk drives in a Model III.
Double Your Density	Domuret	1/82:294		Adding double density to your system section. (Model I)
Four Into One Will Go	Hawkes/Reese	2/82:226		Put a 4K program in 1K by bank. (Model I)
Handy Dandy Tandy Table	Langston	4/82:328		Build a desk for your computer.
Hardware Hacker, Pt. I	Van Praag	10/82:216		Connect a Centronics-compatible printer to the Model I.
Hydra-disk	Robins	3/82:206	6/82:26	Add dual-headed drives. (Model I)
Joy of Interfacing, The	Batie	3/82:242		Joystick interface. (Model I)
Juicing Pin 18	Gorodetzer	9/82:288		Use pin 18 on the MX-80 printer connector with the buffered cable. (Model I)
Look into Disk Drives, A	staff	1/82:179		Buyer's guide to disk drives.
Modem Auto-answer	Westbrook	6/82:229		Build an auto-answer device.
Multi-programming on a Micro	Genovese	1/82:278		See Programming Techniques.
Networking on a Shoestring	Meinke	2/82:184		Build your own networking system. (Model I)
New Generation of Characters	Park	4/82:220		Install the AXX3027 character generator chip. (Model I)
Programmable Baud Rate	Cottle	5/82:306		Device for the LNW interface to get a programmable baud rate. (Model I)
Programmable Sound Generator	Robins	5/82:106		Get up to nine simultaneous voices for about \$125. (Model I)
RAM Wars	McClenahan	3/82:156		Get 64K RAM on the CC.
Singer Printer Interface	Mailhot	6/82:374		Interface the Singer printer.
Sixteen-channel A/D Board	Haan	6/82:310		Interface eight joysticks. (Model I)
Smarten Up, Color Computer	Esposito/Thiel	3/82:126		Add memory to the CC.
Straight Shooter, The	Quindry	1/82:318	10/82:30	Build an inexpensive light pen. (Model I)
Telephone Dialer	Hickey	6/82:160		Device to let your computer dial phone numbers. (Model I)
Those CLOAD Blues	Hartjes	1/82:288		Build a data compensator and audio amplifier. (Model I)
Video Snow Shovel	Smith	3/82:290	9/82:30	Get rid of those black streaks against white characters. (Model I)
Where There's a Will...	McClenahan	3/82:84		Device to let the Color Computer print while on CompuServe.

HOME/HOBBY

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Bringing the Supermarket to Its Knees	Kraynak	4/82:270		Grocery-list program. (Model I)
Computer Racing Form	Bobo	5/82:252		Handicap horse races on your micro. (Model I/III)
Fore! Scorekeeper	Wells	5/82:298		Keep track of your golf scores. (Model I/III)
Gentle Reminder, A	Rosen	6/82:348		Schedule your work projects. (Model I/III)
Home Budgeteer—Reprise	Pablo	5/82:238		Keep track of household expenses. (Model I/III)
If This Is Tuesday, It Must Be . . .	Atkins	1/82:308	5/82:26	Date program. (PC)
Income Tax Estimator	Stark	10/82:168		Figure your income tax on the CC.
Model III Biorhythms	Anderson	5/82:280		Find out what your good and bad days will be. (Model II)
No More 90-pound Weakling	Stevens	1/82:174		Exercise log program. (PC)
Phonfind	Eldridge	6/82:358		Phone-log program. (Model I/III)
To Catch a Thief	Kuhn	4/82:274		Home-inventory program. (Model I/III)
Trick or TRS-80	Keller	10/82:104		Have a jack-o-lantern on your screen greet trick-or-treaters. (Model I/III)
Two Strokes a Side	Avery	5/82:264		Figure your golf handicap. (Model I/III)
Ultimate Parts Manager	McCalley	1/82:140		Keep inventory of Model T parts. (Model I)
You're in the Money	Montgomery	10/82:140		Project the impact of personal savings and borrowing plans. (Model III)



PROGRAMMING TECHNIQUES

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Add That Professional Touch	Steelhammer	1/82:258		Make DBMs easier to use. (Model I/III)
Alpha-graphics	Basch	1/82:190		Technique to build graphic strings. (Model I/III)
Basic Word Processing	Cutrona	9/82:140		See Utilities.
CC on Parade, Pt. I	Barden	10/82:82		See Graphics.
Colorful Computer, Pt. I	Miller	8/82:94		See Graphics.
Colorful Computer, Pt. II	Miller	9/82:152		See Part I, Graphics.
Colorful Computer, Pt. III	Miller	10/82:254		See Part I, Graphics.
Computer Etch-a-sketch	Mustico	2/82:70		Add graphic routines to educational programs. (Model I)
Conversion	Osborne	9/82:238		See Graphics.
Different Perspective	Nielsen	5/82:242		See Graphics.
Dizzy Decimals	Shore	3/82:326		Eliminate round-off errors. (Model I/III)
Do-it-yourself DB, Pt. I	Townsend	6/82:176		How to write your own data base.

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Do-it-yourself DB, Pt. II	Townsend	9/82:242		See Part I.
Do-it-yourself DB, Pt. III	Townsend	10/82:332		See Part I.
Editor's Choice, The	Gesamte/Commander	3/82:78		See Graphics.
Flasher, The	Mickey	1/82:276		Flash prompts. (Model I)
I Have a Secret	Demberger	10/82:296		See Utilities.
I Program, Therefore ISAM	Adcock	5/82:302		Use the indexed sequential addressing mode.
Mirror Imaging	Boothe	3/82:112		See Graphics.
Model I Do Files	Jackisch/Knapp	4/82:254		Ease program operation by using Do files. (Model I)
Multi-programming on a Micro	Genovese	1/82:278		Execute several programs simultaneously. (Model I)
Ordered Chaos	Webb	1/82:310		Using randomness in programs. (Model I/III)
PCLEAR 0	Heusinkveld	9/82:282		Make high-resolution graphics use high memory. (CC)
PEEK of Its Career, The Performance Analysis	Wilson Ballard	6/82:308 2/82:240		Simulate PEEK and POKE on the Model II. Detail the execution path of your programs. (Model I/III)
Polar Generator	Webb	2/82:204		Generate a map of the Arctic on the screen. (Model I)
Priming the Data Base	Ring	3/82:152		Use prime numbers for labels in DBMs for fast sequential searches. (Model I/III)
Printer Color Art	Kalinowski	9/82:168		Get color printouts on your MX-80 using colored ribbons. (Model I/III)
Programmers for Hire	Gillig	1/82:274		Techniques of a professional programmer. (Model I/III)
Programming Pitch, Pt. I	Davis	5/82:142		How to program pitch in music-generation programs. (Model I)
Programming Pitch, Pt. II	Davis	6/82:362		See Part I.
Programming Pitch, Pt. III	Davis	10/82:228		See Part I.
ROM Breakout	Sprott	6/82:350		Use the interpreter's built-in exits to make modifications. (Model I/III)
Sling Some Hash	Knecht	9/82:124		Use hashing to store and retrieve items in an unsorted list. (Model I/III)
Smooth Graphics	Goodman	3/82:304		Add precision to animation. (Model I/III)
Spanning of Mod II Disks	Keen/Dischert	1/82:110		Link files with multi-disk Model IIs.
Stepwise Refinement	Boasso	6/82:232		Excercise using psuedo-code.
STRING\$ the Thing, The	Knight	6/82:298		Use STRING\$ to pack strings. (Model I/III)
Subchaser!	Steiner	3/82:106		See Games.
Super Banner	Balewski	5/82:282		See Graphics.
To Err Is... Okay	Adcock	3/82:230		Use On Error GOTO to work out of programming problems.
Total Recall	Bender	4/82:332		Get direct access to anything in memory with Fortran. (Model I)
Using Print Using	Rende	1/82:290		Tips on using the Print Using command.
Worm Pills for Basic	Keen/Dischert	4/82:290		Find the most efficient way to use Basic keywords.

SCIENCE/MATH

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
Bemusing Triangle, The	Honess	2/82:210		Use the TRS-80 to implement the trapezoidal rule. (Model I/III)
Colorful Titrations	Wood	2/82:202		Isolate specific elements in chemical solutions. (CC)
DIGRAPH Digressions	Gorney	6/82:192		Use a directed graph to learn graph theory. (Model I/III)
Extra-terrestrial	Wells	2/82:112		See Education.
Learning the Elements	Wood	2/82:116		See Education.
Model III Biorhythms	Anderson	5/82:280		See Home/Hobby.
Propagation Prediction	Chipman	6/82:272		Predict high-frequency wave propagation. (Model I)
Two-way ANOVA	McGarvey	3/82:234		Get two-way analysis of variance. (Model I)
You Light Up My Life	Wood	3/82:330		See Education.

TUTORIALS

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
BBS Primer	Wright	6/82:284		What you need to hook onto a bulletin board.
Bit Smitten, Pt. II	Chidsey	9/82:268		Formerly "For the Novice;" heat build-up, turn-on and turn-off shock, and more discussed.
Bit Smitten, Pt. III	Chidsey	10/82:96		What a baud is, screen-dump routines, and more.
Breaker 19	Busch	6/82:96		How to use CompuServe's CB simulator.
Damping Cassette Output	Sinclair	5/82:324		What to do when CLOAD problems are really CSAVE problems.
Data Communications— TRS-80 Style	Derfler	6/82:82		How to set up your TRS-80 as a data-communications terminal.
Do-it-yourself DB, Pt. I	Townsend	6/82:176		See Programming Techniques.
Do-it-yourself DB, Pt. II	Townsend	9/82:242		See Part I, Programming Techniques.
Extended Color Basic	Miller	6/82:266		A look at Extended Color Basic. (CC)
For the Novice, Pt. I	Chidsey	6/82:148		What MEM SIZE?, high and low memory, high and low-level languages are all about.
Grafrax 80	McNamee	9/82:190		Use bit graphics on the MX-80. (Model I/III)
Inside Scripsit, Pt. I	Lindley	9/82:222		Learn how Scripsit works before you modify it. (Model I/III)
Inside Scripsit, Pt. II	Lindley	10/82:276		See Part I.
Learn a Little Pascal, Pt. II	Grothman	1/82:80		Program using RS Tiny Pascal.
Make Butterflies—Not Bugs	Commander	4/82:152		Tips on using utilities.
Master Muses, The	Heath	8/82:186		Author of Master Reversi talks about computer Othello.
Mod III Notes	Ratzlaff	2/82:200		Model II monitors and cassette I/O.
Model I, Meet Model III	Barlow/Brydges	1/82:316		Convert programs from Model I to Model III.
Model II Primer	Baker	5/82:260		Tips for the new Model II owner.
Ordered Chaos	Webb	1/82:310		See Programming Techniques.
Printing Perfection	Phillip	9/82:126		Control print density and size options of the MX-80 while in Scripsit.
Radio Shack Repairs	Kepler	10/82:101		What Radio Shack charges to repair specific things.
Stepwise Refinement	Boasso	6/82:232		See Programming Techniques.
Technological Destiny, Pt. I	Dillio	4/82:264		What a job in data processing requires.
Technological Destiny, Pt. II	Dillio	5/82:228		See Part I.
Technological Destiny, Pt. III	Dillio	6/82:186		See Part I.
Technological Destiny, Pt. IV	Dillio	9/82:260		See Part I.
Technological Destiny, Pt. V	Dillio	10/82:246		See Part I.
Using Print Using	Rende	1/82:290		See Programming Techniques.
Utilities Buyer's Guide	staff	4/82:135		Stats on various utilities for the TRS-80. (Model I/II/III, CC)
Welcome to Cobol	Keen/Dischert	1/82:92		Introductory look at Cobol.
Worm Pills for Basic	Keen/Dischert	4/82:290		See Programming Techniques.
Z80 Bit Tables	Robinson	3/82:260		Op-code secrets revealed. (Model I)

UTILITIES

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
16, 10, 2, or 8—Which Base Do We Appreciate?	Sarnow	6/82:334		Decimal to octal to hex conversion. (Model I/III)
Add CRC ASAP	Baker	1/82:204		Perform cyclical redundancy code checks for tape-based systems. (Model I)
Another Major Operation on Scripsit	Graves	1/82:230		Add serial printer capabilities to Scripsit. (Model I)
Array I/O	Neff	1/82:200	5/82:26	Machine-language routine for fast Basic data transfer. (Model I)

<i>Title</i>	<i>Author</i>	<i>Issue/Page</i>	<i>Debug</i>	<i>Annotation</i>
As the Screen Scrolls	Keller	2/82:264	6/82:26	Protect some of your screen from scrolling. (Model I)
Back to the Drawing Board	Rappaport	3/82:120		Design graphic displays on the screen and let the computer produce the code for it. (Model I)
BAM!	Byrkit	4/82:167		Change one-letter commands in your monitor program to a full word. (Model I)
Base 2 Screenprinter	Kent	3/82:214		Get screen dumps on the Base 2 printer. (Model I)
Basic Communication	McGarvey	6/82:324		Terminal program in Basic. (Model I)
Basic Compiler in Basic	Bertsekas	10/82:122		(Model I)
Basic Translator	Miller	6/82:194		Translate different Basic dialects for communication with other computers.
Basic Word Processing	Cutrona	9/82:140		Basic word processor. (CC)
Can You Get Me a Date?	Phillipp	2/82:220		Routine to let you enter a date in any format you like. (Model I)
Colormon	Cook	3/82:212		Monitor program. (CC)
Command Interpreter	Alford	4/82:244		Directly access machine-language routines. (Model I)
CP80	Cameron	4/82:306		IBM-like monitor program. (Model I)
Datagen	Heusinkveld	6/82:346		Convert machine code to Basic statements. (CC)
Direct Access	Fink	4/82:214		Access Disk I/O routines from Basic using string variables as input buffers. (Model I)
Does Format Get Your Backup?	Hart	1/82:217		Use glitched disks. (Model I)
Error Code Expanded	Alford	2/82:260		Get full error messages. (Model I)
Expand It—Burn It In	Alexander	6/82:344		Test program for memory upgrade. (Model III)
Fill in the Blanks	Schuldenfrei	1/82:224		Pack records before sending them to tape. (Model I/III)
Graphics for Profile	Wood	3/82:284		Get graphics with Model II Profile.
Half Duplexer	McGarvey	5/82:172		Get screen echo for typed communications. (Model I)
Hoodwinking TRSDOS	Anderson	6/82:296		CP/M printer driver for Model II TRSDOS.
Horizontal Scrolling	Foley	6/82:318		Scroll back and forth and up and down. (Model I)
I Have a Secret	Demberger	10/82:296		Data encryption-decryption program. (Model I/III)
JKL Minus Blanks	Straw	9/82:290		Modify the NEWDOS + JKL so it doesn't print blank lines. (Model I)
Loc-Editor	O'Connor	4/82:206		A spelling checker for program listings. (Model I)
Lost and Found	Athanasios	6/82:288		Disk-directory program. (Model III)
Lost in Basic	Paxton	1/82:304	5/82:26	Find variables in Basic programs. (Model I)
Lots of Little Letters to Litter Your Listings	Olsen	2/82:262		Convert upper to lowercase. (Model I)
LP VII Patch for the CC	Degler	10/82:304		Eight-bit printer driver. (CC)
Memory Size?	Jackson	4/82:226		Store machine-language routines as string variables in Basic programs. (Model I)
Micro Melodies	Gibbs	5/82:234		Music-generation program. (Model I)
Model II Disassembler	Faber	4/82:182		A disassembler for the Model II.
Model II Terminal Driver	Korenthal	4/82:176		Terminal driver for use with Lifeboat's CP/M. (Model II)
Model III Master Directory	Muchlig	4/82:250		A master-directory program in 32K. (Model III)
Neatlist	Ewart	1/82:196		Produce neat program listings. (Model I)
One-drive Bulletin Board	Hodgson	3/82:314		Set up a CBBS with one disk drive. (Model I)
Paper Graphics	Rosenberg	3/82:270		Get graphics printouts on an LP IV. (Model I)
Play a Trick on Profile	Scott	6/82:306		Directly access profile files. (Model I)
Print That Index	Everett	6/82:184		Print out an address file. (Model I/III)
Print Whiz	Parker	2/82:250		Routine to use Electric Pencil and the RS LP IV to their full extent. (Model I)
Program Begat, Son of Program Begat	Christensen/Sater	6/82:320		Self-reproducing program. (Model I)
Rapid System Loader	Hedinger	4/82:188		Software tape-load speedup. (Model I)
Reading, Writing, and AL	Morgan	3/82:318		Routines for disk I/O. (Model I/III)
Recover	Gobel	9/82:256		Recover from unwanted exits from Scripsit. (Model I)
Screen Veil	Keller	9/82:286		Temporarily hide your screen's contents. (Model I/III)
Screenplay	Merkey	9/82:204		Print out anything in memory. (Model I)

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Secrets	Mills	3/82:216		Hide sensitive data and protect your software. (Model I)
Snapshot	Rice	2/82:272		See how the values of your variables change during program execution. (Model I)
Systemized Basic	Browne	4/82:234		Save Basic programs in System format. (Model I)
Tab Extender	Hedinger	2/82:248		Put 127 more spaces on your tab limit. (Model I)
Tape Spate	Bowman	1/82:240		Shorten time for cassette data saves and recoveries. (Model I)
TRSDOS 2.0 Fix	Mornini	3/82:332		Keep from exiting to DOS. (Model II)
Two Transfers Please	Hollins	2/82:188		Put Eliza and Micromusic on disk. (Model I)
Using TestIA	Moultrie	4/82:240		Use TRSDOS's memory test with other DOSes. (Model I)
Varispeed	Evans	3/82:336		Control the speed of your Basic interpreter. (Model I)
Zubroutines	Ashley	4/82:209		Fifty short subroutines to aid your programming. (Model I)
Lowercase Done Right	Burgan	9/81:298		Build a better LC mod. (Model I)
Model I ½, The	Fortna	4/81:218		Install your Stringy Floppy in the TRS-80 as one system. (Model I)
Model I as a Dumb Terminal	Tallman	4/81:276		Level I or II communications system. (Model I)
One Man's Robot	McAllister	9/81:114		Build a light-sensitive robot.
Onomatocigthy	Mein	1/81:190		Interface the General Instruments AY-3-8910 programmable sound generator. (Model I)
Plug-compatible Processor	Vonk	6/81:137		Z80A black box to make your Model I run at 4 MHz.
Polyphonic Sound Synthesizer	Brocaw	6/81:166	3/82:18	Complex sound generation using the General Instruments AY-3-8910 Programmable Sound Generator. (Model I)
Pulse Jockey, The	Suter	5/81:236		Interface via serial I/O through the cassette port. (Model I)
Real World Interface, Pt. I	Rar.	10/81:202		Build an interface device. (Model I)
Real World Interface, Pt. II	Rand	11/81:208		See Part I.
Real World Interface, Pt. III	Rand	12/81:192		See Part I.
Recipe for Hardcopy	Keith	7/81:262		Interface a Teletype Model 33 with a Multi-80 and software. (Model I)
Red Letter Day/Lowercase	Ferber	4/81:248		Installing commercial lowercase printer and video mods and patches. (Model I)
Robotics—The Micro Connection	Brown	9/81:104		How robotics are edging into the micro field.
ROM Roll-over	Kelch	11/81:362	4/82:24	Mod to roll 16K of RAM over the ROM operating system. (Model I)
Second Sourcing	Tinis	11/81:348		Program to screen op-amps. (Model I)
See No Evil	Macri/Gregory	3/81:214		Monitor status of the CPU when the video isn't hooked up. (Model I)
Switched-on CLOAD	Bickel	3/81:252		Play tapes without unplugging wires from the keyboard. (Model I)
Tandy Acquires IBM!	Stanley	12/81:268		Interface the Selectric Model 1980 typewriter to the TRS-80. (Model I)
Tape Regenerator	Lewart	10/81:196		Back up even poor tape recordings on a second recorder with this device.
That Annoying Twitch	Smith	10/81:310		Device to eliminate video twitch. (Model I)
TRS-80 Bus Conductor	Fox	4/81:272		Build an expansion bus. (Model I)
TRS-80 Joystick Control	Barker	4/81:262		Interface Atari joysticks. (Model I)
Very Versatile Interface	Stanley	2/81:175		Build an interface board. (Model I)
Wandering 80, The	Hubert	8/81:298		Build a cabinet for your Model I.
Wave Shaper	Shreve	9/81:218		Build a device to square pulses during CLOADs.
Width Control	Barbarelllo	9/81:258		Build a control to set repeatable character widths on RS line printer.
Xerox 1740 and the Mod II	Nestor	6/81:92		Interface Xerox 1740 printer to Model II.

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Computer Games for Business and School	Winthrop Publishers Inc.	9/80:20
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Guide to TRS-80 Information	F. E. Hubener	2/80:38
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Introduction to TRS-80 Graphics	Dilithium Press	4/80:24
Introduction to T-Bug	Dilithium Press	7/80:16
Learning Level II	Compusoft Publishing	5/80:12
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Programming Techs for Level II Basic	Tandy/Radio Shack	11/80:38
Programmer's Book of Rules, The	Lifetime Learning Publications	5/80:14
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SSI Micro Software Guide, The	SSI	2/80:38
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TRS-80 Technical Reference Manual	Tandy/Radio Shack	5/80:12

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Model 440 Paper Tiger	Integral Data Systems Inc.	10/80:36
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SpellStar	Micropro International	9/82:95
Star Blaster	Micro Works	8/82:44
Star Warrior	Automated Simulations	4/82:50
Starfighter	Adventure International	2/82:320
Statistical Analysis	Tandy/Radio Shack	6/82:280
Stud5	Wilson Software Division	1/82:42
Super Color Writer 1.0	Nelson Software	9/82:62
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User Groups

This magazine is not the only good information source for your TRS-80. There are many computer clubs, called user groups, that help out members with technical tips and a pool of experience.

Below is a list of user groups that cater to the TRS-80 owner, many exclusively. The list is long, but by the time you read it, there will certainly be more. Look for one in your area and drop them a line.

If you belong to a user group that does not appear on this list, send a letter to *80 Micro* telling us about the club. We'll get your group in our next list. We also want to hear about any updates on the groups in this list. ■

STATE	GROUP NAME	ADDRESS	CITY	ZIP
=====	=====	=====	=====	=====
AK	ANCHORAGE USERS GROUP	BOX 10, 385 SOUTH STATION	ANCHORAGE	99511
AL	CENTRAL AL MICRO SOCIETY JUNIOR CHAPTER	RT. #3 BOX 570	MONTGOMERY	36110
AL	CENTRAL ALABAMA COMPUTER SOCIETY	2073 REXFORD RD	MONTGOMERY	36116
AL	G2C3	4307 OLD SHELL RD	MOBILE	36608
AZ	PHEONIX USERS GROUP	1850 EAST MARYLAND #27	PHEONIX	
AZ	ARIZONA USERS GROUP	4322 EAST FAIRMONT	PHOENIX	85018
AZ	USERS GROUP OF ARIZONA	6218 W. MARLETTE	GLENDALE	85301
BRA	BRASILIAN CLUB	RUA SAMBAIBA 516, LEBLON	RIO DE JANEIRO	22450
CA	THE FORTH INTEREST GROUP	PO BOX 1105	SAN CARLOS	94070
CA	HOMEBREW COMPUTER CLUB	BOX 626	MOUNTAIN VIEW	94042
CA	VENTURA COUNTY TRS-80	2534 NORTH TEMPLE AVE.	CAMARILLO	93010
CA	USERS GROUP	7465 HOLLISTON AVE., SUITE 23	GOLETA	93017
CA	USERS GROUP	712-C COUNTRY WOOD	WALNUT CREEK	94598
CA	USERS AND ABUSERS	1350 GRANT RD.	SUNNYVALE	94040
CA	REDWOOD EMPIRE USERS GROUP	7136 BELITA AVE.	ROHNERT PARK	94928
CA	SOUTH BAY USERS GROUP	3605 PINE AVE	MANHATTEN BEACH	90266
CA	EAST BAY USERS GROUP	17 ECHO AVE	OAKLAND	94611
CA	SAN FRANCISCO TRS-80 USERS GROUP	338 ALIDA WAY #306	SOUTH SAN FRANCISCO	94080
CA	CAUSE (SOFTWARE EXCHANGE)	18651 VON KARMAN	IRVINE	92713
CA	INLAND COMPUTER SOCIETY	3359 SECOND ST	RIVERSIDE	92501
CA	SOUTH BAY USERS GROUP	BOX 6302	STANFORD	94305
CA	TRS-80 FREE PROGRAM EXCHANGE	4418 MORROW RD.	MODESTO	95350
CA	COUNTRYWIDE USER GROUP	10409 STATE ST.	SOUTH GATE	90280
CA	LITTON CALCULATOR/COMPUTER CLUB	5500 CANOGA AVE	WOODLAND HILLS	91364
CA	MARIN COUNTY USERS GROUP (MCTUG)	45 SELFRIDGE WAY	HAMILTON AFB	94934
CA	SONOMA COUNTY COMPUTER CLUB	BOX 945	COTATI	94928
CA	TRS-80 NIBBLERS	2555 HESPERIAN BLVD	HAYWARD	94545
CA	MONTEREY.BAY USERS GROUP	1002 HALSEY DR	MONTEREY	93940
CA	VALLEY COMPUTER CLUB	3311 WEST THIRD, APT. 1-319	LOS ANGELES	90020
CA	PAMONA COMPUTER SOCIETY	4155 OAK HOLLOW RD.	CLAREMONT	91711
CA	COMPUTER INFO EXCHANGE (CIE SOFTW NEWS)	BOX 159	SAN LUIS REY	92068
CA	ORANGE COUNTY USERS GROUP	3521 E. COMMONWEALTH	FULLERTON	92631
CA	ET-3400 USERS GROUP	11231 OAK ST.	EL MONTE	91731
CA	TRS-80 USERS GROUP OF NAPA	4432 SPRINGWOOD	NAPA	94558
CA	OASIS USERS GROUP	PHASE ONE SYSTEMS	OAKLAND	
CA	VENTURA COUNTY TRS-80 COMPUTER CLUB	567 WEST LOOP DR.	CAMARILLO	93030
CA	VALLEY TRS-80 USERS GROUP (VTUG)	19116 NASVILLE ST	NORTHBRIDGE	91326
CA	SACRAMENTO USERS GROUP	1237 BEARD WAY	CARMICHAEL	95608
CA	SAN JOSE USERS GROUP	3490 BON AIR COURT	SAN JOSE	95117
CA	SAN FRANCISCO USERS GROUP	HQ USARRIX	PRESIDIO OF SAN FRAN	94129
CA	FORTH INTEREST GROUP	PO BOX 1105	SAN CARLOS	94070
CA	SAN GABRIEL VALLEY TRS-80 USERS GROUP	750 E. 5TH ST. #75	AZUSA	91702
CA	SILICON VALLEY COMPUTER CLUB	P.O. BOX 61593	SUNNYVALE	94088
CAN	KITCHENER-WATERLOO MICRO CLUB	UNIVERSITY OF WATERLOO	WATERLOO, ONT	N2L3G1
CAN	MICRO-80 COMPUTER CLUB OF OTTAWA	178 MONTEREY DR	NEPEAN, ONTARIO	K2H7A8
CAN	REGINA OPERATORS OF MICRO SYSTEMS	BOX 1001	REGINA	S4P3B2
CAN	TMUG, TORONTO MICR COMPUTER USERS GROUP	OX 857, STATION A	TORONTO, ONT	M5W1G3
CAN	COLOR COMPUTER USERS GROUP	33 KILLDEER CRESCENT	TORONTO, ONTARIO	
CAN	AURORA COMPUTER SOCIETY	BOX 4342	EDMONTON, ALBERTA	T5H1R5
CAN	INTERESS-80	673 CLAIRETTE	FABREVILLE, QUEBEC	H7P2Y3
CT	NORTH EASTERN BASIC FOUR USER GROUP	22 TOBEY RD.	BLOOMFIELD	06002
CT	FAIRFIELD COUNTY TRS-80 USERS GROUP	10 RICHLEE RD.	NORWALK	06851
CT	SOUTHERN NEW ENGLAND COMPUTER SOCIETY	267 WILLOW ST	NEW HAVEN	06511
CT	CONN MICROISTS	8802 WENDY LANE	WESTPORT	06881
CT	CONNECTICUT COMPUTER CLUB	18 RIDGE COURT WEST	WEST HAVEN	06516
DE	DELAWARE USERS GROUP	1116 PIPER RD	WILMINGTON	19803
DE	DELAWARE USERS OF MICROS	318B CHAPEL AVE	CLAYMONT	19703
DE	SOUTHEASTERN DELAWARE CTY TRS80 USR GRP	1109 MADISON AVE	PROSPECT PARK	19076
ENG	NATIONAL TRS-80 USERS GROUP	40A HIGH ST., STONY STRATFORD	MILTON KEYNES	
FL	TBUG-80 NEWSLETTER (TAMPA BAY GROUP)	322 S. 21ST STREET	HAINES CITY	33844
FL	TBUG-80	PO BOX 247	TAMPA	33602

STATE	GROUP NAME	ADDRESS	CITY	ZIP
=====	=====	=====	=====	=====
FL	ORLANDO, FL, COMPUTER CLUB	ADVENTURE INTERNATIONAL	ORLANDO	32802
FL	CLUB OF CENTRAL FLORIDA	152 MILL RUN DRIVE	LAKE MARY	32746
FL	FL EDUCATIONAL COMPUTER USERS GROUP	5720-1 ATLANTIC BLVD.	JACKSONVILLE	32207
FL	TAMPA BAY USERS GROUP	322 S 21ST ST	HAINES CITY	33844
GA	USERS GROUP OF ATLANTA, LTD.	3408 CLAIRMONT RD, N.E.	ATLANTA	30319
GA	STATESBORO TRS-80 USERS GROUP	223 N. EDGEWOOD DRIVE	STATESBORO	30458
GA	CSRA COMPUTER CLUB	BOX 284	AUGUSTA	30903
GA	USERS GROUP OF ATLANTA, LTD.	1315 RUSTIC RIDGE DR, N.E.	ATLANTA	30319
GRC	USERS GROUP	CHRISSTOMOU SMYRNI 30	NEO PSYHIKO	
HOL	TRS-80 GEBRUIKERS VERENIGING BENELUX	EIZENLAAN 8, 1214 KL	HILVERSUM	
IA	TRS-80 USER GROUP	1400 EAST POST B	MARION	
IA	MARSHALLTOWN COMPUTER CLUB	1101 SOUTH 2ND AVE	MARSHALLTOWN	50158
IA	DES MOINES USERS GROUP (DM-TUG)	#303 4215 GRAND AVE	DES MOINES	50312
IL	COMPUTER RENTAL SERVICE	RR BOX 1138	CRETE	60417
IL	PEORIA AREA COMPUTER CLUB	2019 NORTH IDAHO	PEORIA	61604
IL	CHICAGO TRS-80 USERS GROUP	3950 N.LAKE SHORE DRIVE	CHICAGO	60613
IL	QUAD CITY COMPUTER CLUB	4211 1/2 7TH AVE.	ROCK ISLAND	61201
IL	CHICAGO AREA COMPUTER HOBBYIST EXCH	BOX 52	SOUTH HOLLAND	60473
IL	ONE ON ONE	948 PROSPECT AVENUE	ELMHURST	60126
IN	INDIANAPOLIS TRS-80 USERS GROUP	2203 CORD ST.	SPEEDWAY	46224
IN	GROUP OFF SOUTHWEST INDIANA	BOX 3284	EVANSVILLE	47732
KS	COMPUTER NETWORK OF KANSAS CITY	7631 BROADMOOR LANE	OVERLAND	66204
KS	KBUG	BOX 1398	WICHITA	67201
KS	GREATER KANSAS CITY USERS GROUP	8909 WENONGA	LEAWOOD	62206
KY	TRS-80 USERS CLUB		LOUISVILLE	
LA	CRESCENT CITY COMPUTER CLUB	PO BOX 1097, U. OF NEW ORLEAN	NEW ORLEANS	70122
MA	SMALL BUSINESS SYSTEMS GROUP (SBSG)	6 CARLISLE ROAD	WESTFORD	01886
MA	TRUGEM	61 LAKE SHORE RD	NATICK	01760
MA	NEW ENGLAND SYSTEM/3, INC.	PO BOX 1275	LOWELL	01853
MA	NATIONAL COMPUTER SHOWS	BOX 678	BROOKLINE VILLAGE	02147
MA	BOSTON COMPUTER SOCIETY	17 CHESTNUT ST	BOSTON	02108
MA	PRIME COMPUTER, INC.	40 WALNUT ST.	WELLESLEY	02181
MA	GOSUB TRS80 USERS GROUP	PO BOX 712	WORCESTER	01613
MA	WESTERN MASS COMPUTER CLUB	134 BRECKWOOD CIR.	SPRINGFIELD	01119
MA	ALCOVE COMPUTER CLUB	230 MAIN ST	NORTH READING	01824
MA	NEW ENGLAND COMPUTER SOCIETY	PO BOX 198	BEDFORD	01730
MA	CULPRIT/EDP-AUDITOR USER GROUP	20 WILLIAM ST.	WELLESLEY	02181
MA	TRS-80 NEWSLETTER	96 DOTHAN ST.	ARLINGTON	02174
MD	TRS-80 BALTIMORE USERS GROUP	3505 N. CHARLES ST.	BALTIMORE	21218
ME	AUGUSTA USERS GROUP	BOX 2143	AUGUSTA	04330
ME	SOUTHERN MAINE TRS-80 USERS GROUP	15 MOUNTAIN VIEW ROAD	CAP ELIZABETH	04107
MI	MICROCOMPUTER USERS INTERNATIONAL	1804 WEST 18TH ST	SAULTE STE. MARIE	49783
MI	CENTRAL MICHIGAN USERS GROUP	5582 CORAL WAY	HASLETT	48840
MI	CENTRAL MICHIGAN USERS GROUP	938 WILDEWOOD	EAST LANSING	48823
MI	MACUL (MICH. ASSN. FOR COMPUTER USERS)	C/O WCISD 33500 VAN BORN ROA	WAYNE	48184
MI	COLOR COMPUTER OWNER'S GROUP (CCOG)	P.O. BOX 1113	DEARBORN	48121
MI	EDUCATIONAL RECREATIONAL CLUB (ERCC)	PO BOX 325	OWOSSO	48867
MI	MID-MICHIGAN COMPUTER CLUB	15151 RIPPLE DR.	LINDEN	48451
MI	SOUTHEASTERN MICHIGAN COMPUTER	BOX 9578	DETROIT	48202
MI	MACUL (MICH ASSOC COMP USERS/LEARNING)	33500 VAN BORN RD	WAYNE	48184
MI	HAMUG	HOPE COLLEGE	HOLLAND	49423
MI	FARGO-MOORHEAD COMPUTER CLUB	111 SO MAIN ST.	DILWORTH	56529
MN	MINNESOTA COMPUTER SOCIETY	BOX 35317	MINNEAPOLIS	55435
MO	ST. LOUIS AREA COMPUTER CLUB	PO BOX 28924	ST. LOUIS	63132
MS	OXFORD 2-80 USERS GROUP	PO BOX 847	UNIVERSITY	38677
NC	NATIONAL COMPUTER SOCIETY	PO BOX 41205	FAYETTEVILLE	28304
NC	USERS NOTES	7554 SOUTHGATE RD.	FAYETTEVILLE	28304
NH	NORTHERN NEW ENGLAND SOCIETY	PO BOX 69	BERLIN	03570
NH	GOSUB USERS GROUP	346 S. TAYLOR ST.	MANCHESTER	03103
NJ	AMATEUR COMPUTER CLUB OF NJ	UCTI 1776 RARITAN RD	SCOTCH PLAINS	07076
NJ	TRS-80 USERS GROUP OF CHERRY HILL, NJ	2742 VIRGINIA TRAILS	BROWNS MILLS	08015
NJ	NORTHERN NJ AMATUER COMPUTER CLUB	6 BRYSON ROAD	FAIR LAWN	07410
NJ	BASIC FOUR USER GROUP, MID-ATLANTIC	PO BOX 2214	CLIFTON	07015
NJ	CENTRAL JERSEY COMPUTER CLUB	RD #1, BOX 147	HOPEWELL	08525
NM	LLANO ESTACADA COMPUTER CLUB	1509 FAIRWAY TERRACE	CLOVIS	88101
NM	APPRAISER'S TRS-80 CLUB	1215 FRUIT, NW	ALBUQUERQUE	87102
NV	NORTHERN NEVADA AMATUER COMPUTER CLUB	PO BOX 9068	RENO	89507
NY	TRS-80 COLOR COMPUTER CLUB	347 WEST 48TH ST.	NEW YORK	10036
NY	ZWEIBRUECKEN MICROCOMPUTER USERS GROUP	TAMMC ARMT DIV.	APO NEW YORK	09052
NY	TRS-80 USERS GROUP	245 MAPLEVIEW RD	CHEEKTOWAGA	14225
NY	METRO TRS-80 USERS GROUP	310 WEST 106 ST - 15D	NEW YORK	10025
NY	KINGS BYTE TRS-80 USERS GROUP	1063 EAST 84 ST.	BROOKLYN	11236
NY	USERS GROUP (DIVISION OF C.H.I.P.S.)	407 N. 6TH ST.	FULTON	
NY	TRS-80 SPECIAL INTEREST GROUP	RD 2	BLOSSVALE	13308
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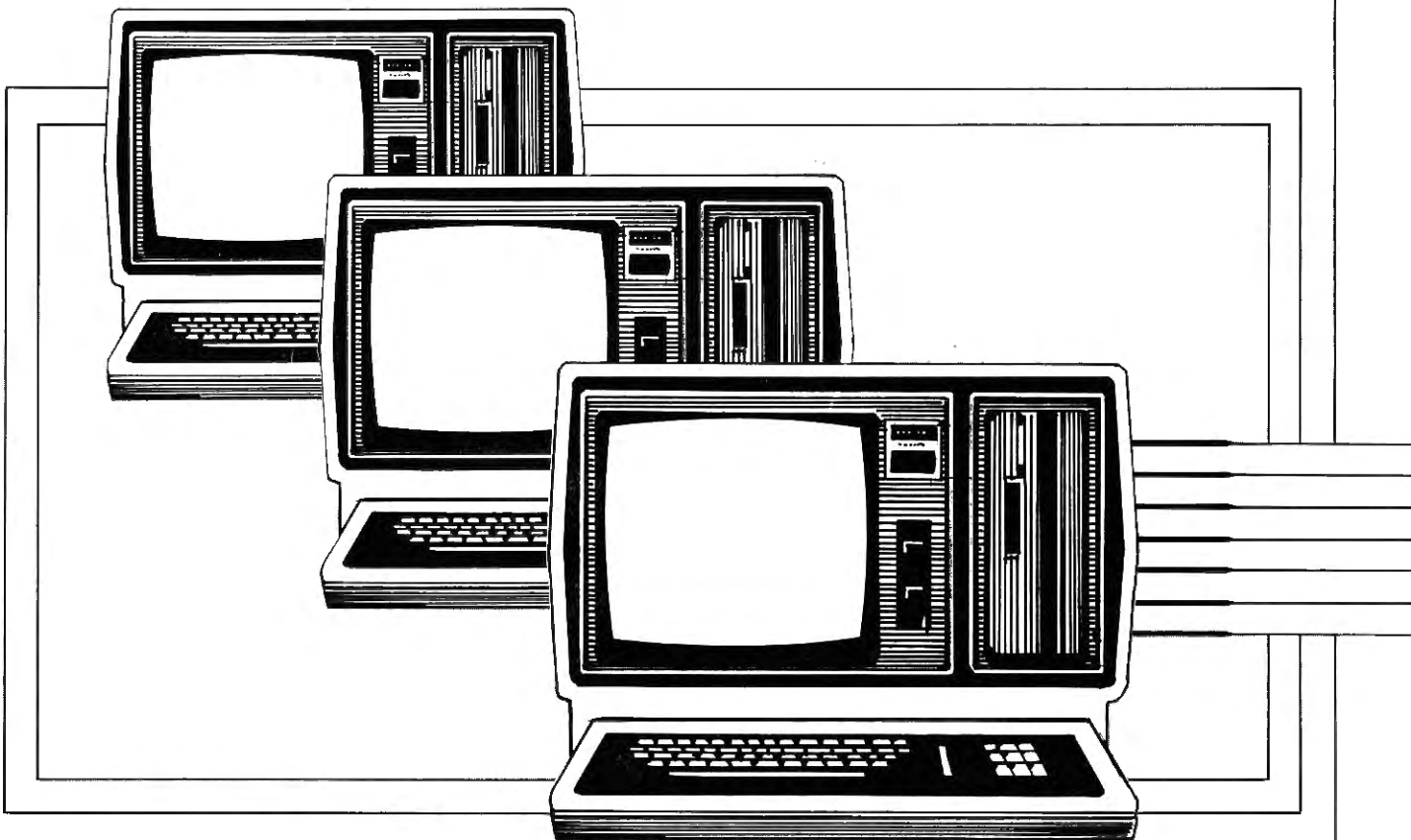
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Part IV.

MODEL II



The Art of Encoding and Decoding

by Karl Andreassen

Use your computer to translate your messages into an indecipherable mess; then, with this program, you can translate them back again.

The work of encrypting and analyzing encrypted messages is drudgery, even though the results are fascinating and the challenge of a cipher message too intriguing to pass up. This drudgery was recognized centuries ago, and machines were invented to create and decode messages.

The art and craft of cryptanalysis has been neglected because many assumed that ciphers were impossible to break.

It wasn't until World War I that cryptology came into its own, and an agency of the War Department was formed specifically for making and breaking codes.

While computers have increased the demand for cryptanalysts, they have relieved the cryptographer of the drudgery of cracking an encrypted message for which he has no key. The computer doesn't do all the work; the cryptanalyst is freed from the trial and error, pencil and paper work formerly required.

Stripped of drudgery by the computer, cryptanalysis becomes a fascinating challenge and a great mind developer. But one thing the computer cannot do: It cannot replace human ingenuity and the all-important hunch. Deductive and inductive reasoning alone are insufficient; the cryptanalyst becomes almost prescient at times.

The Program

This Model II program, Quick Crypto, encodes and decodes messages, using a simple substitution cipher. Line 80 produces a standard A, B, C...Z alphabet, and line 90 produces its inversion. Line 150 produces the cipher encoding key, while line 140 reads the decoding key into A\$. By adding lines and increasing the program's complexity, the program could have produced the decoding key.

The cipher alphabet is a double al-

phabet with the reversed alphabet interspersed between every other letter of the straight alphabet. This may be somewhat complicated to those new to cryptology, but it is one of the most elemental cipher alphabets.

To keep the program within bounds, the encoding must be uppercase and without numerals or punctuation. Most cipher messages are sent and received in this form since punctuation would assist the cryptanalyst in cracking the code. Substituted letters are formed into five-letter code groups, this being the average number of random letters that can be easily keyed into the decoding machine.

As you enter the plaintext (the original message for encoding), the computer screens the message exactly as received from the keyboard. If the message exceeds 500 letters, the program jumps to line 420 and screens the coded text directly beneath the plaintext version. If the message is less than 500 letters, pressing uppercase 8 or * accomplishes the same result. Then the option to printout appears. The printout is the enciphered message only, ready for mailing.

If your addressee is privy to this program, it is simple to decode the message. The menu selection EN or DE engages line 250 if you enter DE. Again, you can use the spacebar, but no punctuation or numerals (an error will result if you do). Backing up and striking over also produces an error; if you make a mistake in entering the message, just keep on going or rerun the program.

As in entering plaintext, when the cipher entry is complete, press * and

A\$()	Straight alphabet
B\$()	Inverted alphabet
C\$()	Accumulate ciphertext
A\$	Decode key
B\$	Encode key
CS	Encode/Decode switch
D\$	Hardcopy/Quit switch
E\$	Transient variable
Z\$	Keyboard string
I	Keyboard count

Table 1

TZGNY	ZQXQI	XFZJV	GWJSY	STHPJ	XIZAP	QXDZK
XAXXG	FSQJA	XYZPQ	XTZGN	QJZJX	QQPHH	SIJJD
XIPFX	JDZJX	FXYJI	STZWG	XJVYV	THPFQ	XQZIX
GSJHI	SHXIJ	NYJDU				

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Figure 1

The Key Box

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the decoded version appears on screen in solid lines without spaces. Punctuation and spaces are almost as great a bounty for a cryptanalyst as having the original cipher key handed to him.

The printout option appears, and the solid lines are repeated on the printer. Punctuation is easy to edit into

the completed plaintext, if this is a message shared with others unfamiliar with crypto procedures.

If you and your addressee have access to modems, you can encrypt your outgoing messages and decipher your incoming messages directly, without going through the printout stage.

Upcoming 80 Micro issues will carry a series on cryptology and cryptanalysis, with programs to assist in decoding with an unknown cipher. ■

Karl Andreassen can be reached at 24750 Chianti Road, Cloverdale, CA 95425.

Program Listing

```

10 CLS
20 PRINTTAB(30)"BASIC CRYPTO PROGRAM"
30 PRINTTAB(31)"by Karl Andreassen"
40 '==Copyright July 3 1982
50 CLEAR 7500 :I=1
60 DIM A$(26),B$(27),C$(500),D(26)
70 FOR X=1 TO 26
80 A$(X)=CHR$(X+64)
90 B$(X)=CHR$(91-X)
100 NEXT X
110 DATA B,D,F,H,J,L,N,P,R,T,V,X,Z
120 DATA Y,W,U,S,Q,O,M,K,I,G,E,C,A
130 FOR X=1 TO 26
140 READ F$ :A$=A$+F$
150 B$=B$+B$(X)+A$(X)
160 NEXT X :PRINT
170 PRINT "TO WRITE A MESSAGE IN
    CIPHER, ENTER < EN >"
180 LINEINPUT " TO DECODE A CIPHER
    MESSAGE, ENTER < DE > ";C$
190 IF C$="EN" THEN 210
200 IF C$="DE" THEN 250ELSE 170
210 PRINT :PRINTTAB(15) "Write message
    in plain language, using spacebar
220 PRINTTAB(15) "between words. No
    punctuation or numbers permitted."
230 PRINTTAB(15) "UPPERCASE letters
    only. Touch < * > at end of
    message."
240 PRINT :PRINT "BEGIN:" :PRINT :GOTO
    310
250 PRINT :PRINT "Enter cipher message
    exactly as received, using
260 PRINT "space bar but no
    punctuation. Do not try to correct
270 PRINT "errors as this will
    introduce additional errors."
280 PRINT "Touch < * > at end of
    message to initiate decode function."
290 PRINT :PRINTTAB(20) "UPPERCASE
    LETTERS ONLY!" :PRINT
300 PRINT "BEGIN:"
310 Z$=INKEY$ :IF Z$="" THEN 310
320 IF Z$="*" THEN 420
330 PRINT Z$;
340 IF Z$=" " THEN 310
350 IF ASC(Z$)=13 THEN 310
360 D=ASC(Z$)-64
370 IF C$="DE" THEN C$(I)=MID$(A$,D,1)
380 IF C$="EN" THEN C$(I)=MID$(B$,D,1)
390 I=I+1
400 IF I>500 THEN 420
410 GOTO 310
420 PRINT :PRINT :FOR X=1 TO I-1
430 PRINT C$(X);
440 IF C$="DE" THEN 460
450 IF RIGHT$(STR$(X),1)="0" OR
    RIGHT$(STR$(X),1)="5" THEN PRINT " ";
460 NEXT X
470 E$=RIGHT$(STR$(I-1),1)
480 IF E$="1" OR E$="6" THEN 560
490 IF E$="2" OR E$="7" THEN 550
500 IF E$="3" OR E$="8" THEN 540
510 IF E$="4" OR E$="9" THEN 530
520 GOTO 580
530 FOR X=1 TO 1 :GOTO 570
540 FOR X=1 TO 2 :GOTO 570
550 FOR X=1 TO 3 :GOTO 570
560 FOR X=1 TO 4 :GOTO 570
570 PRINT CHR$(RND(26)+64); : NEXT X
    :PRINT :PRINT
580 PRINT :PRINT "ENTER <HC> FOR HARD
    COPY PRINTOUT"
590 LINEINPUT " <QT> TO QUIT ";D$
600 IF D$="HC" THEN 620
610 END
620 LPRINT :FOR X=1 TO I-1
630 LPRINT C$(X);
640 IF C$="DE" THEN 660
650 IF RIGHT$(STR$(X),1)="0" OR
    RIGHT$(STR$(X),1)="5" THEN
    LPRINT " ";
660 NEXT X
670 IF E$="1" OR E$="6" THEN 750
680 IF E$="2" OR E$="7" THEN 740
690 IF E$="3" OR E$="8" THEN 730
700 IF E$="4" OR E$="9" THEN 720
710 LPRINT :END
720 FOR X=1 TO 1 :GOTO 760
730 FOR X=1 TO 2 :GOTO 760
740 FOR X=1 TO 3 :GOTO 760
750 FOR X=1 TO 4 :GOTO 760
760 LPRINT CHR$(RND(26)+64); : NEXT X
    :LPRINT :LPRINT
770 END

```

BRKSEL

by Jim Barbarello

What could be worse than accidentally pressing the break key when running a Basic program on your Model II? Disable break using Debug.

Model II owners know that inadvertently pressing the break key halts any Basic program. Any further keyboard input can modify the program currently in the machine by deleting lines or changing variable values. Other undesirable results, such as data files stuck in the open mode, portions of the disk directory damaged, and the boot tracks on the disk damaged, are also possible.

I have a simple remedy for the break-key problem. My short machine-language program, BRKSEL, allows you to enable or disable the break key as simply as turning your living room lamp on and off. BRKSEL can be used in any Basic program.

Creating BRKSEL

Creating the BRKSEL program requires two steps. You must enter the BRKSEL program into the computer's memory, and transfer that program from memory to a disk file that you can use. These two steps are accomplished with another machine-language program (Debug) already part of the TRSDOS 2.0a operating system. Debug lets you view and change the contents of a large portion of the computer's memory. It also allows you to permanently copy some portion of the memory to a disk file. To make the procedure as simple as possible, we'll break it into steps.

- Start with the computer off. If it is not off, end any program, remove all disks, and turn the power off.
- Use any System disk (one that allows you to start up the machine) that doesn't automatically run a program

after startup. Turn on the machine, entering the date and time responses as normal.

- Once in the TRSDOS ready mode, proceed to the next step.
- Type Debug On and press enter. Then type Debug and press enter. The screen will look like Fig. 1.
- Press the M key (to examine/change Memory). Next to the question-mark prompt will be MA = . . . Type EFDA (do not press enter). The screen will look like Fig. 2.
- Press the F1 key. The cursor will move to the first displayed number on the EFDA line. Type in the following 38 characters exactly (do *not* press enter or the spacebar. Make sure the caps key is lit):

```
7EFE0020072100003E03CFC92169603E03CFC9
```

- Review the screen. If any character is incorrect, use the right and left-arrow keys to position the cursor over the incorrect character. Then type the correct character. (In this string the 0s are the number zero, *not* the letter O.) When all characters are correct, press the keyboard's F2 key (this places the characters into the machine's memory). See Fig. 3.
- Now press the O (not zero) key (this turns Debug off). The characters now stored in memory can be transferred to a disk file. The last message you see will be TRSDOS ready.
- Now type the following:

```
DUMP BRKSEL{START=EFDA, END=
EFFF}
```

Check what you have typed. If it is not correct, use the backspace key to return the cursor to the offending position and retype the correct characters. When everything is correct, press enter. The disk drive will start, and after some time, you will again see TRSDOS ready. Type DIR and press enter. Your directory has a new entry entitled BRKSEL.

Using BRKSEL

BRKSEL can only be used by Basic programs or in the Basic command mode. The first line of your Basic program must include the following: CLEAR xxxxxx,61401:SYSTEM 'LOAD BRKSEL':DEFUSR = &HEFDA, where xxxxxx is any number less than 32000, and is the amount of storage space you wish to reserve (if not specified, Basic performs an automatic CLEAR 50).

To disable the break key, you must perform a USR(0) anywhere in the program, or in the Basic command mode with a command such as X = USR(0) or BRKOFF = USR(0). The variable to the left of the equal sign must not be a string or contain any reserved words (such as For or On).

To enable (or re-enable) the break key, use the command USR(x), where x is any number between 1 and 255.

A Test Program

When in the Basic mode, type in the Program Listing.

List the program to make sure it's in memory, and run it. Follow the instructions and note that the break key has no effect when it has been disabled by the program, and then causes the program to end after it has been re-enabled.

When the program has ended, you are in the Basic command mode. Press the break key and note that it is functioning (you will see AC each time you

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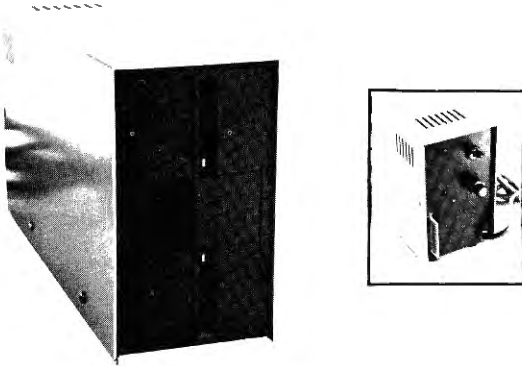
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press it). Now type X=USR(0) and press enter—the break key has no effect. Type X=USR(255) and press enter—the break key again performs normally. You can now use BRKSEL or transfer it to any of your other disks using the TRSDOS command Move. (See pages 120-121 of your TRSDOS 2.0a reference manual for further information on the Move command.)

Some BRKSEL Pointers

In BRKSEL's most simple application, execute a USR(0) immediately after the DEFUSR statement. At the end of the program, execute a USR(1) to re-enable the break key.

However, at some time you might not want the break key disabled. Say your program included a routine for disk access. You might wish to enable

```

10 CLS: CLEAR 500,61401: SYSTEM "LOAD BRKSEL": DEFUSR = &HEFDA
20 PRINT "THE BREAK KEY IS NOW FUNCTIONING."
30 FOR I = 1 TO 1000: NEXT I: BRKOFF = USR(0): PRINT
40 PRINT "I HAVE DISABLED THE BREAK KEY. TRY PRESSING IT AND NOTE THAT THE PROGRAM IS NOT INTERRUPTED."
50 PRINT "WHEN YOU ARE CONVINCED, PRESS 'F1' TO CONTINUE..."
60 AS = INKEY$: IF AS = "" THEN 60 ELSE IF ASC(AS) <> 1 THEN 60
70 BRK = USR(1): PRINT
80 PRINT "THE BREAK KEY IS NOW FUNCTIONING. WHEN YOU PRESS IT THE PROGRAM WILL END."
90 AS = INKEY$: GOTO 90
  
```

Program Listing

break before entering this routine and again disable it upon exit. This would allow you to manually regain control if some problem occurred in disk access. Other subtasks, such as a mathematical iterative process that could become an endless loop (never converge), are prime

candidates for consideration.

If you get into a situation where you cannot regain control, your only recourse is to reset. Of course, this will leave any disk files stuck in the open mode. To properly close the file after restarting, follow these steps:

- Manually open the file by entering OPEN "D", 1, "file name", xx where file name is the name of the file, and xx is the record length (this is for random/direct-access files). This command will cause an AO (already open) or similar error.
- Enter "close." This should close the stuck file. You can verify this by obtaining a directory and noting that there is no question mark after the file's name. For obstinate files, you may have to perform this procedure twice.
- Make sure you modify your program to allow manual override with the break key during the portion that caused you to have to reset. ■

Jim Barbarello can be reached at R.D. #1, Box 241H, Tennent Road, Englishtown, NJ 07726.

```

TRS-80 Model II DEBUG Program
2800 C3 7F 2E 5D 44 7A 44 65 43 1D 45 50 43 08 5E 58 ... ]DzDeC.EPC.~X
2810 61 F8 3A D9 4E C8 4F B3 41 2B 4F 3C 50 42 50 CF a.:.N.O.A+OCPBP.
2820 50 E4 50 C0 61 C3 61 C6 61 33 65 86 65 99 65 A7 P.P.a.a.a3e.e.e.
2830 61 AA 61 AD 61 5D 44 91 44 BD 44 0A 45 E3 5C DB a.a.a]D.D.D.E.\.
2840 5A E0 5A E5 5A A1 5D EF 5C FF 5C 2E 5D 47 5D 77 Z.Z.Z.].\.\.]G]w
2850 5D 80 5D C5 4E 44 C6 4F 52 C3 4C 53 D2 41 4E 44 l.]ND.OR.LS.AND
2860 4F 4D CE 45 58 54 C4 41 54 41 C9 4E 50 55 54 C4 OM.EXT.ATA.NPUT.
2870 49 4D D2 45 41 44 CC 45 54 C7 4F 54 4F D2 55 4E IM.EAD.ET.O'IO.UN
PC SP SZHPNC AF BC DE HL LX IY AP' BC' DE' HL'
2800 21FE 000000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
? P
DEBUG is now ON
TRSDOS READY
DEBUG
  
```

Figure 1

```

TRS-80 Model II DEBUG Program
EFD A 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
EFEA 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
EFFA 00 00 00 00 00 00 02 FF FF FF FF FF FF FF FF .....
F00A FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF .....
F01A FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF .....
F02A FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF .....
F03A FF FF FF FF FF FF 00 00 00 00 00 00 00 00 00 .....
F04A 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
PC SP SZHPNC AF BC DE HL LX IY AP' BC' DE' HL'
2800 21FE 000000 0000 0000 0000 0000 0000 0000 0000 0000 0000
? P
  
```

Figure 2

```

TRS-80 Model II DEBUG Program
EFD A 7E FE 00 20 07 21 00 00 3E 03 CF C9 21 69 60 3E ... !..>...!i>
EFEA 03 CF C9 00 00 00 00 00 00 00 00 00 00 00 00 .....
EFFA 00 00 00 00 00 00 02 FF FF FF FF FF FF FF FF .....
F00A FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF .....
F01A FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF .....
F02A FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF .....
F03A FF FF FF FF FF FF 00 00 00 00 00 00 00 00 00 .....
F04A 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
PC SP SZHPNC AF BC DE HL LX IY AP' BC' DE' HL'
2800 21FE 000000 0000 0000 0000 0000 0000 0000 0000 0000 0000
?
  
```

Figure 3

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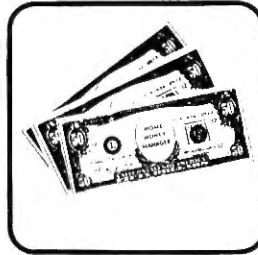
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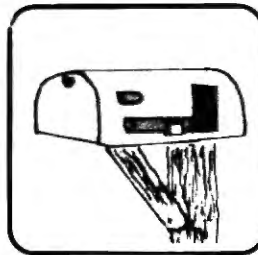


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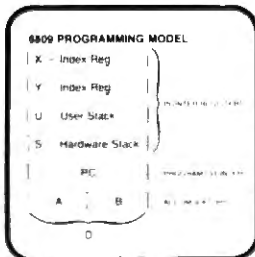


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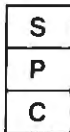
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your values go beyond these, just change the program to make the graduation larger. For example, if your top value is close to or below \$1,800, use a range between zero and \$1,800 in steps of \$100. In a graphics representation the proportional relationships between the values are important.

The remarks in the program make most of the lines self-explanatory. Lines 330-360 define the graphics characters used to draw the scale lines, the bars, and the horizontal ruler lines. Line 410 veers to the subroutine drawing the horizontal ruler lines starting at line 1750. In line 420, EL is the ending length of each bar (line 20 on the video grid); in lines 430, 490, 560, and so on,

BL is the beginning length of each bar. The statement IF D\$=Y GOTO_ appears in several lines including line 300. It reroutes the program where needed on the second trip through (if you choose to graph months for a prior year alongside those for the current year).

You cannot obtain a printout from Program Listing 1, because it uses graphics characters unknown to most printers. Use Listing 2 if you want a printout.

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Program Listing 1

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50 PRINT
60 PRINT
70 PRINT " THIS PROGRAM PROVIDES A GRAPHIC ANALYSIS OF YOUR MONTH
LY ELECTRICITY
80 PRINT" EXPENSE FOR A YEAR. ENTER A ZERO FOR ANY MONTH YOU WAN
T TO SKIP, BUT
90 PRINT" BE SURE YOU COUNT EACH ZERO WHEN ASKED FOR THE NUMBER
OF MONTHS YOU
100 PRINT" WANT GRAPHED. ROUND VALUES TO NEAREST TEN DOLLARS AND
BEGIN
110 PRINT" WITH JANUARY."
120 PRINT
130 PRINT "HOW MANY MONTHS DO YOU WANT TO GRAPH?"
140 INPUT Z
150 CLS
160 PRINT@0, "PLEASE LIST THE";Z;"VALUES TO BE GRAPHED SEPARATED
BY A COMMA."
170 ON Z GOTO 180,190,200,210,220,230,240,250,260,270,280,290
180 INPUT A:GOTO 300
190 INPUT A,B:GOTO 300
200 INPUT A,B,C:GOTO 300
210 INPUT A,B,C,D:GOTO 300
220 INPUT A,B,C,D,E:GOTO 300
230 INPUT A,B,C,D,E,F:GOTO 300
240 INPUT A,B,C,D,E,F,G:GOTO 300
250 INPUT A,B,C,D,E,F,G,H:GOTO 300
260 INPUT A,B,C,D,E,F,G,H,I:GOTO 300
270 INPUT A,B,C,D,E,F,G,H,I,J:GOTO 300
280 INPUT A,B,C,D,E,F,G,H,I,J,K:GOTO 300
290 INPUT A,B,C,D,E,F,G,H,I,J,K,L:GOTO 300
300 IF D$="Y" GOTO 1615
310 CLS
320 PRINT CHR$(02) 'TURNS OFF BLINKING CURSOR
330 A$=CHR$(61)
340 B$=CHR$(42)
350 C$=CHR$(58)
360 L$=CHR$(144)
370 X=20
380 FOR Y=12 TO 71
390 PRINT@(X,Y),A$ 'DRAWS HORIZONTAL SCALE LINE
400 NEXT Y
420 EL=19
430 BL=EL-A/10
440 IF D$="Y" GOTO 460
450 Y=13
460 FOR X=BL+1 TO EL
470 PRINT@(X,Y),B$ 'DRAWS THE FIRST VERTICAL BAR
480 NEXT X
490 BL=EL-B/10
500 IF D$="Y" GOTO 1630
510 Y=18
520 FOR X=BL+1 TO EL
530 PRINT@(X,Y),B$ 'DRAWS THE SECOND VERTICAL BAR
540 NEXT X
550 BL=EL-C/10
560 IF D$="Y" GOTO 1640
```

Listing continues

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Listing 1 continued

```

570 Y=23
580 FOR X=BL+1 TO EL
590 PRINT@(X,Y),B$ 'DRAWS THE THIRD VERTICAL BAR
600 NEXT X
610 BL=EL-D/10
620 IF D$="Y" GOTO 1650
630 Y=28
640 FOR X=BL+1 TO EL
650 PRINT@(X,Y),B$ 'DRAWS THE FOURTH VERTICAL BAR
660 NEXT X
670 BL=EL-E/10
680 IF D$="Y" GOTO 1660
690 Y=33
700 FOR X=BL+1 TO EL
710 PRINT@(X,Y),B$ 'DRAWS THE FIFTH VERTICAL BAR
720 NEXT X
730 BL=EL-F/10
740 IF D$="Y" GOTO 1670
750 Y=38
760 FOR X=BL+1 TO EL
770 PRINT@(X,Y),B$ 'DRAWS THE SIXTH VERTICAL BAR
780 NEXT X
790 BL=EL-G/10
800 IF D$="Y" GOTO 1680
810 Y=43
820 FOR X=BL+1 TO EL
830 PRINT@(X,Y),B$ 'DRAWS THE SEVENTH VERTICAL BAR
840 NEXT X
850 BL=EL-H/10
860 IF D$="Y" GOTO 1690
870 Y=48
880 FOR X=BL+1 TO EL
890 PRINT@(X,Y),B$ 'DRAWS THE EIGHTH VERTICAL BAR
900 NEXT X
910 BL=EL-I/10
920 IF D$="Y" GOTO 1700
930 Y=53
940 FOR X=BL+1 TO EL
950 PRINT@(X,Y),B$ 'DRAWS THE NINTH VERTICAL BAR
960 NEXT X
970 BL=EL-J/10
980 IF D$="Y" GOTO 1710
990 Y=58
1000 FOR X=BL+1 TO EL
1010 PRINT@(X,Y),B$ 'DRAWS THE TENTH VERTICAL BAR
1020 NEXT X
1030 BL=EL-K/10
1040 IF D$="Y" GOTO 1720
1050 Y=63
1060 FOR X=BL+1 TO EL
1070 PRINT@(X,Y),B$ 'DRAWS THE ELEVENTH VERTICAL BAR
1080 NEXT X
1090 BL=EL-L/10
1100 IF D$="Y" GOTO 1730
1110 Y=68
1120 FOR X=BL+1 TO EL
1130 PRINT@(X,Y),B$ 'DRAWS THE TWELFTH VERTICAL BAR
1140 NEXT X

1150 PRINT@1692,"JAN" 'LABELS THE HORIZONTAL SCALE LINE
1160 PRINT@1697,"FEB"
1170 PRINT@1702,"MAR"
1180 PRINT@1707,"APR"
1190 PRINT@1712,"MAY"
1200 PRINT@1717,"JUN"
1210 PRINT@1722,"JUL"
1220 PRINT@1727,"AUG"
1230 PRINT@1732,"SEP"
1240 PRINT@1737,"OCT"
1250 PRINT@1742,"NOV"
1260 PRINT@1747,"DEC"
1270 Y=72
1280 FOR X=2 TO 20
1290 PRINT@(X,Y),B$ 'DRAWS THE VERTICAL SCALE LINE
1300 NEXT X
1310 PRINT@1794,CHR$(26) " MONTH "CHR$(25)
1320 PRINT@234,"180" 'LABELS THE VERTICAL SCALE LINE
1330 PRINT@314,"170"
1340 PRINT@394,"160"
1350 PRINT@474,"150"
1360 PRINT@554,"140"
1370 PRINT@634,"130"
1380 PRINT@714,"120"
1390 PRINT@794,"110"
1400 PRINT@874,"100"
1410 PRINT@954,"90"
1420 PRINT@1034,"80"
1430 PRINT@1114,"70"
1440 PRINT@1194,"60"
1450 PRINT@1274,"50"
1460 PRINT@1354,"40"
1470 PRINT@1434,"30"
1480 PRINT@1514,"20"
1490 PRINT@1594,"10"
1500 PRINT@1674,"0"
1510 PRINT@879,"$"
1520 PRINT@50,CHR$(26) " ELECTRICITY EXPENSE "CHR$(25)
1530 IF D$="Y" GOTO 1540
1540 PRINT@0, "*BARS ON LEFT ARE FOR PRIOR YEAR*"
1550 PRINT@80, "
"
1560 IF D$="Y" GOTO 1610
1570 PRINT@0, "GRAPH SAME MONTHS FOR PRIOR YEAR? Y=YES";
1580 INPUT D$
1590 IF D$="Y" GOTO 1600 ELSE 1610
1600 PRINT@0, "PLEASE LIST THE";Z;"VALUES FOR PRIOR YEAR
":GOTO 170
1610 GOTO 1610
1620 Y=12:GOTO 430
1630 Y=17:GOTO 520
1640 Y=22:GOTO 580
1650 Y=27:GOTO 640
1660 Y=32:GOTO 700
1670 Y=37:GOTO 760
1680 Y=42:GOTO 820
1690 Y=47:GOTO 880
1700 Y=52:GOTO 940
1710 Y=57:GOTO 1000
1720 Y=62:GOTO 1060

```

Listing 1 continues

```

1730 Y=67:GOTO 1120
1740 GOTO 1610
1750 X=19      'BEGINS SUBROUTINE DRAWING HORIZONTAL RULER LINE
S
1760 FOR Y=12 TO 75
1770 PRINT@(X,Y),L$:NEXT Y
1780 X=18
1790 FOR Y=12 TO 75
1800 PRINT@(X,Y),L$:NEXT Y
1810 X=17
1820 FOR Y=12 TO 75
1830 PRINT@(X,Y),L$:NEXT Y
1840 X=16
1850 FOR Y=12 TO 75
1860 PRINT@(X,Y),L$:NEXT Y
1870 X=15
1880 FOR Y=12 TO 75
1890 PRINT@(X,Y),L$:NEXT Y
1900 X=14
1910 FOR Y=12 TO 75
1920 PRINT@(X,Y),L$:NEXT Y
1930 X=13
1940 FOR Y=12 TO 75
1950 PRINT@(X,Y),L$:NEXT Y
1960 X=12
1970 FOR Y=12 TO 75
1980 PRINT@(X,Y),L$:NEXT Y
1990 X=11
2000 FOR Y=12 TO 75
2010 PRINT@(X,Y),L$:NEXT Y
2020 X=10
2030 FOR Y=12 TO 75
2040 PRINT@(X,Y),L$:NEXT Y
2050 X=9
2060 FOR Y=12 TO 75
2070 PRINT@(X,Y),L$:NEXT Y
2080 X=8
2090 FOR Y=12 TO 75
2100 PRINT@(X,Y),L$:NEXT Y
2110 X=7
2120 FOR Y=12 TO 75
2130 PRINT@(X,Y),L$:NEXT Y
2140 X=6
2150 FOR Y=12 TO 75
2160 PRINT@(X,Y),L$:NEXT Y
2170 X=5
2180 FOR Y = 12 TO 75
2190 PRINT@(X,Y),L$:NEXT Y
2200 X=4
2210 FOR Y=12 TO 75
2220 PRINT@(X,Y),L$:NEXT Y
2230 X=3
2240 FOR Y=12 TO 75
2250 PRINT@(X,Y),L$:NEXT Y
2260 X=2
2270 FOR Y=12 TO 75
2280 PRINT@(X,Y),L$:NEXT Y
2290 RETURN

```

Program Listing 2

```

50 PRINT
60 PRINT
70 PRINT" THIS PROGRAM PROVIDES A GRAPHIC ANALYSIS OF YOUR MONTH
LY ELECTRICITY
80 PRINT" EXPENSE FOR A YEAR. ENTER A ZERO FOR ANY MONTH YOU WAN
T TO SKIP, BUT
90 PRINT" BE SURE YOU COUNT EACH ZERO WHEN ASKED FOR THE NUMBER
OF MONTHS YOU
100 PRINT" WANT GRAPHED. ROUND VALUES TO NEAREST TEN DOLLARS AND
BEGIN
110 PRINT" WITH JANUARY."
120 PRINT
130 PRINT "HOW MANY MONTHS DO YOU WANT TO GRAPH?"
140 INPUT Z
150 CLS
160 PRINT@0,"PLEASE LIST THE";Z;"VALUES TO BE GRAPHED SEPARATED
BY A COMMA."
170 ON Z GOTO 180,190,200,210,220,230,240,250,260,270,280,290
180 INPUT A:GOTO 300
190 INPUT A,B:GOTO 300
200 INPUT A,B,C:GOTO 300
210 INPUT A,B,C,D:GOTO 300
220 INPUT A,B,C,D,E:GOTO 300
230 INPUT A,B,C,D,E,F:GOTO 300
240 INPUT A,B,C,D,E,F,G:GOTO 300
250 INPUT A,B,C,D,E,F,G,H:GOTO 300
260 INPUT A,B,C,D,E,F,G,H,I:GOTO 300
270 INPUT A,B,C,D,E,F,G,H,I,J:GOTO 300
280 INPUT A,B,C,D,E,F,G,H,I,J,K:GOTO 300
290 INPUT A,B,C,D,E,F,G,H,I,J,K,L:GOTO 300
300 IF D$="Y" GOTO 1620
310 CLS
320 PRINT CHR$(02)      'TURNS OFF BLINKING CURSOR
330 A$=CHR$(152)
340 B$=CHR$(158)
350 C$=CHR$(151)
360 L$=CHR$(144)
370 X=20
380 FOR Y=12 TO 71
390 PRINT@(X,Y),A$      'DRAWS HORIZONTAL SCALE LINE
400 NEXT Y
410 GOSUB 1750
420 EL=20
430 BL=EL-A/10
440 IF D$="Y" GOTO 460
450 Y=13
460 FOR X=BL+1 TO EL
470 PRINT@(X,Y),B$      'DRAWS THE FIRST VERTICAL BAR
480 NEXT X
490 BL=EL-B/10
500 IF D$="Y" GOTO 1630
510 Y=18
520 FOR X=BL+1 TO EL
530 PRINT@(X,Y),B$      'DRAWS THE SECOND VERTICAL BAR
540 NEXT X
550 BL=EL-C/10
560 IF D$="Y" GOTO 1640

```

Listing 2 continued

```

570 Y=23
580 FOR X=BL+1 TO EL
590 PRINT@(X,Y),B$ 'DRAWS THE THIRD VERTICAL BAR
610 BL=EL-D/10
620 IF D$="Y" GOTO 1650
630 Y=28
640 FOR X=BL+1 TO EL
650 PRINT@(X,Y),B$ 'DRAWS THE FOURTH VERTICAL BAR
660 NEXT X
670 BL=EL-E/10
680 IF D$="Y" GOTO 1660
690 Y=33
700 FOR X=BL+1 TO EL
710 PRINT@(X,Y),B$ 'DRAWS THE FIFTH VERTICAL BAR
720 NEXT X
730 BL=EL-F/10
740 IF D$="Y" GOTO 1670
750 Y=38
760 FOR X=BL+1 TO EL
770 PRINT@(X,Y),B$ 'DRAWS THE SIXTH VERTICAL BAR
780 NEXT X
790 BL=EL-G/10
800 IF D$="Y" GOTO 1680
810 Y=43
820 FOR X=BL+1 TO EL
830 PRINT@(X,Y),B$ 'DRAWS THE SEVENTH VERTICAL BAR
840 NEXT X
850 BL=EL-H/10
860 IF D$="Y" GOTO 1690
870 Y=48
880 FOR X=BL+1 TO EL
890 PRINT@(X,Y),B$ 'DRAWS THE EIGHTH VERTICAL BAR
900 NEXT X
910 BL=EL-I/10
920 IF D$="Y" GOTO 1700
930 Y=53
940 FOR X=BL+1 TO EL
950 PRINT@(X,Y),B$ 'DRAWS THE NINTH VERTICAL BAR
960 NEXT X
970 BL=EL-J/10
980 IF D$="Y" GOTO 1710
990 Y=58
1000 FOR X=BL+1 TO EL
1010 PRINT@(X,Y),B$ 'DRAWS THE TENTH VERTICAL BAR
1020 NEXT X
1030 BL=EL-K/10
1040 IF D$="Y" GOTO 1720
1050 Y=63
1060 FOR X=BL+1 TO EL
1070 PRINT@(X,Y),B$ 'DRAWS THE ELEVENTH VERTICAL BAR
1080 NEXT X
1090 BL=EL-L/10
1100 IF D$="Y" GOTO 1730
1110 Y=68
1120 FOR X=BL+1 TO EL
1130 PRINT@(X,Y),B$ 'DRAWS THE TWELFTH VERTICAL BAR
1140 NEXT X

```

```

1150 PRINT@1692,"JAN" 'LABELS THE HORIZONTAL SCALE LINE
1160 PRINT@1697,"FEB"
1170 PRINT@1702,"MAR"
1180 PRINT@1707,"APR"
1190 PRINT@1712,"MAY"
1200 PRINT@1717,"JUN"
1210 PRINT@1722,"JUL"
1220 PRINT@1727,"AUG"
1230 PRINT@1732,"SEP"
1240 PRINT@1737,"OCT"
1250 PRINT@1742,"NOV"
1260 PRINT@1747,"DEC"
1270 Y=72
1280 FOR X=2 TO 20
1290 PRINT@(X,Y),C$ 'DRAWS THE VERTICAL SCALE LINE
1300 NEXT X
1302 Y=11
1304 FOR X=2 TO 20
1306 PRINT@(X,Y),C$
1308 NEXT X
1310 PRINT@1794,CHR$(26)" MONTH "CHR$(25)
1320 PRINT@234,"180":PRINT@168,"180" 'LABELS VERTICAL SCALE L
INES
1330 PRINT@314,"170":PRINT@248,"170"
1340 PRINT@394,"160":PRINT@328,"160"
1350 PRINT@474,"150":PRINT@408,"150"
1360 PRINT@554,"140":PRINT@488,"140"
1370 PRINT@634,"130":PRINT@568,"130"
1380 PRINT@714,"120":PRINT@648,"120"
1390 PRINT@794,"110":PRINT@728,"110"
1400 PRINT@874,"100":PRINT@808,"100"
1410 PRINT@954,"90":PRINT@889,"90"
1420 PRINT@1034,"80":PRINT@969,"80"
1430 PRINT@1114,"70":PRINT@1049,"70"
1440 PRINT@1194,"60":PRINT@1129,"60"
1450 PRINT@1274,"50":PRINT@1209,"50"
1460 PRINT@1354,"40":PRINT@1289,"40"
1470 PRINT@1434,"30":PRINT@1369,"30"
1480 PRINT@1514,"20":PRINT@1449,"20"
1490 PRINT@1594,"10":PRINT@1529,"10"
1500 PRINT@1674,"0":PRINT@1609,"0"
1510 PRINT@878,"$":PRINT@806,"$"
1520 PRINT@50,CHR$(26)" ELECTRICITY EXPENSE "CHR$(25)
1530 IF D$="Y" GOTO 1540 ELSE 1570
1540 PRINT@0, " *BARS ON LEFT ARE FOR PRIOR YEAR* "
1550 PRINT@80, "
"
1555 IF E$="Y" GOTO 1870
1560 IF D$="Y" GOTO 1840
1570 PRINT@0, "GRAPH SAME MONTHS FOR PRIOR YEAR?";
1575 PRINT@80, "CHOOSE ONE: Y=YES; N=NO";
1580 INPUT D$
1585 PRINT@80, " "
1590 IF D$="Y" GOTO 1600
1592 PRINT@0, " "
1594 GOTO 1840
1600 PRINT@0, "PLEASE LIST THE";Z;"VALUES FOR PRIOR YEAR
":GOTO 170

```

Listing 2 continues

Lastine, J. continued

```

1610 GOTO 1610
1615 BS=CHR$(35)
1620 Y=12:GOTO 430
1630 Y=17:GOTO 520
1640 Y=22:GOTO 580
1650 Y=27:GOTO 640
1660 Y=32:GOTO 700
1670 Y=37:GOTO 760
1680 Y=42:GOTO 820
1690 Y=47:GOTO 880
1700 Y=52:GOTO 940
1710 Y=57:GOTO 1000
1720 Y=62:GOTO 1060
1730 Y=67:GOTO 1120
1740 GOTO 1610
1840 PRINT@80, "DO YOU WANT A PRINTOUT? Y=YES";
1850 INPUT E$
1860 IF E$="Y" GOTO 1870 ELSE 1610
1870 PRINT@80, "PRINTER READY? Y=YES"
1880 INPUT F$
1890 IF F$="Y" GOTO 1910 ELSE 1900
1900 PRINT@160, " ":GOTO 1840
1910 PRINT@80, " "
1920 PRINT@160, " "
1930 SYSTEM "SCREEN"
1940 GOTO 1690

```

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Mod II Disk Index

by Charles R. Perelman

Do you find it hard to keep track of all your disk files, and even harder to read the directories? This disk index utility is for you!

When was the last time you shuffled through your disks or card index to find a program for your Model II and muttered that there must be a better way? Here's a disk index utility that reads

each disk and keeps track of your programs.

A few commands used are unique to Model II Basic, but can be readily translated into other TRS-80 dialects. Ma-

chine-language USR routines are included that take advantage of Model II supervisory calls; the program also uses a machine-language sort and PEEK in a USR routine. You do not need to know anything about machine language to use the program.

Simply put the program disk in drive 0 and insert each disk to be indexed in your second disk drive. The computer reads the directory and processes the information.

You must give your disks identifying numbers. For easy handling, I put sequential self-adhesive numbers purchased at a stationery store on each disk.

Main menu options permit you to create a new index, update, add a disk, delete a disk, list the index alphabetically or in disk sequence, list the contents of a specific disk, list all disks on which a particular program can be found, or save the revised index to disk.

The basic organizational structure and the vertical raster routine were borrowed from "Lost and Found," a directory program for the Model III by

Program Listing

```

0 *****
10 'DIRECTORY PROGRAM FOR TRS-80 MODEL II
20 'ADAPTED FROM PROGRAM BY ATHANASIOU 80 MICRO, JUNE 82
30 'BY CHARLES R. PERLEMAN, A PROFESSIONAL CORPORATION
40 '9777 WILSHIRE BLVD., BEVERLY HILLS, CA. 90212
50 'PROGRAM FILE NAME 'DIRECTRY/MII'
100 *****
110 'SET PARAMETERS
120 CLEAR 20000,62270
130 DEFINT A,J-M,U-Y
140 DEFSTR F,P,D,C
150 DIM PMS(600),DPS(600),U1(23),A(96),U5(93)
160 DIM X,Y,XX,J,I:J=0:V9=0
170 S$(1)=" TO RESTART TYPE: 'BASIC DIRECTRY/MII -F:1' AND PR
ESS <ENTER>.";S$(2)="*** WORKING...PLEASE WAIT ***";S$(3)="PRESS
ENTER TO CONTINUE";S$(4)="PRESS <M> FOR MENU"
200 *****
210 'IMPLEMENT PEEK AND SET UP REGISTERS FOR USR ROUTINES
220 FOR X=0 TO 23:READ U1(X):NEXT
230 V=0:DEFUSR=VARPTR(U1(0)):V=USR(0)
240 U2(0)=15872:U2(2)=8448:U2(6)=256:U2(8)=-13873
250 FOR X=0 TO 93:READ U5(X):NEXT
260 ON ERROR GOTO 11020
300 *****
310 'FILES TO BE OPENED FOR MODEL II
320 CLS:PRINT"MODEL II REQUIRES THAT FILES BE OPENED WHEN ENTERI
NG BASIC.":PRINT"IF YOU NEGLECTED TO DO THIS, PRESS <BREAK>, ENT
ER 'SYSTEM' TO":PRINT"RETURN TO TRSDOS.":PRINT S$(1):PRINT:PRINT

```

Listing continues

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Robert and William Athanasiou (*80 Micro*, June/July 1982, page 288). If you are using that program, you can enhance it, yet reduce the size of many of the program routines by adapting my coding. I have substituted INKEY\$ routines for most of the Input entries, eliminated duplication, and made other structural changes.

Construction of the program is modular. Each section performs a separate function. You can easily debug each part, make changes to it, or use a module in other programs. The remark lines are not referenced in the program and you can delete them in your final work copy to increase available memory. You can remove spaces for further compression.

The dividing remark lines are numbered with even thousands. Descriptive lines end with the digits 10. All program lines are divisible by 10.

Program Overview

The entire directory of the disk in drive 1 is read by a machine-language USR routine. The computer extracts the name of each program and adds the disk identification number for indexing. Except for creation of a new index, your prior index is read automatically from disk before the program proceeds. To update a disk, delete the prior disk information, then read the present directory into the index.

As you review the contents of the index, the headings do not scroll off the screen, but remain in place. Up to 80 entries are on screen at one time. You can page back and forth from the beginning to the end of your index. The entire index may be printed in alphabetical or disk number sequence.

There are no page breaks in the printer routine. You can either stop the printer with the hold key to load another sheet of paper or use continuous roll

or fanfold. The format for printing is 80 characters wide so that you can use standard 8 1/2-inch paper.

A flashing error message alerts you if there is no prior index without terminating the program. If you request a printout without turning on the printer, an error message prompts you so you can try again. At the beginning of the program, you are reminded to open a file as required by Model II TRSDOS. Should you forget to do this, you will be unable to save a revised index to disk. If you try to access a disk file without having opened a file, you will be returned to TRSDOS to start again.

Detailed Tutorial

The program contains multiple Basic statements on a single line separated by colons. This runs faster than individual lines. The If...Then...Else format reduces the number of lines.

- Line 120 clears the maximum space to speed program operation. Memory above 62270 is reserved for the disk-read USR routine.

- Line 130 defines numerical variables as integers, reducing processing time and memory usage.

- Line 150 provides variable space for 600 programs. This is more than sufficient for my needs since many of my programs are CP/M format.

- Line 170 avoids retyping repeated statements by defining them as strings.

- In line 220, hexadecimal coding reads from the data statement at the end of the program for the PEEK function.

- Line 230's USR routine implements the hexadecimal code to replace OCT\$ in Basic with PEEK, only for this program.

- Line 240 has the coding for USR routines to prepare registers, and is used with supervisory calls to read the disk directories and stop the screen from scrolling.

- Line 250 reads a machine-language sort into an array for later call by the USR routine.

- Line 260 initializes an error trap. Any error sends the program to line 11020. When you are typing in the program, disable this line. Put a remark at the beginning. The built-in TRSDOS error routines are then available to you in debugging. After the program is completely debugged, remove the remark.

- Line 320 reminds you that files must be opened with the Model II when you bring Basic into memory.

- Line 330 pauses, holding information on the screen until any key is pressed.

- Line 530 names the index file produced DSKINDEX. The program recognizes only capital letters. Pressing the letter M returns you to the main menu from various points not always specifically prompted.

- Line 620 provides error traps that cause a flashing message if your choice is beyond the limits given, or is not a whole number.

- Line 630 sets flag V2 to 1, if your choice is between 1 and 4. Later, this flag reminds you that you must save the file to disk to retain index changes.

- In line 640, a K value from 1 to 8 directs the computer to the appropriate program section.

- In line 1020, after a subroutine to obtain the disk identification number, each program is checked for a match. An error message flashes if the ID number is already used in the index.

- Line 1030 instructs you to insert the disk to be read and to press enter.

- In line 1040, if you press M instead of enter, the program aborts to the main menu. Otherwise, a message is printed on the screen while the disk directory is read and processed.

- Line 1050 lets you process another disk, save the file, or return to the menu by pressing a single key. The semicolon keeps the cursor immediately after the prompt rather than moving it to the next line. INSTR directs the program to the first line number after the GOTO if M is pressed, the second for D, the third for S. An error message flashes and you get another choice if the character pressed is not listed. This same type of coding is repeated several times in the program.

- In line 2020, if you have not read a disk into memory to begin a new index or recalled the prior index, DSKINDEX is read to memory from disk.

- Line 3040 compares disk numbers for all programs to the disk number you want to delete or list. The index number for each matching program is put into

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Listing continued

```
SS(3);
330 IF INKEY$="" THEN 330
500 '*****
510 'MAIN MENU
520 CLS:PRINT@165,"*** INDEX FOR MODEL II ***":PRINT
530 PRINT,"1. MAKE NEW INDEX":PRINT,"2. ADD DISK TO INDEX":PRI
NT,"3. UPDATE DISK IN INDEX":PRINT,"4. DELETE DISK FROM INDEX"
:PRINT,"5. LIST ALPHABETICALLY OR BY DISK NUMBER.":PRINT,"6. F
IND PROGRAM OR LIST A DISK."
540 PRINT,"7. SAVE INDEX AS 'DSKINDEX'":PRINT,"8. END PROGRAM"
:PRINT:PRINT"      NOTE: USE CAPITAL LETTERS ONLY. PRESS <CAPS
> IF NECESSARY.":PRINTTAB(13)"WHEN CHOICE IS REQUESTED AT ANY ST
AGL Or PROGRAM.":PRINTTAB(13) SS(4)
550 PRINT:PRINT"  PRESS NUMBER DESIRED";
600 '*****
610 'INKEY INPUT FOR CHOICES
620 GOSUB 10020:K=VAL(C$):IF K<1 OR K>8 OR K<>INT(K) THEN M=1:GO
SUB 10120:GOTO 520
630 IF K<5 THEN V2=1
640 CLS:ON K GOTO 1020,2020,3020,3020,5020,6020,7020,8020
1000 '*****
1010 'PRODUCE NEW INDEX
1020 GOSUB 10320:FOR X=1 TO XX:IF DNS=LEFT$(DP$(X),2) THEN M=7:G
OSUB 10120:GOTO 520 ELSE NEXT
1030 PRINT:PRINT"INSERT DISK ";DNS;" IN DRIVE 1":PRINT:PRINT SS(
3);:GOSUB 10020
1040 IF C$="M" THEN 520 ELSE CLS:PRINT@658,SS(2);:DZ$=DNS:IF K>1
THEN DZ$=DP$(1)
1050 GOSUB 10420:V3=1:IF K>1 THEN DP$(1)=DZ$
1060 CLS:C$="":PRINT:PRINT SS(4);" <D> TO INDEX ANOTHER DISK OR
<S> TO SAVE FILE.":GOSUB 10020:ON INSTR("MDS",C$)GOTO 520,1020,
7020:M=2:GOSUB 10120:CLS:GOTO 1060
2000 '*****
2010 'ADD NEW DISK #
2020 IF V3=0 THEN GOSUB 10920
2030 GOTO 1020
3000 '*****
3010 'DELETE FILE
3020 IF V3=0 THEN GOSUB 10920
```

Listing continues

the A array.

● Lines 3050-3080 sort the array and list programs in alphabetical order in horizontal sequence. The comma in 3080 causes a tab after each program name for a five-column listing. If no program matches the input disk number, an error message flashes.

● In line 3090, the same routine is used for deleting, updating, or listing the programs on a disk. K, the number of your original choice from the menu, directs the computer to the proper continuation routine.

● In lines 5030-5060, flag V4 signals an alphabetical or disk number. For alphabetical sorting, the disk number is changed from the first two characters to the last two characters of the string. Alphabetical listing, therefore, takes longer than by disk number.

● Line 5120 selects the proper heading for listing on the screen, based on the V4 flag.

● Line 5130's USR 3 calls supervisory routine 27, preventing the top two header lines from scrolling.

● Lines 5140-5150 list the index on the screen after it is processed by the vertical raster subroutine.

● In lines 5160-5200, W4 starts a new line after each four entries. The pro-

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```

3030 GOSUB 10320:PRINT:PRINT S$(2);
3040 U=1:FOR X=1 TO XX:IF LEFT$(DP$(X),2)=DN$ THEN A(U)=X:U=U+1
3050 NEXT:IF U=1 THEN M=8:GOSUB 10120:GOTO 3030
3060 GOSUB 10530
3070 CLS:PRINT:PRINT"PROGRAMS ON DISK ";DN$;":":PRINT
3080 FOR X=1 TO U-1:PRINT RIGHT$(DP$(A(X)),12);:NEXT:PRINT:C$=""
3090 IF K>4 THEN PRINT:PRINT S$(3);:GOSUB 10020:GOTO 6030
3100 PRINT:PRINT S$(4);" OR <D> TO DELETE";:GOSUB 10020:ON INSTR
("MD",C$)GOTO 520,3110:M=2:GOSUB 10120:CLS:GOTO 3090
3110 PRINT:PRINT S$(2);:GOSUB 10720:IF K=4 THEN 520 ELSE 1030
5000 '*****
5010 'SORT
5020 IF V3=0 THEN GOSUB 10920
5030 PRINT:PRINT"PRESS <D> FOR LISTING BY DISK, <A> FOR ALPHABET
ICAL";:GOSUB 10020:ON INSTR("MDA",C$)GOTO 520,5040,5050:M=2:GOSU
B 10120:CLS:GOTO 5030
5040 V4=0:GOTO 5060
5050 V4=1:PRINT:PRINT S$(2):FOR X=1 TO XX:DP$(X)=RIGHT$(DP$(X),1
2)+LEFT$(DP$(X),2):NEXT
5060 CLS:PRINT:PRINT:PRINT S$(2);:GOSUB 10520:CLS
5100 '*****
5110 'SCREEN LIST
5120 FOR X=1 TO 4:IF V4=0 THEN PRINT"DISK PROGRAM ";:NEXT
ELSE PRINT"PROGRAM DISK ";:NEXT
5130 PRINT:PRINT STRING$(75,"-");V6=0:U2(1)=27:U2(7)=512:DEFUSR3
=VARPTR(U2(0)):V6=USR3(0)
5140 XX=XX-1:FOR I=1 TO XX:GOSUB 10820
5150 IF V4=0 THEN PRINT LEFT$(DP$(J),2);" ";RIGHT$(DP$(J),12);
" ";ELSE PRINT LEFT$(DP$(J),12);" ";RIGHT$(DP$(J),2);" ";
5160 IF W4=4 THEN PRINT
5170 IF INT(I/80)<>I/80 THEN 5190 ELSE PRINT:PRINT"PRESS <C> TO
CONTINUE DISPLAY <B> FOR PRIOR PAGE";:GOSUB 10020
5180 IF I>=160 AND C$="B" THEN I=I-160:GOTO 5210 ELSE 5210
5190 IF I>80 AND I=XX THEN PRINT:PRINT"FOR PRIOR PAGE PRES
S <B>, <C> TO END LIST ";ELSE 5220
5200 GOSUB 10020:IF C$="B" THEN I=I-(80+(XXMOD80))
5210 PRINT STRING$(48,8);
5220 NEXT:XX=XX+1:C$=""
5300 '*****
5310 'PRINTER OUTPUT
5320 PRINT:PRINT:PRINT S$(4);", <P> FOR PRINTOUT";:GOSUB 10020:O
N INSTR("PM",C$)GOTO 5340,5330:M=2:GOSUB 10120:CLS:GOTO 5320
5330 IF V4=1 THEN PRINT:PRINT S$(2):FOR X=1 TO XX:DP$(X)=RIGHT$(
DP$(X),2)+LEFT$(DP$(X),12):NEXT:GOTO 520 ELSE 520
5340 LPRINT:FOR I=1 TO 4:IF V4=0 THEN LPRINT"DISK PROGRAM "
";NEXT ELSE LPRINT"PROGRAM DISK ";:NEXT
5350 LPRINT:LPRINT STRING$(75,"-");W4=0:XX=XX-1:FOR I=1 TO XX:GO
SUB 10820
5360 IF V4=0 THEN LPRINT LEFT$(DP$(J),2);" ";RIGHT$(DP$(J),12);"
";ELSE LPRINT LEFT$(DP$(J),12);" ";RIGHT$(DP$(J),2);" ";
5370 IF W4=4 THEN LPRINT
5380 NEXT:XX=XX+1:IF V4=1 THEN PRINT:PRINT S$(2):FOR X=1 TO XX:D
P$(X)=RIGHT$(DP$(X),2)+LEFT$(DP$(X),12):NEXT:GOTO 520 ELSE GOTO
520
6000 '*****
6010 'SEARCH FOR DISK OR PROGRAM
6020 IF V3=0 THEN GOSUB 10920
6030 CLS:C$="":PRINT@240,S$(4);", <D> TO LIST A DISK, OR <P> TO
FIND A PROGRAM.";:GOSUB 10020:ON INSTR("MDP",C$)GOTO 520,3020,60
40:M=2:GOSUB 10120:CLS:GOTO 6030
6040 CLS:PRINT:LINEINPUT"ENTER NAME OF PROGRAM TO BE FOUND: ";P
N$:IF PN$="M" THEN 520 ELSE J=0:L=LEN(PN$)
6050 IF L<12 THEN PN$=PN$+SPACE$(12-L) ELSE IF L>12 THEN PN$=LEF
T$(PN$,12)
6060 FOR X=1 TO XX-1:IF PN$=RIGHT$(DP$(X),12) THEN J=J+1:PN$(J)=
DP$(X)
6070 NEXT
6080 IF J=0 THEN M=8:GOSUB 10120:CLS:GOTO 6040
6090 CLS:PRINTTAB(5);"PROGRAM";TAB(20);"DISK":PRINT STRING$(55,"
-");PRINT:FOR I=1 TO J:PRINTTAB(5);RIGHT$(PN$(I),12);" ";LEFT$(P
N$(I),2);NEXT
6100 C$="":PRINT:PRINT S$(4);" OR <P> TO FIND ANOTHER PROGRAM";:
GOSUB 10020:ON INSTR("MP",C$)GOTO 520,6040:M=2:GOSUB 10120:CLS:G
OTO 6100
7000 '*****
7010 'SAVE TO DISK
7020 IF V3=0 THEN M=3:GOSUB 10120:GOTO 520 ELSE OPEN "O",1,"DSKI
NDEX":PRINT@658,"*** SAVING INDEX TO DISK ***";
7030 PRINT#1,XX:FOR X=1 TO XX:PRINT#1,DP$(X):NEXT:CLOSE:V3=0:M=5
:GOSUB 10120:GOTO 520
8000 '*****
8010 'END OF PROGRAM
8020 IF V2=0 THEN 8040 ELSE PRINT"TO RETAIN YOUR UPDATED INDEX,
YOU MUST SAVE IT TO DISK.":PRINT"PRESS <S> TO SAVE OR <E> TO END
WITHOUT SAVING.";

```

Listing continues

gram pauses with 80 items on the screen. You may go back to a prior screen. A partial final screen is controlled by lines 5190 and 5200. The MOD operator is a remainder function. XX MOD 80 gives the remainder of XX (total programs) divided by 80. This is the number of programs after the last full screen.

- Line 5210 erases the prompt message.

- In line 5220, For...Next loops always add one more than the number of items processed. Proper program operation requires adjustment at times during the program to the actual number of programs, or an increase by one as though the index had just gone through a loop.

- In line 5360, J is the sequential number of the directory entry in the vertical raster. J determines the print position of the entry.

- In line 5380, if the disk number and name were switched for alphabetical sorting, the disk number is returned to the left side of the string.

- Line 6050 right-justifies the program name with spaces or excess characters truncated to a 12-character length. (The maximum length of a TRSDOS file name is 12 characters including the slash and extension of up to three characters. File names read from disks are adjusted to a 12-character length.)

- Line 6080 gives an error message if the program is not in the index.

- Lines 7020-7030 give an error message if there is no index in memory. Number of entries, XX, is saved to disk with the index.

- In line 8020, if V2 = 1, you called a routine to change the index. You are reminded to save the new index before exiting the program.

- Line 10020 pauses until a key is pressed.

- In line 10220, CHR\$(2) turns off the cursor to avoid flashes as it moves to the message area.

- In line 10240, Y loops determine on and off time for flashing messages.

- In line 10250, CHR\$(1) turns the cursor on.

- In line 10320, line Input avoids printing a question mark on the screen as Input would do.

- Lines 10330-10340 ensure that one-digit disk numbers are preceded by zero, allowing only numbers for disk ID.

- Lines 10410-10490 are a USR routine with supervisory call 53. It reads the entire disk directory into RAM. Each entry is 34 characters. Using PEEK, the name is extracted and right-justified with spaces to a 12-character length. The disk number, DZ\$, is add-



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```

8030 GOSUB 10020:CLS:ON INSTR("MS",C$) GOTO 520,7020
8040 IF C$="E" OR V2=0 THEN CLS:PRINT"*** END OF INDEX PROGRAM *
***":END ELSE M=2:GOSUB 10120:CLS:GOTO 8020
10000 '*****
10010 'SUBROUTINES
10020 C$=INKEY$:IF C$="" THEN 10020 ELSE RETURN
10100 '*****
10110 'FLASHING MESSAGES
10120 F$(0)="** INCORRECT ENTRY--":F$(1)="ONLY 1 TO 8 PLEASE":F
$(2)="ONLY LETTERS IN BRACKETS PLEASE":F$(3)="NO INDEX FILE":F$(
4)="ENTER 2 NUMBERS, NO DECIMALS":F$(5)="INDEX SAVED TO DISK":F
$(6)="PLEASE TURN ON PRINTER"
10130 F$(7)="THIS INDEX NUMBER ALREADY IN USE. REENTER.":F$(8)=
"DISK NUMBER OR PROGRAM NOT IN INDEX":F$(9)="DISK DELETED FROM I
NDEX"
10220 PRINT CHR$(2):FOR X=1 TO 2
10230 IF M<5 THEN PRINT@15,F$(0)+F$(M)+" ***"ELSE PRINT@15,"*
* "+F$(M)+" ***"
10240 FOR Y=1 TO 300:NEXT Y:PRINT@15,SPACE$(65):FOR Y=1 TO 300
:NEXT:Y
10250 M=0:PRINT CHR$(1):RETURN
10300 '*****
10310 'DISK ID#
10320 CLS:DN$="":PRINT:LINEINPUT"ENTER A 2 DIGIT DISK ID NUMBER:
";DN$
10330 IF DN$="M" THEN 520 ELSE IF LEN(DN$)<>2 THEN 10350
10340 FOR X=1 TO 2:IF INSTR("0123456789",MID$(DN$,X,1))=0 THEN 1
0350 ELSE NEXT X:RETURN
10350 M=4:GOSUB 10120:GOTO 10320
10400 '*****
10410 'READ DIRECTORY FROM DRIVE 1 TO RAM AND EXTRACT FILENAME
10420 V1=0:U2(1)=53:U2(7)=256:U2(3)=-3267:DEFUSR2=VARPTR(U2(0)):
V1=USR2(0)
10430 IF V3=0 THEN XX=1
10440 FOR X=-3267 TO -3 STEP 34:PN$(XX)="
10450 FOR Y=0 TO 13
10460 IF Y=0 AND OCT$(X)=35 THEN RETURN
10470 IF Y>0 AND OCT$(X+Y)=58 THEN PN$(XX)=MID$(PN$(XX),2,(Y
-1)):L=LEN(PN$(XX))-1:PN$(XX)=PN$(XX)+SPACE$(11-L):DP$(XX)=DZ$+P
N$(XX):GOTO 10490
10480 PN$(XX)=PN$(XX)+CHR$(OCT$(X+Y)):NEXT Y
10490 XX=XX+1:NEXT X:RETURN
10500 '*****
10510 'MACHINE LANGUAGE SHELL SORT
10520 J(0)=VARPTR(DP$(1)):J(1)=XX-2:GOTO 10540
10530 J(0)=VARPTR(PN$(1)):J(1)=U-2
10540 DEFUSR5=VARPTR(U5(0)):V9=USR5(VARPTR(J(0))):RETURN
10700 '*****
10710 'DELETE AND SORT MARKERS TO END
10720 FOR X=1 TO U-1:MID$(DP$(A(X)),1,2)="ZZ":NEXT
10730 GOSUB 10520:XX=XX-U
10740 XX=XX+1:M=9:CLS:GOSUB 10120:RETURN
10800 '*****
10810 'VERTICAL RASTER ROUTINE
10820 W1=(I-1)MOD4:W2=XXMOD4:W3=W1:IF W2<W1 THEN W3=W2
10830 J=W3+W1*INT(XX/4)+INT((I-1)/4)+1:W4=W1+1:RETURN
10900 '*****
10910 'DISK INPUT OF PRIOR INDEX
10920 OPEN "I",1,"DSKINDEX":PRINT@658,"*** LOADING INDEX ***":I
NPUT #1,XX
10930 FOR X=1 TO XX:INPUT #1,DP$(X):NEXT:CLOSE:V3=1:CLS:RETURN
11000 '*****
11010 'ERROR ROUTINES
11020 IF ERR=52 THEN CLS:PRINT"YOU MUST START AGAIN AND OPEN FIL
ES.":PRINT"PRESS <ENTER> TO RETURN TO TRSDOS":PRINT:PRINT S$(1):
PRINT:PRINT S$(3):LINEINPUT C$:SYSTEM
11030 IF ERR=53 THEN M=3:GOSUB 10120:CLS:RESUME 520
11040 IF ERR=56 THEN CLS:M=6:GOSUB 10120:RESUME 5320
11100 '*****
11110 'DATA FOR PEEK
11120 DATA -13023,8797,26623,17441,8830,26625,-15583,8955,26627,
14910,1330,104,-12255,8773,10757,17697,8779,10759,-15583,8959,23
259,26430,-8910,-13990
11200 '*****
11210 'DATA FOR MACHINE LANGUAGE SORT
11220 DATA 24013,-6844,-7715,20189,-8958,838,1048,-6695,-15911,3
3,-18688,17133,-13360,-13512,-15079,-7719,-8743,622,26333,-18685
,17133,-9755,-9775,-13560,2183,20189,-8960,326,8645,1,-9755
11230 DATA -6719,-11815,-6887,10705,-8935,94,22237,6401,-10799,6
373,-7924,2273,2293,-13327,10311,6321,6863,17999,9173,9054,-5290
,-6703,9195,9054,-7850,1284,1568,3340,12064,4120,3340,3112,-1687
0
11240 DATA 1568,4899,3333,-6120,7472,-10791,-9787,-7727,-4681,10
322,5054,-9771,-9791,6,782,-7727,-6903,2539,6373,-7752,-10799,17
65,6659,30542,4729,4899,-2288,-13560,2247,-12776

```

ed to each program name. SPACE\$ prints the indicated number of spaces. The symbols # (ASCII 35) and : (ASCII 58) are directory and file-name end indicators, respectively.

● Lines 10520-10540 are the machine-language sort. USR5 is called to sort either the entries on one disk or the whole index.

● Lines 10720-10740 change the disk number of all programs to be deleted to ZZ. Index is sorted by disk number, moving these programs to the end. The counter for number of programs is reduced by U, the number of ZZ marked programs. This effectively deletes these programs.

● Lines 10820-10830 contain the vertical raster algorithm. (See the Athanasiou article.) W4 is the column in which a program is printed.

● Line 10930 sets flag V3 to indicate an index is in memory after loading.

● In line 11020, error 52 means no file was open when Basic entered. Error 53 means no previous index was on the disk. Error 56 means the printer output was selected but the printer wasn't on.

● Lines 11220-11240 are a machine-language Shell sort from *Basic Faster and Better* by Lewis Rosenfelder, page 134. It is a very fast sort that swaps pointers rather than strings.

Hints on Using the Program

If you use disk number 1 or 0 solely for your index, all your programs other than the one directory program will be indexed when you have read your other disks with the program. Your directory will be handy for ready reference on your first disk. Otherwise, you will need to use your back-up disk to index your master disk and then copy the augmented DSKINDEX file from the back-up disk to the master.

The slowest part of the program is the Basic conversion of directory entries for alphabetical search. You will locate your file quickest by using function 6 to find your program by name or disk number, or listing all programs by disk number with function 5. Use the alphabetic listing only for a summary print-out of all your disks.

The Model II default-length parameter for printout is 60 lines. Three lines are used for heading. You can print 228 programs on an 11-inch sheet. Using 14-inch paper and setting FORMS P = 84 L = 80, you can get 308 programs on a single sheet. ■

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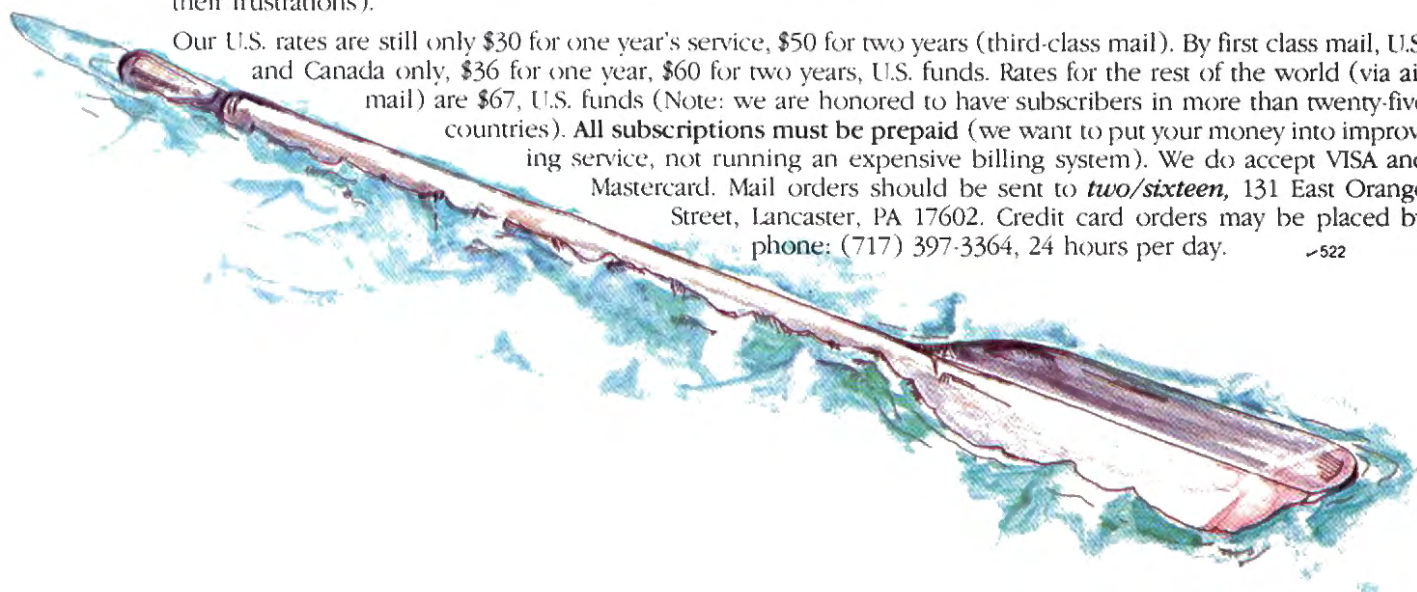
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Compress, Mod II Style

by Charles Wood

Basic programs written with spaces between words, and many comments, are easy to read but quickly eat up memory. Here's the solution.

Recently I entered a long Basic program into my Model II with spaces between words to clearly show the syntax.

The listing was generous with comments, even describing how each variable was used.

But the inevitable happened. I finally developed the perfect program, but it couldn't process anything because there was no more work space. The fix was to extract a run-time program that loaded memory without spaces and comments. I needed a compress utility. Although Model III TRSDOS supplies one, Model II TRSDOS does not.

Simply eliminating spaces can be dangerous. For example, compare these two statements:

```
40 IF Q=BF OR A=13 THEN...
50 IFQ=BFORA=13THEN...
```

Line 50 is a spaceless version of line 40. Line 50 is syntactically wrong. Basic searches a statement for keywords first, then for variables. Without spaces, the command Or becomes For and the variable BF is broken up. The perfect compress program analyzes syntax as completely as the Basic interpreter itself.

But these combinational errors rarely appear. If one does occur, Basic usually flags an error. Also, programmers are sensitive to the listing of the program and can quickly eyeball a funny-looking statement. Since I check out my own software, I decided to write a short compress program and save money.

My simple approach is to work with a Basic file saved in the ASCII mode (SAVE "filename",A). Here, the record length (LRL) is one and the number of records in the file is the number of bytes in the source program. Files of this kind make disk input/output (I/O) very easy by using the sequential

```
100 'CMPRS -      Compress BASIC statements      by Charles Wood
112 'output file name has suffix '/cmp'
130 CLEAR 1000:DEFSTR B-D:DEFINT E-Z
150 CLS:PRINT"CMPRS - Compress BASIC statements":PRINT:PRINT
160 PRINT"Did you load -F:2?":PRINT
200 INPUT "Name of File ";DI 'Input file name
210 DO=LEFT$(DI,8)+"/cmp" 'Output file name has suffix '/cmp'
220 ON ERROR GOTO 2010 'file not found/wrong mode
300 OPEN "I",1,DI 'read only input
305 ON ERROR GOTO 2030 'no space available
310 OPEN "O",2,DO 'write only output
315 ON ERROR GOTO 2000
320 IC=0:OC=0 'Input/output chrctr counters
400 LINE INPUT#1,BI 'read a statement to BI
405 L=LEN(BI):IC=IC+L 'Length of input statement augments IC
407 QF=0 'quote flag
408 CC=""
410 FOR I=1 TO L
420 G=ASC(MID$(BI,I,1)) 'ASCII of a character
430 IF QF=0 AND G=39 THEN 690 'ends in remark
440 IF QF=0 AND G=34 THEN QF=1:GOTO 480 'start quote
450 IF QF=1 AND G=34 THEN QF=0 'end quote
460 IF QF=1 THEN 480 'enclosed quotes unaltered
470 IF G=32 OR G=9 THEN NEXT I
480 CC=CC+MID$(BI,I,1):NEXT I
490 GOTO 700
690 IF I<8 THEN 400 'delete the line ;option IF I<8 THEN I=L+1
700 L=LEN(CC):OC=OC+L 'Length of out statement augments OC
750 PRINT CC:PRINT #2, CC 'sequential write one statement
800 GOTO 400 'back for another
2000 IF ERR=60 OR ERR=62 THEN RESUME 2020
2005 PRINT"ERR #";ERR;" at ";ERL:STOP
2010 IF ERR=53 OR ERR=54 OR ERR=63 THEN RESUME 2011 ELSE RESUME
2005
2011 CLOSE:PRINT "File not found or Bad file mode":PRINT:GOTO 20
0
2020 CLOSE:PRINT:PRINT"End of File":PRINT:PRINT
2021 PRINT "[",IC,"] input characters in file ";DI
2022 PRINT "[",OC,"] output characters"
2023 PRINT:PRINT TAB(13) "Saved"; 100*(IC-OC)/IC;"%." :PRINT:GOTO
200
2030 IF ERR=59 THEN RESUME 2031 ELSE 2010
2031 CLOSE:PRINT"Disk is full":PRINT:GOTO 200
```

Program Listing 1

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```

130 CLEAR1000:DEFSTRB-D:DEFINTE-Z
150 CLS:PRINT"CMPRS - Compress BASIC statements":PRINT:PRINT
160 PRINT"Did you load -F:2?":PRINT
200 INPUT"Name of File ";DI
210 DO=LEFT$(DI,8)+"/cmp"
220 ONERRORGOTO2010
300 OPEN"I",1,DI
305 ONERRORGOTO2030
310 OPEN"O",2,DO
315 ONERRORGOTO2000
320 IC=0:OC=0
400 LINEINPUT#1,BI
405 L=LEN(BI):IC=IC+L
407 QF=0
408 CC=""
410 FORI=1TOL
420 G=ASC(MID$(BI,I,1))
430 IFQF=0ANDG=39THEN690
440 IFQF=0ANDG=34THENQF=1:GOTO480
450 IFQF=1ANDG=34THENQF=0
460 IFQF=1THEN480
470 IFG=32ORG=9THENNEXTI
480 CC=CC+MID$(BI,I,1):NEXTI
490 GOTO700
690 IFI<8THEN400
700 L=LEN(CC):OC=OC+L
750 PRINTCC:PRINT#2,CC
800 GOTO400
2000 IFERR=60ORERR=62THENRESUME2020
2005 PRINT"ERR #";ERR;" at ";ERL:STOP
2010 IFERR=53ORERR=54ORERR=63THENRESUME2011ELSERESUME2005
2011 CLOSE:PRINT"File not found or Bad file mode":PRINT:GOTO2000
2020 CLOSE:PRINT:PRINT:PRINT"End of File":PRINT:PRINT
2021 PRINT"[",IC,"] input characters in file ";DI
2022 PRINT"[",OC,"] output characters"
2023 PRINT:PRINTTAB(13)"Saved";100*(IC-OC)/IC;"%":PRINT:GOTO2000
2030 IFERR=59THENRESUME2031ELSE2010
2031 CLOSE:PRINT"Disk is full":PRINT:GOTO2000

```

Program Listing 2

read/write statements LINE INPUT #1 and PRINT #2, where #1 and #2 are buffer numbers.

The fancy approach is to work with the non-ASCII saves that contain the numeric code for the command. By logical matching of op-codes and tables, the fancy approach can prevent troubles by leaving some spaces in. But the file structure is harder to work because statements can bridge two records (LRL = 256); deblocking and reblocking becomes awkward. Further, I did not want to invest time for logical tables that have a marginal advantage.

When compressed, the long Basic program of some 13,000 bytes was reduced by 1,600 bytes, a saving of 12 percent. The listing of the long program remains well documented in an auxiliary file. Moreover, the compressed program ran the first time; there were no combination errors.

As shown in the Program Listings, one statement is read at a time. Spaces between quotes are retained (line 460). Other spaces, tabs, and remarks are deleted by making them ASCII nulls (statement 470). The string is then reassembled at which time the nulls are discarded. The statement is then written back to the output file in line 750. Lines 2000 onward trap errors such as end of file and wrong file type.

Some programmers may want to make a change in line 690. If your Basic programs use "GOTO all-remark statements," you may want to preserve the all-remark statements:

690 IF I<8 THEN I = L + 1 'retain the statement

Program Listing 1 is the CMPRS utility in the fully documented form. Listing 2 is the same program, but compressed. The saving is 32 percent. After compressing a program, load Basic with the compressed version and then save it, this time in the regular non-ASCII format. Check your listing for possible errors and then test.

To run the program from TRSDOS, type BASIC CMPRS -F:2. Then, you can compress programs of your choice. To compress, the input program must be saved in the ASCII mode.

Follow the prompting of CMPRS. The output will be "filename/cmp." You can then load the compressed file by Basic, obtain a listing, and test the program. ■

Charles Wood can be reached at 327 Seventh Ave., Pelham, NY 10803.

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Take a Letter...

by James Barbarello

Spruce up your printer output with this Basic program for your Model II. It lets you draw large block letters using standard characters.

A common feature of reports generated by data processing facilities is large lettering on title pages. This lettering is usually a 9 by 7 array of standard-size letters forming the large character. The large T is made up of standard size Ts, the large E is made up of standard size Es, and so on.

Letters provides your Model II with this function.

Letters gives you a number of capabilities. You can print any message in large format on any printer (no maximum column restriction). In addition, you can change the letter's shape to your liking. You can also change the

standard-size letters that form the characters. Letters can be incorporated into your own programs.

The Strategy

Forming readable characters by arranging printed symbols in an array is far from unique. This is the way characters are formed on a video monitor or a dot-matrix printer. The monitor or printer receives a message indicating the character you want printed and looks for the instructions to form that character in ROM. We'll follow essentially the same strategy, but the ROM will be a disk file, and not an integrated

circuit. Using the LETTERS/ROM file makes the program required to do the printing relatively short. It also makes it simple to modify any of the instructions for printing the allowable characters.

The LETTERS/ROM file contains instructions for printing ASCII characters 32 (space) through 90 (Z). This includes all numbers, uppercase letters, and punctuation marks. The first instruction is for a space (ASCII 32), the second is for an exclamation mark (ASCII 33), and so on. Then it's simple to convert the characters to their ASCII equivalent numbers, subtract 31, and access that instruction directly. In its simplest form, the Basic program is about 10 lines. The Letters program is more complex.

The Program

Letters begins by opening the LETTERS/ROM data file and printing the message "Letter Writer" on the screen in large characters (lines 50-80). This is a menu-driven program with four tasks. Tasks 1 and 2 (write message) are similar, task 1 writes to the printer and task 2 writes to the screen. Task 2 is useful if you want to see how a message looks before you print it. Task 3 lets you change the form of the character as well as from which ASCII characters it is formed. Task 4 (end) closes open files automatically. It is good pro-

Program Listing

```

1 REM**          PROGRAM # P4
2 REM**          NAME: LETTERS
3 REM**          LATEST UPDATE: #0, 26 SEPT 1981
4 REM**
5 REM** THIS PROGRAM DRAWS LARGE LETTERS ON SCREEN OR PRINTER
6 REM**
10 CLEAR 3000:CLS:DEFSTR A,D:DIM AM(12,10),A(10),NU(12):LN=0:P=0
:N=0
20 ON ERROR GOTO 5500
30 DLN=STRING$(79,150):DR=CHR$(26):DN=CHR$(25):PRINT@(11,30),DR;
" WAIT... ";DN;
40 OPEN"D",1,"LETTERS/ROM",10:FIELD 1,10 AS AROM
50 MSG$="LETTERWRITER":GOSUB 5000
60 FOR J=1 TO 10:FOR I=1 TO 6
70 PRINT@(J-1,12*(I-1)+5),AM(I,J);:PRINT@(J+10,12*(I-1)+5),AM(I+
6,J)
80 NEXT I,J
90 PRINT@(22,25),DR;" Press ENTER to continue... ";DN;
100 A=INPUT$(1):IF ASC(A)<> 13 THEN 100
110 CLS:PRINT@(4,27),"L E T T E R   W R I T E R":PRINTDLN
120 PRINT@(8,25),DR;" 1 ";DN;" Write to PRINTER"
130 PRINT@(10,25),DR;" 2 ";DN;" Write To SCREEN"
140 PRINT@(12,25),DR;" 3 ";DN;" CHANGE Letters"
150 PRINT@(14,25),DR;" 4 ";DN;" END"

```

Listing continues

The Key Box

**Model II or 16
64K RAM
Disk Basic
TRSDOS 2.0A
One Disk Drive
Printer**

gramming practice to include an end task in all programs that use disk files.

Task 1 asks for the maximum number of columns on your printer. It then calculates the maximum letters that can be printed on each line (MSGSIZE in line 1040). This information flashes on the screen and a Forms set is performed to reset the computer's line counter. Now you're asked to enter the message. If the message is greater than the allowable maximum, it is erased from the screen and nothing prints. When you enter a printable message, the screen shows a wait prompt while the subroutine at line 5000 constructs the instructions for the printer.

If the printer isn't available, the message "Printer is not available" displays and you are asked if you want to continue or return to the menu. If the printer is available, the message prints on the line printer. Upon completion, you are asked again if you want to continue or return. You can continue printing your message one line at a time until finished, and then return to the menu.

Task 2 is similar to task 1, except that the message is printed on the screen. Because there are only 80 screen columns, the message length is fixed at six characters. If you enter a message greater than six characters, only the first six are displayed on the screen. As with task 1, you can continue printing messages on the screen until you select R (return to menu).

Task 3 allows you to change any character's form in the LETTERS/ROM file. Each character is formed by a 10 by 10 grid of locations. Each location can contain a blank or any printable character. Large characters are formed by arranging printable characters in a recognizable pattern. When you select task 3, the message in lines 3010-3030 flashes on the screen. You're then asked to press the key of the character you want to change the form of.

The LETTERS/ROM file is then accessed and the selected character displays on the screen in a 10 by 10 grid. All blank positions contain a dot (period). Then the message in lines 3120 and 3130 displays to show how to perform modifications. If you press the space bar to blank out a position, a dot appears there.

As indicated in the instructions, the arrow keys move the cursor. Cursor movement is transparent and doesn't disturb the display. When you're finished, press F1 to end the modification procedure. At this point, you have

Listing continued

```

160 PRINT@(22,20),"Press the ";DR;" NUMBER ";DN;" of the Task De
sired...";
170 A=INPUT$(1):IF VAL(A)<1 OR VAL(A)>4 THEN 170ELSE TSK=VAL(A)
180 ON TSK GOSUB 1000,2000,3000,4000:GOTO 110
1000 REM**          PROGRAM BEGINS
1010 CLS:PKINTTAB(30);"TASK # 1: WRITE TO PRINTER":PRINTDLN:GOSU
B 5120
1020 PRINT@(22,0),CHR$(24):PRINT@(3,10),"Enter MAXIMUM Number of
Columns Available on Printer (EX:80)...";
1030 LINE INPUT A:NU=VAL(A):IF NU<12 OR NU>132 THEN 1020
1040 MSGSIZE=INT(NU/12):TB=(NU-MSGSIZE*12)/2
1050 PRINT@(5,10),"MAXIMUM PRINTER COLUMNS:";DR;NU;DN;TAB(45);"M
AXIMUM LETTERS PER LINE:";DR;MSGSIZE:GOSUB 5120:PRINT@(10,0);:S
YSTEM FORMS L=66,W=132":PRINT@(10,0),CHR$(24)
1060 PRINT@(22,0),CHR$(24):PRINT@(10,20),"Enter MESSAGE (";MSGSI
ZE;"characters MAX)...";CHR$(23);
1070 LINE INPUT A:IF LEN(A)>MSGSIZE THEN 1060
1080 PRINT@(22,35),DR;" WAIT... ";DN;MSG$=A:GOSUB 5000
1090 PRINT@(15,0),CHR$(24):PRINT@(22,35),DR;" WAIT... ";DN;:LPRI
NT CHR$(1):REM* DUMMY LPRINT TO CHECK STATUS OF PRINTER *
1100 FOR J=1 TO 10:FOR I=1 TO LEN(MSG$):LPRINT TAB(TB);AM(I,J);"
";:NEXT I:LPRINT:NEXT J:LPRINT:LPRINT
1110 PRINT@(22,0),CHR$(23);:GOSUB 5120:GOTO 1060
2000 CLS:PRINTTAB(30);"TASK # 2: WRITE TO SCREEN":PRINTDLN:GOSUB
5120
2010 PRINT@(2,0),CHR$(24):PRINT@(4,20),"Enter Message (6 Charact
ers MAXIMUM)...":LINE INPUT MSG$:IF LEN(MSG$)>6 THEN MSG$=LEFT$(
MSG$,6)
2020 GOSUB 5000:PRINT@(6,0);:
2030 FOR J=1 TO 10:FOR I=1 TO LEN(MSG$):PRINTTAB(5);AM(I,J);" "
";:NEXT I:PRINT:NEXT J
2040 GOSUB 5120:GOTO 2010
3000 CLS:PKINTTAB(25);"TASK # 3: CHANGE LETTERS":PRINTDLN
3010 PRINT@(3,0),"          This task allows you to change the form o
f the letters to be printed. The
3020 PRINT"change is permanently stored in the LETTERS/ROM Disk
File, which contains the"
3030 PRINT"form of all the printable letters.":GOSUB 5120
3040 GOSUB 5200:PRINT@(3,0),"Press the LETTER you wish to change
...";
3050 A=INPUT$(1):NU=ASC(A):IF NU<32 THEN 3050ELSE IF NU>96 THEN
NU=NU-32:PRINT CHR$(NU) ELSE PRINT A
3060 NU=NU-31:NU=NU*10-9:IF NU>LOF(1) THEN 3060
3070 FOR J=NU TO NU+9:GET 1,J
3080 AM(1,J-NU+1)=AROM:NEXT J
3090 FOR I=10 TO 19:PRINT@(I,35),AM(1,I-9):NEXT
3100 FOR I=1 TO 10:FOR J=1 TO 10:IF MID$(AM(1,I),J,1)=" " THEN P
RINT@(I+9,J+34),". ";
3110 NEXT J,I
3120 PRINT@(21,0),"Use the ARROW keys to position the cursor (Fo
rward, Backspace, Up or Down).";
3130 PRINT"Type in new characters as desired (use the Spacebar t
o delete a character).":PRINT"Press ";DR;" F1 ";DN;" when ALL ch
anges have been completed...":PRINT@(10,35);:
3140 GOSUB 5300:PRINT@(21,0),CHR$(24):PRINT@(21,4),"To save this
new form, press ";DR;" C ";DN;". Otherwise, press ";DR;" R ";DN
";:GOTO 3130";
3150 GOSUB 5130:PRINT@(20,0),CHR$(24):PRINT@(22,30),DR;" SAVING
NEW FORM... ";DN;
3160 FOR J=NU TO NU+9:LSET AROM=AM(1,J-NU+1):PUT 1,J:NEXT J
3170 PRINT@(22,20),"New Form Saved. Press ANY key to Return to M
enu...":A=INPUT$(1):RETURN
4000 CLS:PRINT@(0,33),"TASK # 4: END":PRINTDLN
4010 GOSUB 5100
4020 GOSUB 5200:PRINT@(10,35),DR;" WAIT... ";DN;
4030 CLOSE:PRINT@(10,35),DR;" PROGRAM ENDED. ";DN:PRINT@(18,0);:
CLEAR 50:END
5000 REM**          ACCESS LETTERS/ROM FILE SUBROUTINE
5010 FOR I=1 TO LEN(MSG$):NU(I)=ASC(MID$(MSG$,I,1)):IF NU(I)>96
THEN NU(I)=NU(I)-32
5020 NU(I)=NU(I)-31:NEXT
5030 FOR X=1 TO LEN(MSG$):NU=NU(X)*10-9:IF NU>LOF(1) THEN NU=1
5040 FOR J=NU TO NU+9:GET 1,J
5050 AM(X,J-NU+1)=AROM:NEXT J
5060 NEXT X:RETURN
5070 FOR J=1 TO 10:FOR I=1 TO LEN(MSG$):PRINTAM(I,J);" ";:NEXT
I:PRINT:NEXT J
5080 IF TTL=1 THEN PRINT:PRINT:PRINT
5100 REM**          CONTINUE/RETURN QUERY (CLEAR TO END OF SCREEN)
5110 PRINT@(2,0),CHR$(24)
5120 PRINT@(22,30),DR;" C ";DN;"ontinue or ";DR;" R ";DN;"eturn.
...";
5130 A=INPUT$(1):NX=ASC(A):IF NX>96 THEN NX=NX-32:A=CHR$(NX)
5140 IF A="R" THEN IF ERR=0 THEN 110ELSE RESUME 110ELSE IF A<>"C

```

Listing continues

Listing continued

```

" THEN 5130
5150 PRINT A;:RETURN
5200 REM** CLEAR SCREEN BELOW TITLE
5210 PRINT@(2,0),CHR$(24):RETURN
5300 REM** CHANGE LETTER UTILITY
5310 LN=10:P=35
5320 A=INPUT$(1):N=ASC(A):IF N=1 THEN RETURN ELSE IF N<28 THEN 5
320
5330 IF N<28 THEN 5320ELSE IF N<32 THEN 5370
5340 MID$(AM(1,LN-9),P-34,1)=CHR$(N):PRINT@(LN,P),CHR$(N);:IF N=
32 THEN PRINT@(LN,P),". ";
5350 P=P+1:IF P>44 THEN P=35:LN=LN+1:IF LN>19 THEN LN=19
5360 GOTO 5410
5370 IF N=28 THEN P=P-1:IF P<35 THEN P=35
5380 IF N=29 THEN P=P+1:IF P>44 THEN P=35:LN=LN+1:IF LN>19 THEN
LN=19
5390 IF N=30 THEN LN=LN-1:IF LN<10 THEN LN=10
5400 IF N=31 THEN LN=LN+1:IF LN>19 THEN LN=19
5410 PRINT@(LN,P),":GOTO 5320
5500 REM** ERROR TRAPPING ROUTINE
5510 IF ERR=56 THEN PRINT@(15,0),CHR$(24):PRINT@(15,28),DR;" PRI
NTER IS NOT AVAILABLE...";DN:GOSUB 5120:RESUME 1090
5520 RESUME 110

```

```

888..... ..8888... ..888... .88888888. 88888888.. .88888888.
.888..... ..888888.. ..88..8... 88888888888 8888888888. 88888888888
..888..... ..88...88.. ..88...88.. 888...888 888...888 888...888 888...888
..888... ..88...8888 ..88.8.888. 888...888 888...888 888...888 888...888
...888... ..888... ..88..8.8... 88888888888 8888888888. 888...888...
...888... ..88... ..88..8... 888...888 888...888 888...888 888...888
..888... ..88... ..88...888 888...888 888...888 888...888 888...888
.888..... ..88... ..88...888 888...888 8888888888. 88888888888
888..... ..88... ..8888... 888...888 888888888.. .88888888.

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88888888... 88888888888 88888888888 ..8888888.. 888...888 .88888888..
8888888888. 88888888888 88888888888 .888888888. 888...888 .88888888..
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88888888... 88888888888 888...888. .88888888. 888...888 .88888888..
88888888... 88888888888 888...888. ..888888.. 888...888 .88888888..

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...88888888 888...888 888...888 888...888 8888...88 ..8888...
..88888888 888...888. 888...888. 8888...8888 8888...88 .8888888..
...888... 888...888. 888...888. 88..88..88 88..88..88 .888...888.
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..888... ..888...888 88888888888 88...888 88...88888 ..88888...

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8888888888.. ..8888.. 8888888888.. ..888888.. 8888888888.. 888...888
8888888888.. ..888888.. 8888888888.. ..88888888.. 8888888888.. 888...888
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888..... ..888888..8 888...888 .88888888.. ..888... ..8888888..

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888...888 88...88 888...888 888...888. 88888888888
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888...888 88...88 888...888. 888...888. 888...888.
888...888 88...88 888...888. 888...888. 888...888.

```

Figure 1

the option of saving the modified form; C saves the modified form. If you press R, the LETTERS/ROM file stays the same.

Task 4 ends the program by closing the LETTERS/ROM disk file.

The access LETTERS/ROM file subroutine at line 5000 is the workhorse of the program. You can include this subroutine in any of your programs. Lines 5010 and 5020 convert any lowercase characters in the message to uppercase. Lines 5030-5060 put the character information in an array the length of the message by 10 deep. Line 5030 begins incrementing through the message.

Records 1-10 in the LETTERS/ROM file contain the instructions for a space (ASCII 32). Records 11-20 contain the instructions for an exclamation point (ASCII 33), and so on. Line 5030 determines where the information for the nth character in the message begins, and assigns that number to NU. If the character in the message isn't in the LETTERS/ROM file, then NU equals one (and prints a space). Line 5040 gets the instruction for each of the 10 rows, and line 5050 puts that information in the AM array. Once the AM array contains the information for the complete message, program execution returns to the calling line. One program line (in this case, line 1100) prints the complete message.

The remaining subroutines of the program (lines 5070-5520) are program utilities used in the different tasks.

To create the LETTERS/ROM disk file, run the following short program:

```

10 CLEAR 100
20 OPEN "D",1,"LETTERS/ROM",10:
FIELD 1,10 AS AS
30 LSET AS=SPACES(10)
40 FOR I=1 TO 590:PUT I,1:NEXT I:
CLOSE

```

This one-time program creates a blank file. Now you can use task 3 in the Letters program to form the 58 large characters (ASCII 33 through ASCII 90). ASCII 32 (space) was formed when the blank file was created. You can form each large character exactly as shown in Fig. 1, or modify the Fig. 1 ROM set to your own desires. As you build your ROM file, you can periodically check its contents using task 2 (write to screen). ■

Jim Barbarello lives at RD #1 Box 241H, Tennent Road, Englishtown, NJ 07726. He enjoys woodworking, music, and computing.



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Banks and other financial institutions have used IRR to determine yields, generally without considering tax effects. IRR computes the yield to maturity on

bonds or mortgages purchased at either a premium or discount rate. Allowances for income taxes must be made before determining the net cash flow for IRR.

Although IRR is primarily applicable to real-estate transactions, it can be used to evaluate any type of investment. Most tax shelters either require that you make a certain number of payments into them, or they pay out several years after the initial investment (often in installments), or both. Syndicated real-estate, oil, and gas and leasing partnerships emphasize tax benefits, and they generally furnish all the data required for IRR computations.

Using the Program

Two types of IRR computations are provided. After entering the cash flows, you can choose your required or minimum IRR, and the program will calculate the present value of the investment at this interest rate. If the IRR value is below the asking price, you can turn down the deal or renegotiate the price to obtain the desired yield. Alternatively, for a given price and terms, you can determine the IRR for cash flows to be received.

If you are contemplating the purchase of two assets with widely varying terms, the program enables you to compare them on the basis of the effective compounded interest earned on your funds. You need to figure the cash requirements and positive cash flow for each year you will hold the investment.

Figure 1 is a worksheet for a shopping center syndication and Fig. 2 is for a corporate jet-aircraft lease deal. The right column gives you the figures for the IRR program. These are actual tax

SHOPPING CENTER						
Year	Purchase Installments	Cash Flow	Net Cash Required	Tax Gain Or Loss	Tax Benefit	Net Cash Flow
					50% rate	
0	11700		11700			(11700)
1	17200	175	17025	(29991)	14996	(2029)
2	16575	250	16325	(43021)	21511	5186
3	15600	250	15350	(41453)	20727	5377
4	14975	250	14725	(39059)	19530	4805
5	13700	375	13325	(37491)	18746	5421
6		375	(375)	(34290)	17145	17520
	Sale	89750	(89750)	225305	(45061)	44689
					20% capital gain rate	
Internal Rate of Return = 44.38%						

Figure 1

CORPORATE JET						
Year	Purchase Installments	Cash Flow	Net Cash Required	Tax Gain Or Loss	Tax Benefit	Net Cash Flow
					55% rate	
0	9150		9150			(9150)
1	30230	59	30171	(27476)	15112	(15059)
2	23500	55	23445	(64833)	35658	12213
3	20290	55	20235	(44026)	24214	3979
4	19120	55	19065	(38437)	21140	2075
5		55	(55)	(35578)	19568	19623
6		55	(55)	(13346)	7340	7395
	Sale	80150	(80150)	80150	(44083)	36067
					55% ordinary income rate	
Internal Rate of Return = 35.35%						

Figure 2

The Key Box

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shelters merchandised in 1981.

Tax losses result from a combination of interest paid and depreciation. Cash flows from tax benefits are computed by multiplying gain or loss by your assumed top tax bracket. Fifty percent was used for the real-estate deal and 55 percent for the airplane (based on combined federal and state rate). In the year of sale, tax must be paid on the gain. The maximum long-term capital gains rate of 20 percent applies to the real estate, but depreciation on the jet will be "recaptured," so that gain is taxable at ordinary rates.

In both cases, cash paid out to you during the life of the investment is nominal. Sales price is assumed to be sufficient to return the principal cash

invested. Even so, a high rate of return results from "tax leverage." This is an after-tax rate.

The program lets you change the initial cost, sales price, or flow for any year without re-entering the other data. This permits you to explore creative financing terms and assumptions about the state of the market when you dispose of the asset. You can study their effects on the yield of a down payment split over several years, greater purchase price in exchange for a longer due date on junior financing, lower down payment or lower annual payments with greater balloon, and any other variations.

In Fig. 3, calculations are made for three possible sales prices. Amounts

APARTMENT BUILDING

Year	Purchase Installments	Cash Flow	Net Cash Required	Tax Gain Or Loss	Tax Benefit	Net Cash Flow
0	350000					(350000)
1		8223	(8223)	(84322)	46377	54600
2		9010	(9010)	(67180)	36949	45959
3		14505	(14505)	(53295)	29312	43817
4		20380	(20380)	(38990)	21445	41825
5		26665	(26665)	(24230)	13327	39992

55% rate

Cash to loan sale: 25% capital gains tax

A. 7%/yr. appreciation	(689691)	686491	(171623)	518068
B. 3%/yr. appreciation	(470166)	466966	(116742)	353424
C. 0% appreciation	(311200)	368000	(92000)	219200

Internal Rate of Return:

- A. IRR = 19.77%
- B. IRR = 13.32%
- C. IRR = 6.48%

Figure 3

Program Listing

```

100 REM *****
110 REM INVESTMENT ADVISOR
120 REM BY CHARLES R. PERELMAN, 1982
130 REM 9777 WILSHIRE, BEVERLY HILLS, CA.
140 REM PRESENT VALUE COMPARISON OF INVESTMENTS
150 REM INTERNAL RATE OF RETURN
200 REM *****
210 DIM F(20),PV(20)
220 D1$="$$#,###,###.##":R$="####.###":E$="-_1234567890"
250 CLS:PRINTTAB(20)"INVESTMENT ADVISOR":PRINT:PRINT"DO YOU WANT
INSTRUCTIONS? (Y OR N)";
260 Y$=INKEY$
270 Z$=INKEY$:IF Z$="" THEN 270
280 IF Z$<>"Y" AND Z$<>"Y"AND Z$<>"N" AND Z$<>"n" THEN 270
290 IF Z$="Y" OR Z$="y" THEN GOSUB 6020
300 REM *****
310 REM MAIN MENU
320 CLS:PRINTTAB(20)"INVESTMENT ADVISOR":PRINT
330 PRINT:PRINT:PRINT"MAIN MENU":PRINT" 1. ENTER ITEMS":PRINT"
2. REVIEW OR CHANGE ENTRIES":PRINT" 3. COMPUTE PRESENT VALUE"
:PRINT" 4. COMPUTE INTERNAL RATE OF RETURN":PRINT" 5. EXIT FR
OM PROGRAM":PRINT:PRINT" PRESS NUMBER FOR CHOICE";

```

Listing continues

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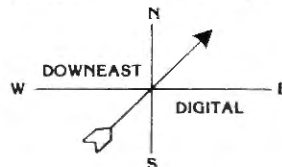
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Listing continued

```

340 Y$=INKEY$
350 Z$=INKEY$:IF Z$="" THEN 350
360 IF VAL(Z$)<1 OR VAL(Z$)>5 THEN L=910:A=1:GOSUB 7120:GOTO 340
370 ON VAL(Z$) GOSUB 1020,2020,3020,4020,5020
380 GOTO 320
1000 REM *****
1010 REM ITEM ENTRY ROUTINE
1020 CLS:T=0:C=0:SP=0:FOR X=1 TO N:F(X)=0:NEXT:PRINT"ENTER COST
OF ASSET ";:L=21:PF=1:GOSUB 7520:C=VAL(Z1$):PF=0
1030 IF C=0 THEN A=5:GOSUB 7120:GOTO 1020
1040 LINEINPUT"ENTER NUMBER OF YEARS, MAXIMUM OF 20: ";N$:N=VAL
(N$):L=0
1050 FOR Y=1 TO LEN(N$):Z=ASC(MID$(N$,Y,1)):IF Z<48 OR Z>57 THEN
PRINT@119,SPACE$(41);:A=2:L=80:GOSUB 7120:N=0:N$="":GOTO 1040 E
LSE NEXT Y
1060 IF N<1 OR N>20 THEN PRINT@119,SPACE$(41);:A=2:L=80:GOSUB 71
20:N=0:GOTO1040
1070 PRINT:PRINT:FOR X=1 TO N:PRINT X;" ENTER ANNUAL CASH FLOW
";:L=(X*80)+268:GOSUB 7520:F(X)=VAL(Z1$):NEXT
1080 PRINT"ENTER NET SALES PROCEEDS AT END OF LAST PERIOD ";:PF
=1:L=(X*80)+288:GOSUB 7520:SP=VAL(Z1$):PF=0
1090 RETURN
2000 REM *****
2010 REM REVIEW AND CHANGE
2020 IF C=0 THEN A=5:GOSUB 7120:RETURN
2030 CLS:PRINT"COST OF ASSET ";:PRINTUSING D1$;C
2040 FOR X=1 TO N:PRINT X;" CASH FLOW FOR PERIOD ";:PRINTUSING
D1$;F(X):NEXT
2050 PRINT"SALES PROCEEDS AT END OF LAST PERIOD ";:PRINTUSING D
1$;SP
2060 PRINT@1760,"ENTER NUMBER TO CHANGE, C FOR COST, S FOR SALES
PRICE, 0 FOR NONE. ";CHR$(8)+CHR$(8);:LINEINPUT Z$
2070 IF Z$="0" THEN RETURN
2080 IF Z$="C" OR Z$="c" THEN PF=1:L=15:PRINT@L,SPACE$(15);STRIN
G$(15,8);:GOSUB 7520:C=VAL(Z1$):PF=0:GOTO 2060
2090 IF Z$="S" OR Z$="s" THEN PF=1:L=(N+1)*80+39):PRINT@L,SPACE
$(15);STRING$(15,8);:GOSUB 7520:SP=VAL(Z1$):PF=0:GOTO 2060

```

Listing continues

were adapted from an actual apartment project. Commissions and costs of sale are estimated at six percent of the sale price. Total cost is \$1,000,000 with \$350,000 down. Depreciation is computed under the new ACRS rules. Comparison for a range of sales prices can be made rapidly with the facilities of the program.

In evaluating real estate, you can compare the results of possible changes in cash flow upon your ultimate return within the range you would anticipate on a worst-case or best-case basis. This is called sensitivity analysis. This kind of calculation is often revealing and can either warn you that the deal is on "thin ice" or else spot a bonanza where you have figured out a way to increase income levels and cash flows.

Perform the following steps:

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computations. You might be surprised at the difference two or three percent in gross income will make in your effective return.

IRR is also used to determine the best time to sell a property. The interplay among annual tax benefits (which decrease as depreciation is used up and the principal portion of loan payments grows larger), possible yearly increases in value of the asset, and the tax you will have to pay to realize the sales price (which depends upon whether the gain qualifies for long term capital treatment) is taken into account when you determine the net cash flow after taxes and measure the success of your investment with IRR.

Program Structure

Investment Advisor can be converted for use on Model I or Model III with changes in the Print statements. SPACES on the Model II prints a series of blanks and can be replaced by STRING\$. By dimensioning the program for 20 periods, all inputs fit on the Model II screen and permit review of all data when making changes for subsequent runs.

You can use the same data to deter-

Listing continued

```

2100 IF VAL(Z$)>=1 AND VAL(Z$)<=N THEN X=VAL(Z$):L=((X*80)+27):P
RINT@L,SPACE$(15);STRING$(15,8);:GOSUB 7520:F(X)=VAL(Z1$):GOTO 2
060
2110 A=7:GOSUB 7120:GOTO 2060
3000 REM *****
3010 REM PRESENT VALUE PROGRAM
3020 CLS:PRINT"ENTER REQUIRED INTEREST RATE WITHOUT PERCENT SIGN
,E.G.":LINEINPUT"FOR SIX AND ONE HALF PERCENT ENTER 6.5 ";Z$
3030 IF VAL(Z$)<=0 THEN A=4:GOSUB 7120:GOTO 3020 ELSE I1=VAL(Z$)
/100
3040 F(N)=F(N)+SP:FOR X=1 TO N:P(X)=F(X)/((1+I1)^X):T=T+P(X):N
EXT:F(N)=F(N)-SP
3050 IF T=0 THEN A=5:GOSUB 7120:RETURN
3060 CLS:PRINT"AT INTEREST RATE OF ";USING R$;I1*100:PRINT"PRESE
NT VALUE OF CASH FLOWS IS";:PRINTUSING D1$;T:PRINT
3070 T=0:LINEINPUT"PRESS ENTER TO CONTINUE";Z$:RETURN
4000 REM *****
4010 REM INTERNAL RATE OF RETURN
4020 CLS:PRINT"COMPUTING INTERNAL RATE OF RETURN":I1=.4:I2=0:I3=
2:F(N)=F(N)+SP
4025 IF I1<.01 THEN PRINT:PRINT"SORRY, IRR IS LESS THAN 1%. BAD
INVESTMENT OR ERROR?":PRINT"PLEASE START AGAIN":GOTO 4090
4030 FOR X=1 TO N:P(X)=F(X)/((1+I1)^X):T=T+P(X):NEXT
4040 IF T=0 THEN A=5:GOSUB 7120:RETURN
4050 IF ABS(C-T)<C*.001 THEN 4080
4060 IF C>T THEN I3=I1 ELSE I2=I1
4070 I1=(I3+I2)/2:T=0:GOTO 4025
4080 PRINT:PRINT"INTERNAL RATE OF RETURN = ";:PRINTUSING R$;I1*1
00
4090 F(N)=F(N)-SP:T=0:PRINT:LINEINPUT"PRESS ENTER TO CONTINUE";Z
$:RETURN
5000 REM *****
5010 REM END PROGRAM
5020 A=6:PRINT CHR$(31);CHR$(26);:GOSUB 7120:PRINT CHR$(25);CHR$
(30):END
6000 REM *****
6010 REM INSTRUCTIONS

```

Listing continues

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```

6020 CLS:PRINTTAB(20)"INVESTMENT ADVISOR":PRINT
6030 PRINT" THE PRESENT VALUE PROGRAM WILL COMPUTE THE VALUE O
F ALL OF CASH FLOWS YOU":PRINT"WILL RECEIVE FROM AN INVESTMENT A
T THE INTEREST RATE OF YOUR CHOICE. THIS IS":PRINT"THE VALUE TO
YOU NOW OF THIS INVESTMENT."
6040 PRINT" THE INTERNAL RATE OF RETURN PROGRAM COMPARES ALL O
F THE CASH FLOWS TO THE":PRINT"AMOUNT OF YOUR INITIAL INVESTMENT
AND GIVES YOU THE COMPOUND RATE YOUR":PRINT"INVESTMENT EARNS OV
ER ALL THE PERIODS."
6050 PRINT" ENTER NUMBERS WITHOUT DOLLAR SIGN OR COMMAS. ENTE
R NEGATIVE CASH FLOWS":PRINT"OR PAYMENTS REQUIRED WITH A MINUS S
IGN.":PRINT:LINEINPUT"PRESS ENTER TO CONTINUE";Z$:RETURN
7000 REM *****
7010 REM SUBROUTINES
7100 *****
7110 REM FLASHING MESSAGES
7120 M$(1)="FROM 1 TO 5 ONLY PLEASE":M$(2)="MUST BE BETWEEN 1 AN
D 20":M$(3)="REENTER--EXCEEDS LIMIT":M$(4)="MUST BE POSITIVE NU
MBER":M$(5)="DATA NEEDED":M$(6)="BYE NOW!!":M$(7)="INCORRECT ENT
RY"
7130 FOR W=1 TO 2:PRINT@45,"** " +M$(A)+" **":FOR Y=1 TO 500:NE
XT:PRINT@45,SPACE$(35):FOR Y=1 TO 300:NEXT:NEXT W:PRINT@L,"";:RE
TURN
7200 REM *****
7500 REM *****
7510 REM ENTRY ROUTINE
7520 Y$=INKEY$:Z1$=""
7530 Z$=INKEY$:IF Z$="" THEN 7530
7540 IF ASC(Z$)=8 AND LEN(Z1$)>0 THEN PRINT CHR$(8);:Z1$=LEFT$(Z
1$,LEN(Z1$)-1):GOTO 7530
7550 IF ABS(VAL(Z1$))>9999999.99 THEN A=3:GOSUB 7120:PRINT@L,SPA
CE$(10);STRING$(10,8);:Z1$="":GOTO 7520
7560 IF PF=1 AND Z$="-" THEN A=4:GOSUB 7120:Z1$="":GOTO 7520
7570 IF ASC(Z$)=13 THEN PRINT STRING$(LEN(Z1$),8);:PRINTUSINGD1$
;VAL(Z1$):RETURN
7580 IF INSTR(E$,Z$)=0 OR LEN(Z1$)>0 AND Z$="-" THEN Z$="":GOTO
7530
7590 Z1$=Z1$+Z$:PRINT Z$;:GOTO 7530

```

mine present value of cash flows or IRR. An assumed cost for the investment must be entered. Extensive error trapping is provided. Only positive inputs are accepted for cost and sales price.

The IRR calculation beginning at line 4010 uses a trial-and-error repetitive loop to zero in on the actual rate of return. CHR\$(31) changes to 40 characters per line and CHR\$(26) to reverse video. CHR\$(25) and CHR\$(30) return to normal video and size after the program-ending message.

Variable L is used for cursor positioning after error messages. The INKEY\$ entry module at 7510 can be used in any program requiring numerical entries. When PF=1, a minus sign will not be accepted.

Financial return is only one of the measures for sophisticated investing, but it must be evaluated. Use it to help you make intelligent decisions for a successful economic future. ■

Charles R. Perelman is an attorney, CPA and certified tax specialist in California. He lives at 9777 Wilshire Blvd., Suite 700, Beverly Hills, CA 90212.

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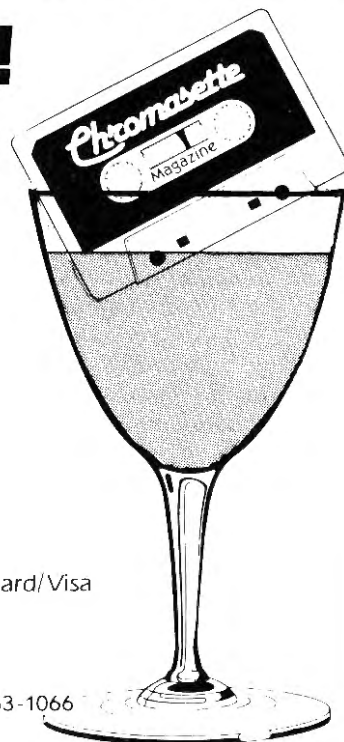
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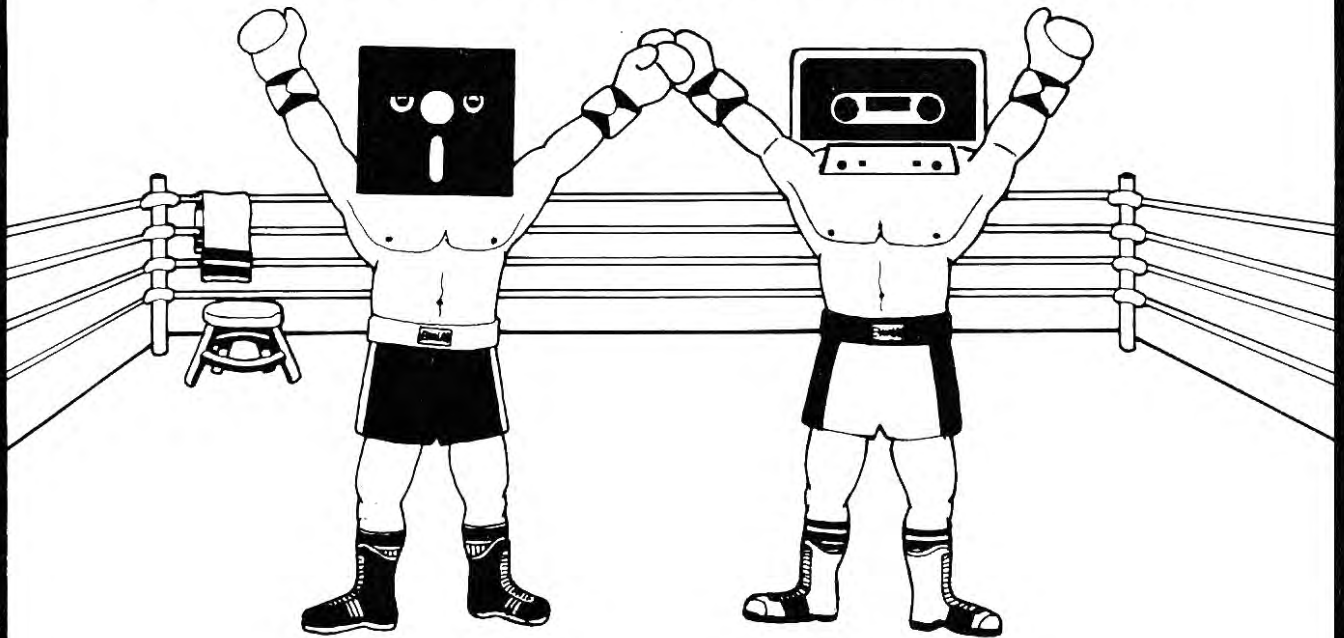
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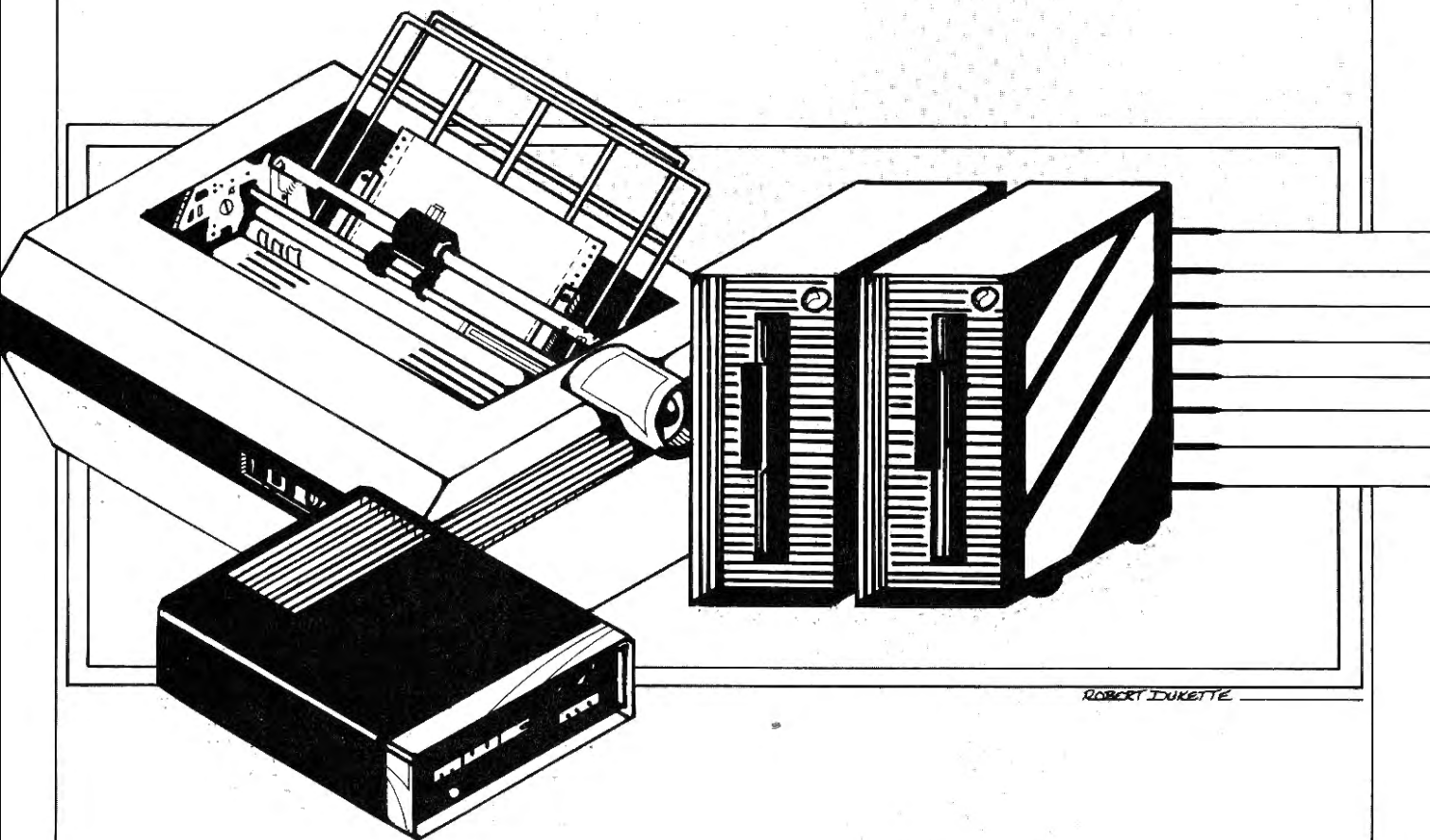
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Part V.

PERIPHERALS



How to Buy a Printer

by Jim Hansen

Epson, IDS, Okidata, NEC—which do you choose? Jim Hansen is an industry insider who can give you good advice when printer shopping.

You've paid your dues. With upwards of \$2,000 invested, your computer system has a reasonable amount of memory, disks, and a good monitor. The time has come to select a printer. The choice can be difficult because printer manufacturers do not all talk the same language (from both a technical and ethical point of view), and prices range from around \$300 to over \$10,000. By selecting the wrong printer you can make an expensive mistake.

The two major printer technologies available are impact (where something

strikes the paper to form the character image) and nonimpact printing where heat, light, electric current flow, or other techniques are used to make an image visible.

Generally, nonimpact printing requires the use of special paper. This paper may be coated with aluminum (which is burned away to form characters) or a chemical that is activated by heat or light. Another nonimpact printing technology involves squirting ink directly onto paper. The ink is deflected electrostatically much like the electron

beam of a tv picture tube to write the character, or squirted from nozzles to make dot-matrix-like characters. This technology is currently out of the price range of most home computerists.

Nonimpact printing is usually in dot-matrix form, characters formed by a series of dots much like a baseball scoreboard. Paper for these printers is available from a limited number of outlets or mail order, and is relatively expensive. I don't like the feel of any of these papers. They tend to curl and never lie flat. Since they come only in rolls, you have to carefully trim the stuff if you want an 8½-by-11 sheet. They are typically thin, and therefore fragile. The images formed by this technology often have low contrast (they aren't very dark) but they usually copy well. Thermal papers (such as used by Texas Instruments and Computer Devices Inc. portable terminals) fade if left in the sun.

The real advantage of nonimpact printing is that it is quiet. I once built an interface for a Casio ink-jet printer. The most noise I heard from the mechanism was the sound of the paper sliding down the back of it during line feeds.

Impact Printers

Impact printing includes all the common dot-matrix, daisy-wheel, and line printers found in computer centers today. The two divisions within this technology are dot-matrix and fully formed character printers. Fully formed character printers use a type pallet much like a typewriter to make the characters. The daisy-wheel and selectric-like (ball) printers fall into this category.

Line printers found in large computer installations have drums, chains, or bands that carry the typeface pallets. Some popular terminals also use this

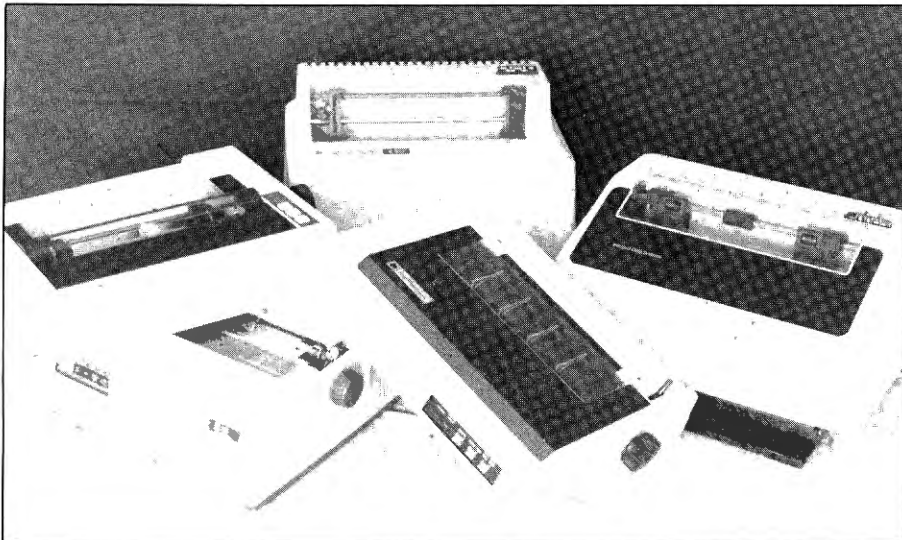


Photo 1. Several popular printers—which one is for you? Top to bottom, left to right, they are the Epson MX-80; the Okidata Microline 82; the IDS 440, the latest low-cost printer from IDS, the Micro-prism; and finally the full-size Prism 80.

technique. The General Electric Terminet series is one example. Line printers are usually designed for speed rather than quality. The daisy-wheel and ball printers are designed to produce quality print.

Selectric-based printers use a variation of the IBM Selectric typewriter mechanism (usually called a Selectric I/O model) and can print around 10 to 15 characters per second. Output from a well adjusted Selectric printer is unmatched in quality. Prices for such a printer on the used market are also very attractive. These printers are old (but fully repairable by typewriter stores), slow, and above all, not reliable. (The type-ball positioning bands will not take sustained high-speed output and go out of adjustment or break.) Selectric-type printing terminals are good enough to make offset masters for printing, offer a wide range of typefaces, and provide you with a good typewriter when your computer isn't using it.

Most daisy-wheel printers are from Diablo, the company that made this printing technique practical; Qume, a company formed by former employees of Diablo; and NEC, a Japanese company. (The NEC printer uses a "type basket" instead of a daisy wheel, but otherwise the printer is about the same.) Radio Shack also sells an imported daisy-wheel printer similar in construction to the Diablo-type printer.

The printing element of daisy-wheel printers is a spoked wheel with a type pallet molded on the tip of each spoke. The selected character is spun into position where a hammer strikes it. Until recently (the last couple years or so) the daisy-wheel printer was the only printer offering dot-addressable graphics and proportional spacing. The speed of these printers is typically 30 to 60 characters per second. While not high-speed printers, they produce typewriter-quality printing and take any kind of paper you can put into a typewriter. The images printed are usually not as clean or dense as those of a Selectric printer, but the mechanism is much more reliable and at least twice as fast.

The dot-matrix printer was originally designed to print lottery and racing tickets back in the early 1960s. These designs were meant to be used in very light duty, low-speed applications. Gradually, print-head improvements provided faster needle operation and longer lasting heads. The microprocessor came along in the late 1970s, and soon there was a huge demand for low-cost printers for low-cost microcomputers. Without the microcomputer, the

demand for printers of this type would not support the present market, and without the microprocessor, today's dot-matrix printers could not be made, an interesting case of symbiosis.

The dot-matrix printer is the most widely accepted printer technology on the market, because it can be mass produced cheaply for low-performance, basic printing applications, yet with more sophisticated design can print much faster, with high quality. Dot-matrix printers still cannot produce typewriter-quality images, but are doing an increasingly good job at trying. The dot-matrix printer can electronically change character fonts, automatically justify text, provide intercharacter proportional spacing, print in four or more colors (with overstrike), automatically feed letterhead paper, and they can do this fast. Even the slowest popular models such as the Epson MX-80 or MX-100 have throughput rates over 30 characters per second.

What to Ask the Salesman

Since nearly every manufacturer has a different way of saying the same thing, and there is a lot of "specsmanship" involved, talking to a salesman can be confusing. (Specsmanship is

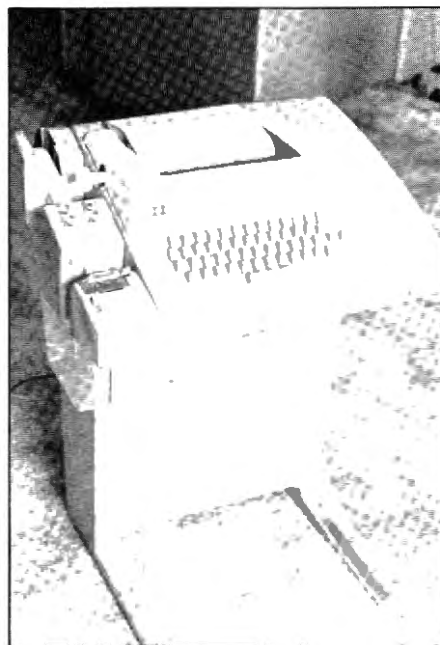


Photo 2. The ubiquitous Teletype Model 33. Probably the lowest-cost terminal/printer you can own. This printer is a 10-character-per-second unit, uppercase only. Features include a paper-tape reader, punch, and keyboard. These printers were designed in the 1950s and over a half million of them were produced. They are available on the surplus market at around \$250, and will last forever if properly maintained (oiled) and you keep the mice out of them.

where specifications are written so the reader thinks things are better than they are.) Here are a few terms and their definitions that are bandied about. You should understand them before you begin to compare printers.

Cps usually means characters per second. Advertising might say that a given printer is an 80-cps printer. What they actually mean is that it is possible for the printer to print something at a rate of 80 characters per second. This might be two adjacent periods. In any event, this specification is meaningless.

The only meaningful speed rating is throughput. This is the number of characters or lines of text that is actually put down on paper in a given unit of time. You can measure the throughput of a given printer with a simple program that outputs a given number of characters; simply divide the number of characters by the time it takes to print them. This figure varies with the length of the line and other printer features, but in most low-cost printers, it is something around 30 to 40 characters per second.

Near letter quality (nlq), correspondence quality, and other such terms are the way manufacturers say that they have a print head that provides overlapping dots. This closes in the dot pattern and makes the characters look more fully formed. Some printers overlap dots only vertically, others both vertically and horizontally. You will probably find that those printers with nlq have a shorter (typically .09 in.) character, rather than the standard .1-inch-high matrix character. Unless you prefer larger characters for easy reading, there is no reason to choose a printer on this issue alone.

Lowercase descenders: Are they above or below the base line? It is cheaper to build a printer with a seven-needle head than a nine-needle version. If the print head has only seven needles, then lowercase characters must be printed entirely above the base line. One of the most popular terminals I've used is the Decwriter II from Digital Equipment Corporation. It has only seven needles. The lowercase g, j, p, q, and y characters are scrunched above the base line. No legibility problem, but I recommend a printer with nine needles if everything else is equal, or if print quality is important.

Printer buffer: This is the internal memory capacity of a printer. Cheaper printers buffer only one line. What this means is that the printer can gobble up only one line of text at a time from your computer, print that line, then gobble another. In the meantime, you and your

computer must sit around and wait for the printer. Larger printer buffers, some as big as 3,600 bytes (or characters), allow the printer to consume that much text, then free your computer to do other things while it prints the buffered information. Special programs called spoolers do much the same thing.

Character sets and fonts: A character set is the list of all printable characters. Typically, this is all the ASCII characters from CHR\$(32)—a space—to CHR\$(127). A printer that prints all these characters is called a 128-character printer. A 64-character printer is one that only prints the capital letters A through Z. If you are interested in a printer like this, be sure that it can be set to print the uppercase equivalents of the lowercase characters. (Sooner or later you will send lowercase text to it.) A font is the design of the characters in a character set. For example, the two most common typewriter fonts are pica and elite. Spec sheets that do not mention fonts mean the printer has only one font.

A printer that can be loaded with a font from your computer is said to have "downloadable" fonts. This may seem

like a powerful feature, but a complete character set is difficult to design. (I have done it, and it takes several weeks of fulltime work to just set up the character-set dots on paper.) Downloadable-type printers sometimes don't allow you to replace just a single character. Further, many printers of this variety don't have the high density, overlapping dot fonts of the near letter-quality printers.

Multispeed printing: Manufacturers have discovered that by printing fewer dots and spreading them apart, they can make a printer with higher throughput. Since the character-set font has fewer dots, the quality of it is not as good, and so these high-speed fonts have a variety of names. So-called "draft" fonts can nearly double the throughput of a given printer.

Proportional spacing is the ability of a printer to vary the amount of spacing between characters. Intercharacter proportional spacing allows a printer to print text so that it can be justified; the right margin of the text can be made square like the left, without simply doubling up on the spaces between words. Most daisy-wheel printers have this capability as does the Centronics 739

printer. In these cases, your computer must maintain a table of character widths and tell the printer how much to space each character. Integral Data Systems IDS 460, 560 and the entire Prism and Microprism line feature automatic proportional spacing.

Text justification, as mentioned earlier, is the squaring off the right margin of print. If the printer can proportionally space characters, then by keeping track of the amount of print space left on a line and the length of the following word to be printed, you can add or delete space between characters so the line is completely filled each time. You naturally do not want to break a word in the middle, so each line must be examined and the spacing computed before it is sent to the printer. A very few printers provide automatic text justification. When enabled, text is justified within the bounds set by the margins. Margins can be set to any width so that newspaper-like columns or full-page lines alike can be automatically filled with text, without any assistance or text processing from your computer.

Most dot-matrix printers in the low price range have a number of miscellaneous print features that add to their

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versatility. Bolding, available on some, is simply an automatic overstrike. (The printer prints a bolded line twice.) Double-width characters are printed by doubling up on the horizontal dots, making characters twice as wide.

Many printers have selectable pitch. Names for pitch vary. Epson talks about enlarged or condensed characters, while most American companies use a character-per-inch (cpi) term. Standard pitches are 10, 12, and about 16 characters per inch. (The 16-character-per-inch pitch is important since it allows a 132-character line to be printed in eight inches, and therefore on 8½-by-11 pages.)

Underscore capability is difficult for low-cost printers because a line through any dot-matrix character just about destroys legibility. Dot-matrix printers have met the challenge three ways. The first is to ignore the issue and let the user manually underscore text using a period or graphics. Second, some printers have a special font that leaves the bottom (ninth) dot free. Automatic underscore simply fires the bottom needle for every character. The third variation is to provide underscore on the ninth dot and wipe out the lowercase descenders.

(This makes it difficult to read words with descenders in them, but does give something to print on the spec sheet.)

At this writing Centronics and Integral Data Systems are the only companies selling a low-cost color printer. The Centronics 739 printer can be fitted with an option for a red-black ribbon. The IDS Prism printers use a four-color ribbon. Colors can be mixed by overstrike.

Graphics capability is a natural for dot-matrix printers. Instead of internally looking up a list of dots to be printed from the ASCII character code, the only difference in printing graphics is that the ASCII character code itself is printed. Printers differ in the way the character codes are handled. For instance, Centronics uses graphics characters only above 32; this allows control codes such as carriage returns and line feeds to work normally. IDS uses all ASCII values from 0-127, using a control code as an escape from graphics. Epson requires that the computer tell the printer how many graphics characters are coming, then prints all the following characters as graphics. The character codes themselves are printed in two ways. Bit zero of the ASCII code can be

used to print either the top or bottom needle of the head. Each following bit of the ASCII code is used to control the following needle.

The printer's resolution is about the only feature mentioned in the graphics part of a specification sheet. Horizontal resolution is determined by how fast the head moves across the paper and how fast the needles fire. This is typically over 72 dots per inch, but can vary. Vertical resolution is controlled mechanically by needle spacing in the head. The only way this can be changed is to change the head. Generally, the more dots per inch, the finer the printed image. Most graphics output comes from screen dumps, and the resolution of these graphics is limited to that of the screen, regardless of your printer.

Mathematically, if the vertical and horizontal resolutions are the same, images printed will not be distorted. If a circle is plotted, then sent to a printer with 100-by-100-dot-per-inch resolution, the circle prints round. If the printer had a resolution of 100 by 80, the circle becomes egg shaped by about 20 percent. If your printer has a resolution near 80 dots per inch, it is state of the art. If the image distortion due to



Hello thayuh. This is Eben Flow, proprietor of the Fish or Cut Bait Company, buyer and seller of lobstah bait for 49 years. My hobbies are collecting linoleum samples, squashing flies and playing pac-person on my home computer.

But here on Martinicus Rock, off the coast of Maine, the power can be a tad erratic. So, to cure the brownout and blackout problems, and to keep them spikes and surges off my picture tube, I got me a **MAYDAY** Uninterruptible Power Supply from SUN RESEARCH. Them fellas fixed me up real good and real light on my pocketbook, too. Got me a **MAYDAY** for my mini-calcaputer with a voltage regulator and everything for only 325 clams. They even included the battery in a nice waterproof box. Handy out here, you know. Now, if **MAYDAY** would only keep them sea dogs out of my barrel. . .

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nonsymmetrical resolution is important, it can be corrected by software.

Your printer's interface is important. There are two kinds: parallel and serial. A parallel interface is common among the cheaper printers because it requires less electronics and is simpler to control. Basically, a parallel interface requires a common ground, a signal for each bit in the characters to be sent (normally 7), a strobe (the signal from your computer that says a character is ready for the printer to pick up), and a busy or acknowledge from the printer that says it is ready for the next character.

If the printer doesn't want another character, it signals "busy" or doesn't acknowledge the last character sent. Your computer waits to send the following character until the busy or acknowledge is returned, and that is why it hangs up if your printer is offline when you try to print to it. The so-called "Centronics" parallel interface (which, incidentally, has no formal standard) is the most common parallel interface, and usually printers and computers with this interface work together without any problems.

Serial interfaces are required if you want to use your printer with a terminal connected with timesharing computers. Many low-cost printers do not offer a serial interface, or offer it as an extra-cost option. Serial data requires a ground, a data line from your computer, and a signal to tell your computer when to stop. This may be the Data Terminal Ready (DTR) signal that is either on or off, or an actual ASCII code for control S (XOFF) or control Q (XON). The XON-XOFF code is used when you are connected through telephone lines. Data Terminal Ready can only be used if your printer is "hardwired" to your computer.

The problem that printers have with serial data is that the data can come in just about anytime. Also, it has to be serviced within one character time, or the next character can arrive and be lost. If you are running serial data at 9,600 baud, for example, the characters have to be handled in 1/960th of a second.

Another problem is that when the printer wants data to be stopped, there may be another character already on the way, or when XON-XOFF is used, 10 or 20 more characters may arrive before the computer gets around to stopping them. The management of serial data requires processing time from your printer, plus a buffer area in memory to handle the data. Many low-cost printers do not have the software sophistication or memory to handle serial data, and so

the serial option becomes a little box that lives outside the printer.

I can't think of any reason why one interface should be preferred over another, if you can run serial at 9,600 baud. Serial interfaces might be considered more flexible since you can use them with a terminal and a computer. One thing that is not important is the parallel data-transfer rate. I once found a Japanese firm extolling the parallel data rate—how fast characters could be accepted by the printer. This specification has no meaning as long as it is faster than the throughput of the printer.

Paper-handling ability is an important aspect of the printer. Until recently (the last year or so), most printers required perforated continuous stock, because it is difficult to design a printer that will take a single sheet of paper or continuous stock equally well, and because the print quality of earlier dot-matrix printers was so poor that nobody

*"Educate yourself
to be coldly objective about
what you
see, hear, and read."*

wanted to send a letter printed by them.

With the advent of the improved character sets, all this has changed. Low-cost printers can now take single-sheet paper, but for the most part, paper insertion is difficult and you must carefully align each sheet for left and right margins as well as for the top edge. I am not aware of any low-cost printer than can take an envelope, but this problem will probably be solved within the next two or three years.

The operating costs of a printer are primarily a function of ribbon cost in terms of dollars per characters printable, and the cost of a replacement head. Ribbon lifetimes can vary, depending on how fast they are used (the ink can dry up over a period of time) and how fussy you are. Ribbon usefulness is subjective; a dead ribbon for one person is only half gone for someone else. You had better believe that the ribbon lifetime on a specification sheet means the end of lifetime to everyone.

Quoted print-head lifetime is a statistical matter. Print heads can die in several ways. The jewel in the nose of heads (it is a bearing that aligns and guides the print wires to the paper) can

crack or wear out so the wires are not held evenly. This results in "wavy" characters. It can also gum up with ink and paper lint. This results in a sticky needle that won't work well when it is cold. Other electrical or mechanical faults usually stop operation of a needle. The lifetime of a head is usually specified in millions of characters. Cheap, disposable heads last 30 or 40 million characters. Nondisposable heads can last 200 or 300 million characters. Compare the cost on a character-to-dollar basis to find which is the best bargain. (The more expensive heads usually win.)

Off to the Market

Now, how does one go about shopping for a printer? Unless you live near a good-sized town that has several computer stores, you are going to have to trust in the reviews that you have read in magazines or pick a printer that a friend has, simply because it is the only one you have seen work.

First, educate yourself to be coldly objective about what you see, hear, and read. Second, slow down and take the necessary time to find your printer. This can not only save you money, but also get the printer that fits *all* your needs.

Let's practice by picking a printer for someone that would have a typical variety of printing needs. Assume that you are a college student in the junior or senior year. By this time, a student would have a variety of text that could be edited and printed by a small computer system.

If this student were involved with mathematics or statistics, then the computer would certainly be an asset to him in other areas, especially if the printer could handle graphic output. An economics major might find one of the popular spread-sheet programs of use. These requirements are not too far removed from those of a small business user, except that small businesses would generally run the same programs every month, and usage might require a heavier-duty printer. Since small businesses might use the system to run billing or other higher-volume data through the printer, throughput is a greater concern.

So let's pick a general-purpose printer in the low price range. This printer must print near-letter-quality text, because you will want to print term papers and the like on it. Since term papers typically use single-sheet paper, it must be able to print on typewriter paper as well. The printer should be able to super and subscript text, as well as underline and overstrike text for bolding.

Already, the list of specifications has gotten us into trouble. There are only one or two printers on the market that can automatically fill all the above needs, unless you go shopping for a word processor that supports your printer. You might not only have to look for a printer in your price range, but will have to select and pay for a word-processor package as well.

The next step is to get a collection of magazines together and systematically compile a list of available printers, phone numbers, and addresses of each manufacturer. Call those with 800 numbers and write (or circle bingo numbers) all the others that interest you. You may find that literature reaches you faster if you write directly rather than using bingo numbers (reader service cards) offered by some magazines.

Check the literature off the list as you receive it. Don't start your decision-making process until you have all your data, unless a given printer sells for more than your budget. Simply mark your list as "price out of bounds," but keep track of all printers until you have made your final decision.

Make a chart with columns for brand name, model, and each feature that you want. A student will want proportional spacing, a near-letter-quality font, super/subscripting, single-sheet paper handling, probably graphics, and price. You might also want some idea of the throughput of a given printer, but you will probably have to find this in a review since advertising literature normally mentions only the character-per-second print rate. The last column should be the retail price. Use this instead of any mail-order prices you might have found. (Comparing mail-order prices may be misleading.)

Ignoring any gloss that you might find on the brochures, examine the claimed performance of every printer and check off the columns for each feature that is important to you found on the printer. Ignore any features (for now) that you didn't put on the chart.

After you've entered the entire stack of printer literature onto your chart, set aside the literature for the printers that do not meet your needs, and don't let them influence any further product selection.

Your next step is to read product reviews for the printers that made the first cut. Hopefully your library has a couple computer magazines. If not, order back issues of *80 Micro* and other magazines that have a cumulative index. From that you can find the issue that has the review you are looking for.

A book that you may find useful is called *The Index* by W. H. Wallace. (Missouri Indexing Inc., P.O. Box 301, St. Ann, MO 63074, 314-997-6470). This book is an index of over 40 magazines printed to about mid-summer, 1981, most from the first issue.

The important thing about reading reviews is to try to get a feel for the author. I don't know how many times I've read something like, "This is the first widget I've ever used, and it is the best one in the world." The best thing you can do with a review of this caliber is to trash it. Look for an objective review, keeping in mind that there is something wrong with every product, and if the reviewer doesn't mention something bad, he hasn't done a good job.

At this time you should also visit computer stores in your area, and friends (and strangers) that have printers of the type you are considering. After researching reviews, your list of possibilities should narrow. Now you

*"Don't spend your money
until you understand
what you are buying."*

must assess the product support for the remaining printers. Where do you get the printer fixed and how long will it take? If you call the factory (or importer), can they give a competent answer to your questions? Is there any "canned" software that is necessary for your application?

Typically, there are three possible places to get your printer fixed. The most obvious is to take it to the place you bought it. Results of this type of service vary, but if you have purchased products from a computer store and are known there, your service is likely to be much better than if you buy your printer by mail order. Part of the higher price of retail sales is for customer support, to be rendered before and after the sale. This hand holding, as it is sometimes called, doesn't come free. Mail-order houses can laugh at you if you have a problem.

In any event, check into factory-authorized service facilities; how many are there, where are they located, and so on. You can find this information in the literature you already have. If not, call the printer company and ask. Don't let yourself be talked into the idea that the

printer is so reliable it doesn't break. That is pure balderdash. Ask about company factory repair, and the usual turnaround. If you do a thorough job, you will also call the factory service center and ask, "My model XYZ just broke (nothing happens when I turn it on, and there is a strange smell inside). Any guess how long and how much it will take to get it back?"

Many import products have little or no service program and rely on random dealers to fix broken printers. Since the dealers are very often undersold by mail-order houses, they are not terribly interested in fixing the mail-order specials, and so you suffer the results. The other side of this is that dealers very often have not been trained by the importers and have to rely on manuals not much different from user manuals sent with the product. In the search for your printer, place a heavy value on the quality of service you can expect when it breaks.

Not many importers offer help over the phone; American companies do better in this respect.

The final consideration in product support is perennial for both computers and peripherals. What software is available for the product? Word processors are important, but many applications do not need them. Many newer features such as proportional spacing built into the printer cannot be used on popular word processors. Graphics is another area where existing software is vital. Most people either could not or will not develop a graphics handler for their printer. If graphics is important, and you want to do more than a simple screen dump, look for a graphics package to drive the printer before you buy it.

If you have conscientiously followed the guidelines I have given you, the printer you buy will suddenly pop out of the list. I can't tell you which one is best. This decision is one that you must make. But you can make a wise decision if you take the time to learn the jargon around printers and examine everything you can from advertising, product reviews, trade journals, retail stores, and friends.

The important thing is not to hurry. Don't spend your money until you understand what you are buying. And above all, don't give up and just buy the printer that is most widely advertised. When you do that, the advertisers win, and you might come in second place. ■

Jim Hansen's address is P.O. Box 234, New Boston, NH 03070.

Suppress Those Demon Transients

by G. Michael Vose

Your micro needs good, clean electrical power to run at its best. Here's what you can do to minimize noise and voltage disturbances.

Like a dark and slimy creature living in the bowels of a nightmarish fantasy, there is a demon hiding in the nooks and crannies of your computer room. These demons force themselves into the lifeblood of your computer system—its electrical power lines—to zap your data or crash your programs.

These creatures have supercharged names—spikes, surges, transients, sags, pulses—and can infect any electrical power-transmission grid. They are impossible to see, difficult to measure, but fortunately, are easy to eradicate.

Understanding the dynamics of power-line disruptions will help you to cope with these demons in your computer room.

Dirty Power

Electrical power can be suspect for a variety of reasons. Power fluctuations can be transmitted along utility power lines, or they can be generated within a building or room by a number of sources. The kinds of electrical interference that can affect computer devices include:

- Transient voltage above or below the normal voltage for the system (called spikes, surges, dips, sags, or brownouts).
- Noise interference (often called hash by electrical engineers).

According to studies by the Institute of Electrical and Electronic Engineers (IEEE), harmful power line disturbances occur as frequently as four times a day on average. Of these distur-

bances, 88 percent are power spikes (transients and surges), 11 percent are brownouts (low voltages), and .5 percent are power outages.

The difference between transients and surges is strictly one of duration and degree. A transient is a voltage increase to 6,000 volts or higher lasting 100 microseconds or less. A surge usually lasts slightly longer but is characterized by voltages of 3,000 volts or less. Voltage surges of 1,000 volts are common, everyday occurrences in most industrial and commercial electrical environments.

The most common causes of electrical interference are voltage imbalances generated by the operation of electrical machinery. A refrigerator motor or a furnace blower motor can cause voltage spikes and voltage reductions during operation. Other causes of interference include the obvious, like lightning, and the not so obvious such as sunspots.

Spikes and Sags

What kind of damage is caused by increased or decreased voltage? Commonly, little permanent damage occurs to a computer as a result of most voltage fluctuation. It is possible in the case of an extraordinary event such as a lightning strike for sensitive semiconductor devices, such as memory chips and microprocessors, to experience circuit melting, corrosion, arcing (which will break down insulation), and

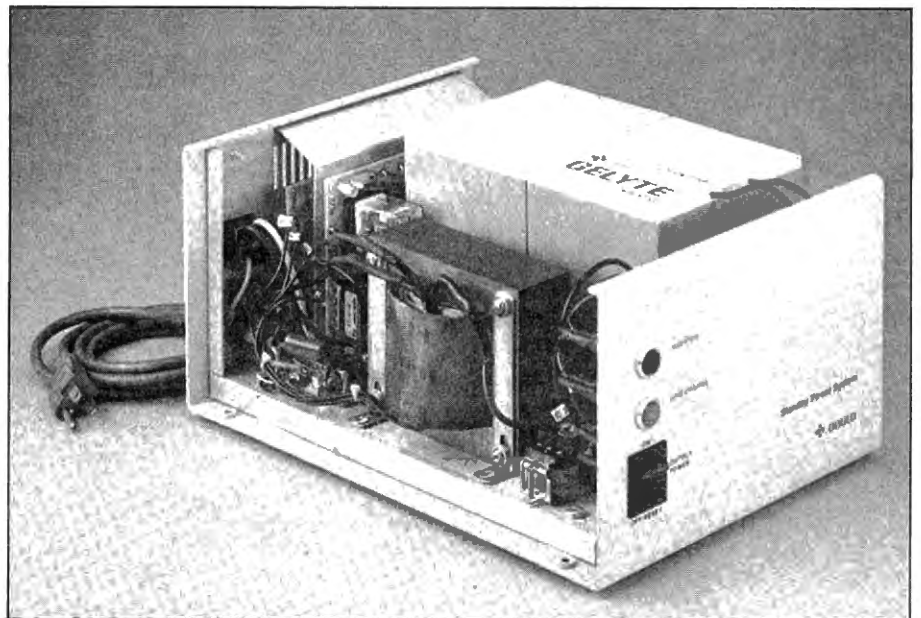


Photo 1. The Gould Standby Power System

reduced component life. Disk drives and other mechanical components can suffer pitting and metal transfer amongst switch contacts.

The most common effect of voltage transients on computing devices, however, is alteration of memory. Small voltage fluctuations can be interpreted by low-power computer circuitry as legitimate input signals. Therefore, random memory errors are often a direct result of electrical interference.

Semiconductor memory chips contain circuitry that comprises hundreds of individual memory cells. These cells are composed of field-effect transistors that act as gates that can either be open or closed, coupled with capacitors that store an electrical charge.

During a read/write operation, the transistor that acts as a gate is opened and a small electrical charge (for a binary 1) or no charge (for a binary 0) is stored in the accompanying memory cell capacitor. If the data being written is subject to a spike or surge during the read/write operation, a memory capacitor could be set high instead of low. Since memory pulses are stored simultaneously one bit per chip over eight chips in each 16K of memory, an entire byte of memory could be written incorrectly. If this happened to be a vital byte, an entire data block would be rendered unusable.

Equally critical is the effect of over-voltages on disk-drive units. Since the read/write head in a floppy disk drive is designed to alter magnetic fields, voltage spikes often cause the head to alter the data on a disk even when the head is engaged in a read operation. These alterations will occur randomly. However, since the disk reads the directory tracks more than any other track on a disk, the probability that a random glitch will alter the directory is high. When this occurs, the entire disk can be rendered unusable.

Voltage spikes are most likely to occur as the result of the switching on or off of an electric motor. Copy machines, elevators, air conditioners, printing presses, furnaces, and so on all generate voltage spikes. These spikes occur within the building where the equipment is located and are transmitted to all parts of the building along its electrical wiring.

Low voltage, commonly called a dip or sag and resulting in a 5-20 percent voltage reduction of approximately a second in duration, often occurs when there is a sudden call for power by an electrical device. Low voltages can cause the picture of a television or vid-

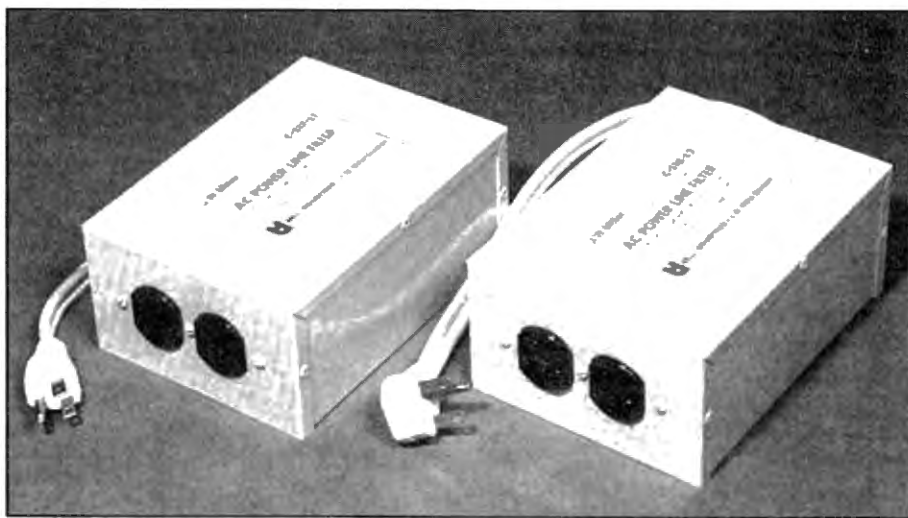


Photo 2. J. W. Miller Line Filters

eo monitor to shrink visibly for a brief moment. Commonly, low-voltage periods are followed immediately by a high-voltage surge as the system draws power from the outside to satisfy the needs of its consuming devices.

Brownouts are long-term voltage reductions, typically of 5-8 percent. They usually are gradual in nature and may last from several minutes to several hours. Brownouts are initiated by the utility supplying the power, usually due to equipment failure or excessive demand on the power grid. Because they occur gradually, brownouts seldom cause difficulty in computers since the power transformer in the computer adjusts the incoming power to suit the needs of the system. These transformers are ideally suited to accommodating gradual power fluctuations.

Noise Interference

Voltage fluctuations are the more serious of the two kinds of electrical interference, but noise interference comes in a greater variety of forms. Noise is simply an unwanted electrical signal and can be as unobtrusive as a jolt of static electricity. Anyone who has ever worked in a computer room without antistatic carpet knows that static electricity can cause data loss in computers.

The common forms of noise are:

- Radio frequency interference (RFI) caused by the reception of electromagnetic signals (radio/tv transmission) by power lines acting like antennas.
- Electromagnetic interference (EMI) caused by a fluctuating magnetic field such as that produced by an operating electric motor.
- Electromagnetic pulse (EMP) caused

by a collapsing magnetic field such as lightning. Static electricity is an EMP.

Noise occurs at lower magnitudes than voltage spikes and is less dangerous to equipment. However, it can degrade performance and cause data loss in computers, because noise occurs at extremely high frequencies and high speeds. The response time for most power transformers is not sufficient to trap these high-speed signals.

Noise can be generated by many common devices: fluorescent lights, radio and television transmitters, electric typewriters, hand tools, automobile ignition systems, and sunspots. Computers themselves generate some RFI and their disk-drive motors and power supplies generate EMI. Loose electrical connections and damaged power cords are other sources of noise.

What Can You Do About Spikes and Noise?

The obvious solution to the problem of "dirty" power lines is to incorporate into the distribution system some sort of filter. In much the same way that an oil filter extracts impurities from your car engine's motor oil, a power-line filter can knock down voltage transients and eliminate noise. This is done using circuitry specially designed to handle the offending voltage fluctuations.

Power-line filters come in a variety of types, sizes, and voltage configurations. The cost spectrum for these devices ranges from \$20 to \$2,000. Some power-line filters merely dissipate voltage spikes; others offer battery backup to guard against power sags, brownouts, and outages, and one system even prints out a record of every occurrence of a power-line fluctuation.

Table 1 shows a representative cross section of the devices for power-line filtering currently on the market.

Typically, power-line filters work by rerouting unwanted voltage through circuitry equipped with electrical components called varistors that cause the excess electrical energy to be given off as heat. In some cases, part of this excess energy may be diverted to the main electrical system's grounding loop.

Power-line filters should be installed between the main source of power and the device to be protected. Normally the power-line filter plugs into a wall receptacle and then your computer plugs into the filter. Many filters have an on/off switch so that the entire circuit can be turned off when your machinery is not in use.

The principle qualities to look for in a power-line filter are the overvoltage-handling capacity, the response time, and the frequency range for noise suppression. Usually, a low-cost filter offers only minimal protection. In fact, the lower-priced filters may offer overvoltage protection only with no noise-suppression capability. Furthermore, only the most expensive filters offer battery back-up for protection in the event of brownouts or power outages.

The overvoltage-handling capacity of power-line filters ranges from 1,000 volts to 12,000 volts. A capacity of 5,000 volts will protect the line from any spike other than a lightning strike. Many manufacturers call this capability the "clamping voltage." This refers to the maximum voltage that will be "clamped," or suppressed by the device.

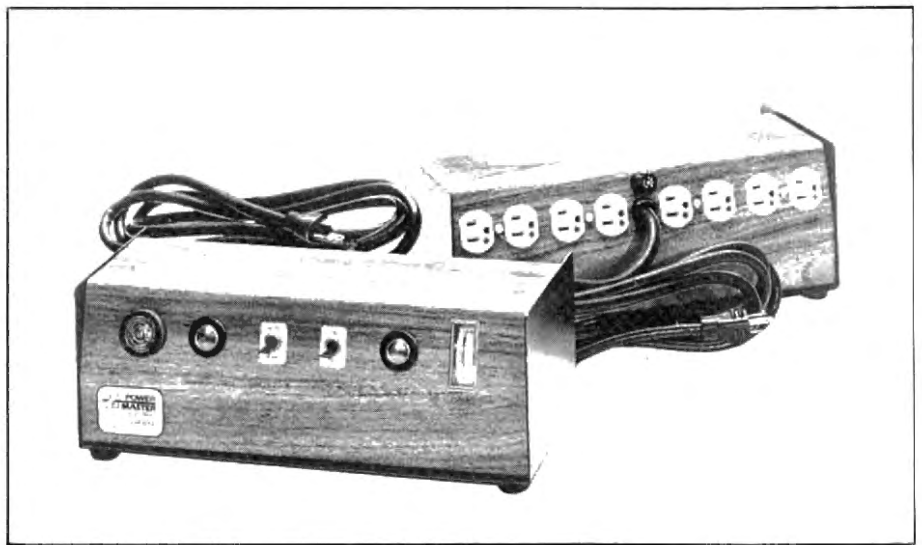


Photo 3. The Power Master Line Monitor from SGL Waber Electric

The response time of power-line filters typically ranges from 5 to 15 nanoseconds (1 nanosecond is one billionth of a second). Noise-reduction frequency response is usually in the range 150 KHz to 30 MHz. Some devices are rated as high as 200 MHz. Unless your building is near a microwave transmission site such as a tv station or a radar installation, an upper level of 20 to 30 MHz of protection should be sufficient.

Picking the Right Filter

The line filter that you choose for your particular application will depend on several factors. Principle among these is the investment you've made in hardware and software. Second, you must consider the cost of having your system crash. In a business setting, a

lost inventory file could require dozens of man hours of labor to rebuild, which could mean several hundred dollars in direct expenditure plus lost sales or decreased efficiency.

You must also consider the frequency and severity of electrical interference in your operating environment. The condition of the electrical wiring in your building and the number of electrical devices drawing power from the system are important factors. Your power company might be able to produce statistics on the frequency of voltage irregularities in their service area. The electrical specifications of the power supply in your computer will reveal the degree of its susceptibility to electrical interference—the manufacturer can usually provide this information.

Finally, you will want to consider the aesthetics of the variety of units on the market. Some devices plug directly into a wall socket and are unobtrusive, while others feature multiple-socket design arranged in a so-called "power strip." Yet others are housed in boxes of varying size and color that become part of your computer installation.

Ultimately, you may decide that your computer functions well enough in its present environment. The extra expense of another piece of hardware may be unnecessary. On the other hand, if your machine seems possessed by demons that randomly chew up data or spit out garbage, you may want to consider cleaning up your electricity supply. Sending nasty notes to the power company is optional. ■

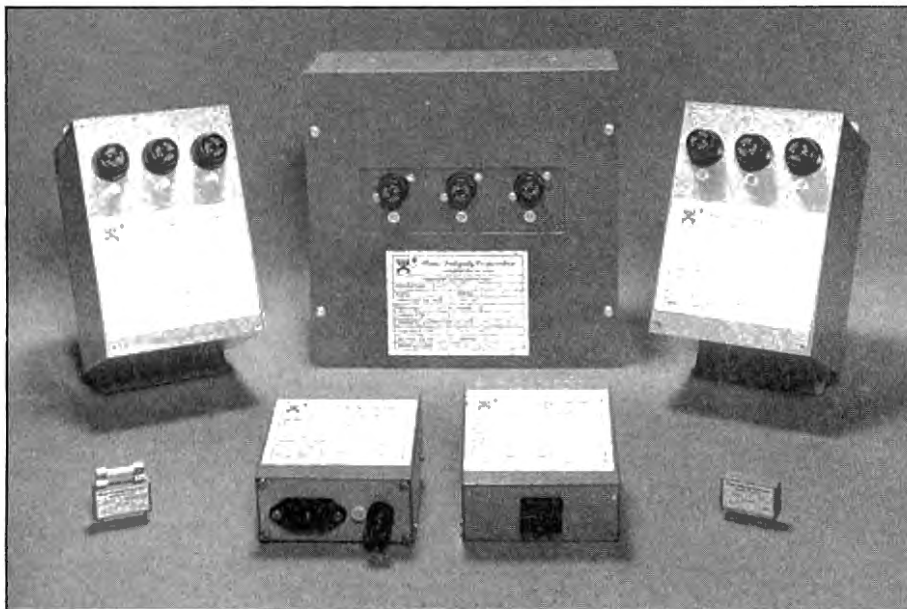


Photo 4. Power Integrity Corporation's Transient/ Surge Suppressor Line

G. Michael Vose is a technical editor for 80 Micro.

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5. Spike-Spiker Mini-I and Mini-II
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6. Isolator (Iso-1, 2, 3, 4, and Iso II)
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18. Quiet Line 6
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BWJ Technology
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19. Glitch Guard POP
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20. Glitch Sentinel (GS-1, GS-2, GS-3)
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21. Standby Power System (SPS)
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Gould, Inc.
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22. Power Line Filter
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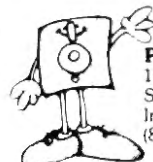
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Into the 232

by Howard Miller

Ever wonder about the RS-232 port on the back of your micro? Just how does it receive and send data? Stay tuned. Howard's got the scoop.

The TRS-80's serial interface receives parallel bytes of information and sends them out one bit at a time. This makes data transmission between machines simpler; only a single pair of lines is needed to transmit signals from one point to another.

The factors involved in sending information this way, such as which bit (most significant or least significant) is sent first, how the start and end of a character are defined, and the current

flow in the line, are all decided in advance. The hardware details, determined a number of years ago, are collectively referred to as the RS-232C standard.

The RS-232C standard allows information to be sent from one machine to another even though the machines were made at different times and by different manufacturers. There are actually 25 lines in the standard and 25 pins in an RS-232C connector, but it is not necessary to use all of them.

Current, rather than voltage, levels are used to transmit information. In this way, the resistance of the lines is extremely low and interference from outside sources such as lightning, fluorescent lights or radio is reduced. There are actually two data communication channels in the standard, but the serial interface of the TRS-80 only implements one of them.

RS-232C Lines

The transmit data line (TD) connects the serial output of the interface to whatever is on the other end. I will call the TRS-80 and its serial interface the data terminal and whatever is on the other end the data set. Receive data (RD) transfers information from the data set to the data terminal.

DTR tells the data set that the data terminal is ready and DSR tells the data terminal that the data set is ready. Request to send (RTS) lets the data set know that the data terminal has information it wishes to pass to the data set. Clear to send (CTS) lets the data terminal know that the data set is ready to accept information.

Two more lines are used by modems to give additional status information to the data terminal. These lines are carrier detect (CD) and ring indicator (RI). Carrier detect signals the data terminal that the modem has detected the mark frequency on the telephone line or other communication channel it is attached to. This lets the data terminal know it is in touch with another data set. Ring indicator lets the data terminal know that the telephone is ringing; on more sophisticated systems, the data terminal can answer the phone.

Table 1 shows the pin assignments of the RS-232C standard.

UART and ASCII

The heart of the TRS-80 serial interface is the large-scale integration (LSI) chip known as the universal asynchro-

Pin Number	Abbreviation	Description
1*	—	Ground
2*	TXD	Transmitted data
3*	RXD	Received data
4*	RTS	Request to send
5*	CTS	Clear to send
6*	DSR	Data set ready
7*	—	Signal ground
8*	CD	Carrier detect
9	—	Used for data-set testing
10	—	Used for data-set testing
11	—	Unassigned
12	SCF	Secondary carrier detect
13	SCB	Secondary CTS
14	SBA	Secondary TXD
15	—	Synchronous transmit clock
16	SBB	Secondary RXD
17	—	Synchronous receive clock
18	—	Unassigned
19	—	Secondary RTS
20*	DTR	Data terminal ready
21	—	Signal quality detector
22*	RI	Ring indicator
23	—	Synchronous clock rate
24	—	Transmit signal timing
25	—	Unassigned

*Lines used by TRS-80

Table 1. RS-232C Pin Designations

nous receiver transmitter (UART).

The particular UART used in the TRS-80 is a TR1602B, but several other chips are pin-for-pin compatible with it.

The TR1602B has two tri-state data buses and some tri-state status lines. Input lines get data into and out of the UART, enable the status lines, and make it possible to modify the way the UART operates. Tri-state lines simplify the design of the serial interface by electrically isolating various outputs from a common line until they are called upon. That way, several outputs can be tied to the same line without shorting anything out.

“...for exchanges between computer bulletin boards or remote data bases, seven bits are usually used.”

The serial output line (SO) of the UART maintains a logic one, or mark condition, whenever it is not actively engaged in sending out information. When data is ready for transmission, the SO goes to logic-zero condition (space) for a predetermined period of time. This mark condition is referred to as a start bit, and is immediately followed by the bits that make up the data sent to the UART by the computer. Now, the computer normally uses data made up of eight bits (a byte), but the number of data bits that the UART sends out isn't necessarily eight. In the TRS-80 serial interface, the number can be five, six, seven or eight—more about that later.

Immediately after the data bits, an optional parity bit can be sent. Its purpose is to indicate the number of ones and zeros (marks and spaces) in the character just sent. This allows the data terminal at the other end to determine if the information has been garbled in transmission. Many services, such as computer bulletin boards, omit the parity bit.

After all this information has been sent, the UART returns to the mark condition for a specific period of time to let the data terminal at the other end know it has finished sending that particular bit of data.

Data can be sent in the 8-bit format, but for exchanges between computer bulletin boards or remote data bases, seven bits are usually used. In this format letters and numbers are transmitted; special codes allow control of

the data terminal from the other end. The letters, numbers and codes are usually in the format known as the American Standard Code for Information Interchange (ASCII). In this format the number of stop bits can be either one or two. Another code format known as Baudot uses only five bits in sending letters, numbers and control codes. Baudot code requires 1½ stop bits, which the UART automatically provides whenever it is set up to send 5-bit code.

Input Port

D7—Receive data available
D6—Transmit buffer empty
D5—Receiver over run
D4—Receiver framing error
D3—Receiver parity error
D2—Not used
D1—Not used
D0—Not used

Output Port

D7—Parity odd/even
D6—Word select bit 1
D5—Word select bit 2
D4—Number of stop bits
D3—Parity enable
D2—Serial data out direct from computer
D1—Request to send
D0—Data terminal ready

Table 2. I/O Port 234 Configuration

Input Port

(DIP switch configuration)

D7—Parity odd/even
D6—Word length bit 1
D5—Word length bit 2
D4—Number of stop bits
D3—Parity enable
D2—Baud rate bit 2
D1—Baud rate bit 1
D0—Baud rate bit 0

Output Port

(Baud Rate Generator)

D7—Transmit clock bit 3
D6— " " bit 2
D5— " " bit 1
D4— " " bit 0
D3—Receive clock bit 3
D2— " " bit 2
D1— " " bit 1
D0— " " bit 0

Table 3. I/O Port 233 Configuration

Even though the UART is said to send and receive information asynchronously, this is only true to the extent that no synchronizing clock is shared by the data sets on each end. But if the data sets are to talk to each other, their respective clocks must be very close to each other in frequency. With the TR1602B and similar UARTs, the clock rate is 16 times the rate at which data is sent (the baud rate). A very common rate is 300 baud, and so the clock frequency for 300 baud is 300 times 16 or 4,800 hertz (cycles per second). The baud rate is determined in advance, along with the number of data bits, parity bit, and number of stop bits.

While the UART waits for information, it checks the incoming line at a rate 16 times its baud rate. In other words, when the baud rate is 300 the UART checks its line 4,800 times a second. When the incoming line goes to a space condition, the UART waits 16 clock cycles, then samples the incoming line again. If the line is still low, the first bit is a logic zero. Since the number of bits in the character has been decided in advance, the UART repeats the above action for the number of bits in the character. If there is to be a parity bit, the UART checks for that, and then checks to make sure the line stays at mark for the preset number of stop bits.

If the parity is wrong, the tri-state status line that indicates a parity error is set. If the line did not stay at mark for the duration of the stop bit time, another tri-state status line is set. In the meantime, the data bits have been assembled in a register inside the UART and can be read out in the parallel format by the computer. The receive data bus has eight lines, so if the serial data format is less than eight bits, the unused parallel data bits are always set to logic low (zero). Serial data always goes out and comes in feet first—the first bit to be sent or received is always the least significant bit, and the last bit to be sent or received is always the most significant bit.

The UART itself is actually two units that can run entirely independent of each other. They can even run at different baud rates, though this is not often done. The transmit section can receive parallel data and send it out serially while the receive section takes in serial information and formats it for parallel output.

In fact, the clock generator in the TRS-80 serial interface has two outputs: one for the transmit clock and

one for the receive clock. The clock generator can be set to output two different frequencies. This IC is referred to as the baud rate generator (BRG).

I/O Ports

The serial interface board is controlled by the computer through the use of four input/output (I/O) ports. The TRS-80 has 256 I/O ports; the four used by the serial interface are 232, 233, 234 and 235 (ports E8, E9, EA and EB in hexadecimal).

Port 235 is used to transfer data bytes to and from the UART. Even though the data from the computer always has eight bits, the UART ignores all bits except those it is set to use.

The rest of the I/O ports pack a lot of status information into 8-bit bytes by using the individual bits as flags. A given flag will be set (a logic one) if something is going on, or not set (a logic zero) if not.

Port 234 is used to set up the operating conditions of the UART, and to send RTS and DTR flags to the data set. One of the operating conditions of the UART is parity enable. This bit is set if you want a parity bit sent with your data. The parity bit can be set to be a mark for an odd number of ones

in the serial data or for an even number of ones. Parity odd/even is set by the computer to choose this condition. If the parity enable is not chosen, though, the parity odd/even flag has no effect.

Two bits of the byte output through port 234 select the number of data bits in the serial output. As I mentioned before, five, six, seven or eight bits can be selected. These two bits are known as word select bit 1 and word select bit 2. The number of stop bits is low for one stop bit and high for two stop bits. However, if you have selected a 5-bit word, the number of stop bits will be 1½, no matter how the number of stop bits is set.

The byte the computer receives from the input port 234 contains status information from the UART. The receive-data-available flag tells the computer that the UART has received a character of serial information and is ready to output it on the receive data bus. Transmit buffer empty tells the computer that the UART is ready to receive a parallel byte for serial transmission. The receiver-overflow flag indicates character was received before the UART could transfer a previous character to the receiver parallel buffer and set the receive-data-available flag. The receiver-framing-error flag is set if the UART detects a space condition on its serial input line when expecting the line to stay at mark for stop bits. If the parity option is in effect and the parity bit that the UART receives is not the parity it has calculated for the character preceding the parity bit, the receiver-parity-error flag will be set. See Table 2 for these flags and the data bit they are assigned to.

A set of switches on the serial interface board allows you to preset the operating parameters of the UART.

The position of the switches can be sensed by reading information from port 233. The switches allow presetting parity odd/even, word length bit 1, word length bit 2, number of stop bits, and parity enable. In addition, three of the switches allow you to set the baud rate for 50–1200 for the transmit and receive clocks simultaneously. The baud-rate generator itself is capable of generating rates from 50–19,200 baud and accepts a separate 4-bit code for receive clock rate and transmit clock rate. The baud-rate generator is programmed by sending the appropriate byte out through output port 233. Data bits 4–7 contain the binary code for the transmit clock rate and data bits 0–3 contain the binary code for the receive clock rate.

The last port used by the serial interface board is I/O port 232. In the output mode, port 232 strobes the master reset pin of the UART.

Input 232 contains information concerning the status of the data set. CTS, DSR, CD and RI are sensed through this port. In addition, serial data bits from the data set will appear on data bit 0.

All the signals that go out to or come in from the RS-232C connector go through special ICs that either have TTL (5-volt logic) inputs and 20 mA current outputs or have 20 mA current inputs and TTL-level outputs (20 mA is the current specified by the RS-232C standard). ■

Howard Miller works at Siemens Corporation's Nuclear Medicine Division. He can be reached at 360 E. Wind-ing River Drive, Dunwood, GA 30338.

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Input Port
D7—Clear to send
D6—Data set ready
D5—Carrier detect
D4—Ring indicator
D3—Not used
D2—Not used
D1—Not used
D0—Serial data from RS-232C
Output Port
Master Reset for UART

Table 4. I/O Port 232 Configuration

Binary Code	Baud Rate
0000	50
0001	75
0010	110
0011	134.5
0100	150
0101	300
0110	600
0111	1200
1000	1800
1001	2000
1010	2400
1011	3600
1100	4800
1101	7200
1110	9600
1111	19,200

Table 5. Codes for Setting the Baud-rate Generator



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Serial RS232 2k buffered int. card \$109

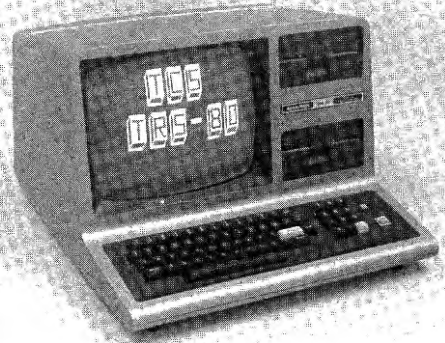
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Ribbon Rewind

by Dan Keen and Dave Dischert

Learn how to rewind multistrike carbon ribbons for your Daisy Wheel II printer, and you can get seven extra printings from a cartridge.

Everybody wants to get the most they can out of the things for which they lay out their hard-earned cash.

Here is a trick for Daisy Wheel II owners that can save them hundreds of

dollars a year in ribbon expenses.

The multistrike carbon ribbons (Radio Shack number 26-1419) for the Daisy Wheel printer are one-shot deals; they are designed to be used once

and then thrown away. We have found that it is a very simple matter to rewind the ribbon and reuse it not once, not twice, but up to seven or eight times!

These ribbons cost \$24.95 for a box of three at your local Radio Shack store. That figures out to about \$8.32 each. Add sales tax, let's say five percent, and that brings the price up to \$8.72 for one cartridge.

Now if you can get seven extra printings from a cartridge, that's a savings of \$61.04 per cartridge or \$183.12 per box!

The best news is that the quality of the second printing is almost identical to the first. Naturally, with each rewind of the ribbon the print will become slightly more faded. After about the fourth pass the print density reaches a point where you would not want to use it for formal letters. But it still remains fine for general computer use as well as line listings.

The Rewinding Procedure

First, remove the small belt for the top of the cartridge as seen in Photo 1. The cartridge itself pries apart very

Photos by George M. Keen



Photo 1

The Key Box

Any TRS-80
Daisy Wheel II



Photo 2

easily. Insert a small screwdriver into one of the large holes where the ribbon enters and exits the cartridge, as shown in Photo 2.

Once you have raised the corner, slip the screwdriver along the crack in the side (Photo 3). Continue to pry until you have gone completely around the circumference of the cartridge. The top will then pop off.

With the inside exposed, remove the clear thin circular sheet of plastic that sits on top of the supply reel. Carefully unlace the ribbon from around the gear and other guides. Position the ribbon so it goes directly from the take-up reel to the supply reel, bypassing any guides or wheels.

The supply reel has little hollow indentations, or bins, around its hub. This makes it easy to insert a screwdriver or ball point pen into any one of these bins and use it as a lever with which to rewind the ribbon. This is seen in Photo 4.

After a half dozen turns or so it is important to stop and push down on the ribbon as it goes onto the reel. It has a tendency to ride up as you wind. The ribbon cannot stick up or else it will be squeezed when the cover is put



Photo 4



Photo 3

back on, preventing the ribbon from moving. Photo 5 demonstrates the best way to apply pressure, which is by pushing down on opposite sides of the reel using two or three fingers.

When the rewind is complete, the ribbon must be threaded again. In case you forget how you took the ribbon off, Fig. 1 shows the path of travel.

Upon completion of the rewind, replace the clear plastic disk on the supply reel. The top cover simply snaps back on. Place the belt back on top of the cartridge.

Using your fingers, turn the green manual knob that is used to take up slack. Look at the exposed ribbon as it passes through the open area and be sure it is moving along. If it isn't, pry the top off again and press hard on the ribbon several times. As we mentioned before, there is no extra room in that slim cartridge to accommodate any part of the ribbon that rises higher than the top of the reels.

You will become very proficient at this procedure after rewinding a few cartridges, and the whole operation will take only 10 or 15 minutes.

We have been using this technique for over a year and a half. We do heavy

printing and, needless to say, have saved a small fortune in ribbons.

Occasionally you can only get a few passes from a cartridge. The ribbon itself is super thin and not very durable, since it is only designed for a single pass. Careless handling of the ribbon may cause it to break. It is usually impossible to recover a broken ribbon.

So start saving those used cartridges and cash in on the recycled market. ■

Dan Keen and Dave Dischert can be reached at RD1 Box 432, State Highway 83, Cape May Court House, NJ 08210.

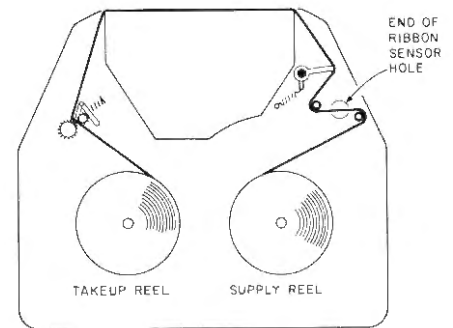


Figure 1

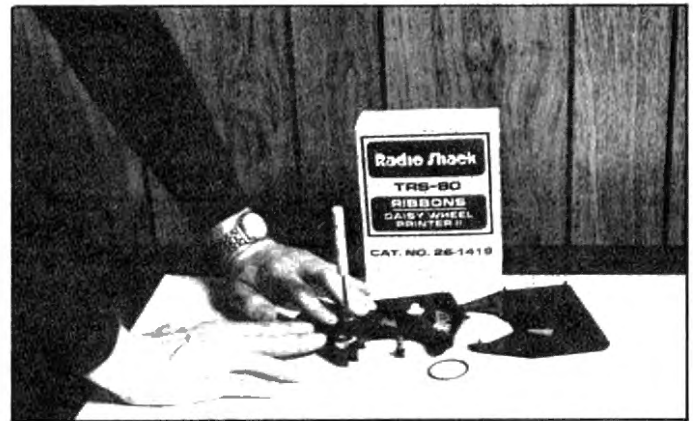


Photo 5

Homebrew Green Screen

by James Conroy

So you want to add a filter to your video screen, but you think they are too expensive? Follow these directions and build your own.

If you are tired of the harsh black-and-white video screen Radio Shack provides with the Models I, II and III, there is something you can do about it. Your options are to buy a \$300 green phosphor monitor, buy a plastic video-screen filter for about \$10, or build your own for less than \$5!

Here's How

Most commercial video-filter pro-

ducts are made of acrylic resin-based plastics. This inexpensive plastic sheeting is available at your local hardware store or window-glazing supply house. Lucite, Plexiglass, Acrylite, and Polycast are pseudonyms for the same basic product and will do fine for a homebrew screen filter. You should choose a transparent green plastic sheet 1/8 inch thick (see Fig. 1).

Ask for a pre-cut piece of acrylic

plastic 8½ by 11 inches. I purchased a sheet for \$2.66.

Mounting the Screen

Your plastic sheet is covered on both sides with protective adhesive paper; peel this off carefully. (This paper removes more easily in a warm environment than a chilly one.)

To copy the method used by video filter suppliers, find two narrow strips of pressure-sensitive adhesive tape (double-back carpet tape will do) and apply them to the vertical sides of your screen. (See Fig. 2.) It's a good idea to wipe the monitor and plastic sheet with alcohol to remove any grease before affixing the tape to the plastic. Press the screen to the monitor—that's all there is to it!

A Few Refinements

If you own a light pen, you will want to remove your filter from time to time. (The space between the plastic sheet and the video screen is too great for reliable light pen use.) A simple way to accommodate this is to use Velcro tabs instead of adhesive strips. Velcro holds firmly and yet allows you to place and remove your video screen at will. Velcro, used to secure carpet or electrical cords and garments, is available at hardware and sewing stores. Simply glue one tab at each corner of your plastic sheet and a corresponding tab on the monitor.

As a final refinement you may want to use silver or black paint for 1/4-inch margins on the plastic sheet. ■

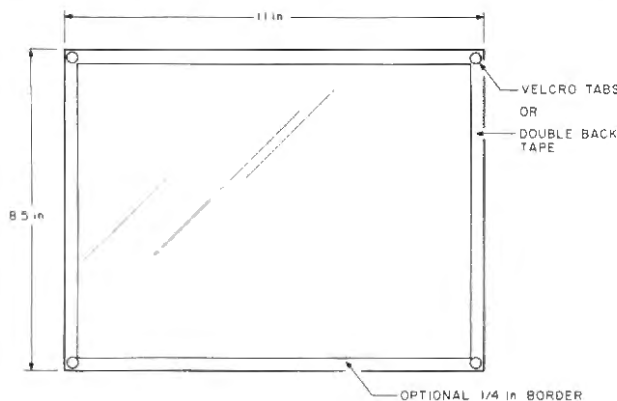


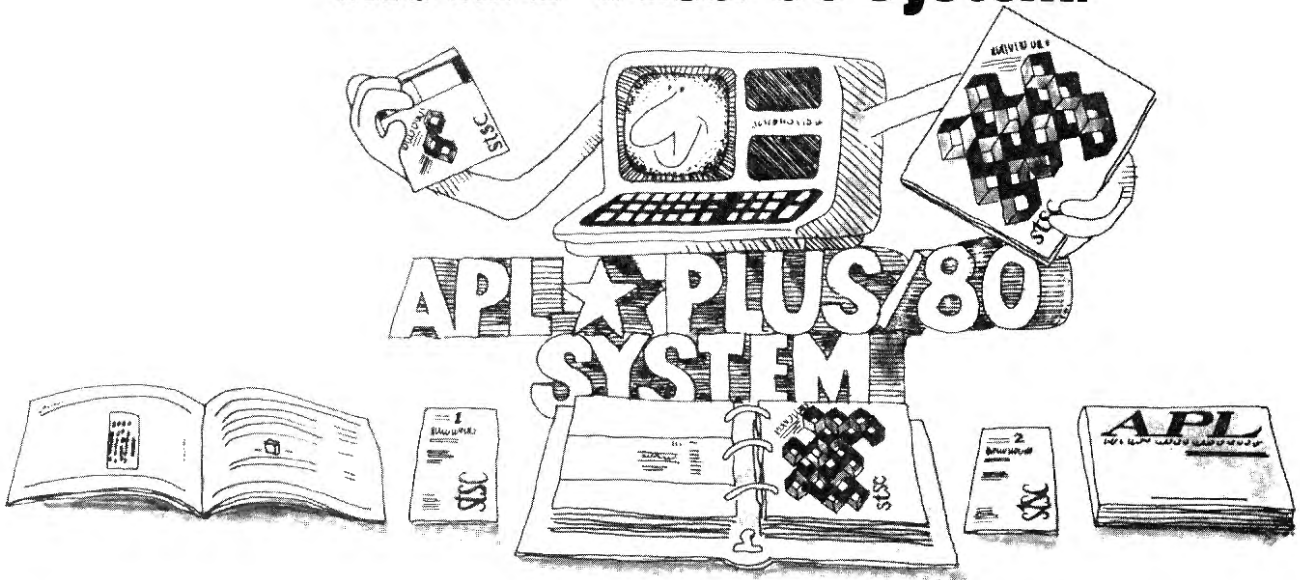
Figure 1

ACRYLITE	POLYCAST
GREEN 545-2	# 2092
GREEN 546-7	# 2082
GREEN 539-6	# 2414
A SAMPLE LISTING OF BRAND NAME PLASTICS AND PRODUCT NUMBER COLOR CODES	

Figure 2

James Conroy can be reached at 1227 Walnut St., Allentown, PA 18102.

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Challenge to BASIC

Build a data file with 15 records of 21 random numbers between 1 and 100 chosen without duplicates (in a record) and arranged in tables with 3 rows and 7 columns. Write a subroutine that reads a specified record and prints the table with row and column totals in fields 6 columns wide. Here is an APL solution:

```

V RANDOMTABLES;I
[1] 'EZTABLES' FCREATE 10 0 I-1
[2] L:(3 7p21?100)PAPPEND 10 0 -(15zI+I+1)pL
V SHOWTABLE N;M
[1] 'IG' FMT N,[1]+/[1]M+M,+/M-FRPAD 10,N
V
RANDOMTABLES 0 SHOWTABLE 12
89 1 45 30 84 50 100 399
57 8 93 13 49 40 77 382
14 63 29 96 3 44 68 323
155 78 167 139 186 134 245 1104
    
```

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80-AN82

Coping with Cassettes

by Richard Whitney

You will have a peaceful co-existence with your cassette recorder if you follow these tips and perform these maintenance procedures.

My problems with the cassette recorder began nearly five years ago. I figured I could save money if I used my existing audio cassette recorder instead of purchasing the cassette unit recommended for the TRS-80. Unfortunately, my cassette recorder drew more power than the control relay in the TRS-80 could handle. The relay contacts fused together causing the motor to run continuously. Radio Shack replaced the relay and I had learned my lesson.

Even after purchasing a new cassette recorder, using cassettes didn't become painless. However, I have finally learned to live with the cassette recorder and my cassette-based system is virtually trouble free.

Here are some tips that I have developed over the years that should help new and experienced TRS-80 users.

General Tape Tips

Use standard audio cassettes for file storage. Expensive certified computer cassettes are not worth the extra money. Most low-noise cassette tapes work just as well.

Use the short tapes: sizes C-10, C-20 or C-30. Longer tapes require extensive amounts of file searching and it's usually faster to change the tape than search for a file at the end of the tape.

Always *stop* the recorder when the tape motion stops for any significant length of time. When the tape is not moving, the capstan presses on one spot of the tape and will, after just a short time, cause a crease in the tape. This is probably the most common cause of data recovery errors. For example, always stop the recorder after loading a program from the tape and before ex-

ecuting it. It is easy to forget this after you have started the program.

Group program categories together on the same tape, i.e., games, utilities and so on. It organizes your tapes and makes retrieving files easier when you need them.

Use both sides of the tape instead of squeezing too many files on one side.

Reset the tape counter to zero when the tape is in the fully rewound position.

Label tapes with file grouping, group number (if more than one), baud rate (if your computer uses more than one rate), side of tape, and a description of each file. The description should include: tape counter starting number—first file copy, second copy; file name or description; file type—Basic or System; file identification used for access.

There is little room on the cassette to write all this information. The tape label should contain just the group name and number which matches the name on the tape box and the tape side information. Place a piece of paper in the tape box with the rest of the information. (See Table 1.)

Tape Recording Techniques

Never start recording a file at the very beginning of the tape even if the tape is leaderless. This portion of the tape is often stretched when the tape is rewound causing file recover errors. Allow the tape counter to advance to at least five.

Start files at tape counter multiples of five (or ten). This aids in keeping track of file positions and provides some spacing between files.

Make two copies of each file, one after the other placing the usual space between them. This helps ensure a good copy in case of a file read error. If the file is very important, you might

Utilities Vol. 2			
Baud Rate: 1500			
Counter	File Description	Type	File ID
5, 35	Debugger	System	DBUG
70, 85	Renumber	Basic	"R"
105			
Side 2.			

Table 1

consider placing another copy on a separate tape.

Verify all copies of the file after recording them. Basic programs can be verified using the CLOAD? command. Most system program copiers usually provide the ability to verify files.

When recording over existing files, the new files are often of a different length than the file being overwritten. Pieces of the old file are thus left between the newly written files. To clean up any remains of the old files and make a cleaner, easier-to-read tape, first disconnect the motor control cable from the cassette recorder to control the tape motion manually. You can reconnect it after the file(s) is written.

Second, type in the command to write the file, but don't press enter yet. Third, press record and play together on the recorder, starting the recorder at a tape counter multiple of five or ten. If re-recording the first file on the tape, start the recorder on the clear plastic leader and advance it to five or ten to ensure that the beginning of the tape is clean.

Fourth, wait for the tape counter to advance beyond the selected count by approximately one count. Then start

writing by pressing enter on the keyboard. The extra space after the indicated file starting count helps correct inaccuracies in the tape counter mechanism after fast forwarding or reversing the tape.

Fifth, when the file has been written on the tape and a prompt appears on the monitor, allow the recorder to continue to advance until the next multiple of five or ten. If the end of the file is near the next multiple, allow the count to proceed until the second count multiple. This provides an inter-file spacing that aids locating the beginning of files.

Sixth, stop the recorder and write down the counter value. That value is the start of the next file on the tape.

Finally, reconnect the motor control cable if this is the last file to be written, otherwise repeat the steps above for each file.

Tape Storage

Rewind the tape before storing it. Then only the tape leader is exposed and the tape stays clean.

When storing tapes, place them in the cassette tape boxes. It helps keep them cleaner and prevents the tape

from becoming snagged.

Store tapes away from any magnetic devices, such as the power supply, tv monitor, and line printer. Such devices can affect data on the tapes.

Tape Recorder Maintenance

Clean the tape recorder heads regularly. Depending on use, this should vary from weekly to monthly. Use either a commercial tape recorder head cleaner, or 190-proof isopropyl (not rubbing) alcohol and a Q-tip.

Degauss tape heads after every three or four tape head cleanings. Degaussing removes magnetic buildup that interferes with recording and playback. You can purchase an inexpensive tape head degausser at most Radio Shack and many audio equipment stores.

I have presented some techniques for using the cassette tape recorder to store data for your home computer. These guidelines make the cassette recorder more reliable and even enjoyable to use. ■

Richard Whitney (105 O'Kelly Lane, Cary, NC 27511) is employed by Data General Corp.

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Ultimate Joystick Interface

by Donald E. Michel and Art May

Wouldn't you rather use a joystick when you play games on your Mod I? This joystick interface is cheap, and easy to build and use.

The first item needed to build a joystick addition to your computer is the stick. Most sticks use potentiometers to read the paddle's position—voltage values vary as the stick is moved around. This arrangement

works well, but is needlessly complex. The computer only wants ones and zeros anyway.

Atari manufactures a joystick that simply depresses a switch anytime the stick is fully thrown into a particular

position. There had to be a way to make this stick fit my requirements (inexpensive, no complicated hardware modifications), and indeed there is.

The Circuitry

The schematic in Fig. 1 shows one

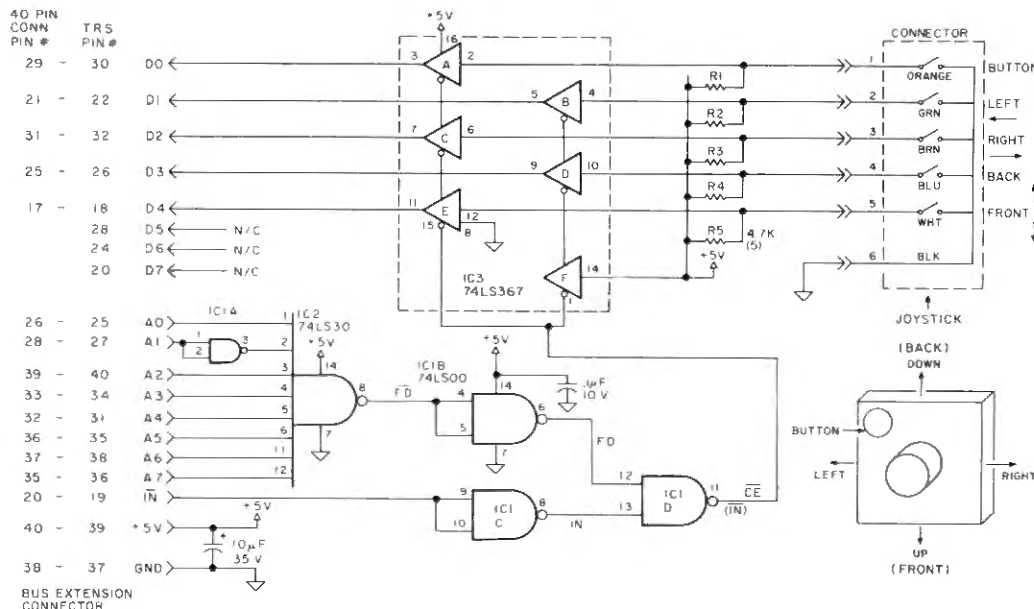
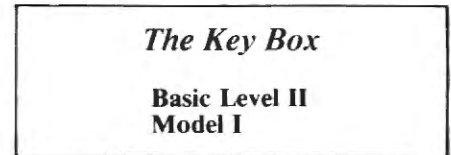


Fig. 1. Joystick Interface

improvement over some other designs: our port (OFDH) is properly decoded by the 74LS30 IC. This technique makes the interface essentially transparent to the rest of system, avoiding hang-ups if an inadvertent call to a port is made.

The address line A1 is inverted by pins 1 and 2 of the 74LS00 (IC 1), while the balance of the address lines feed directly to the 74LS30. The resulting signal is inverted once again and, when coupled with the In line going to pin 13, creates all the logic necessary to selectively fire the buffers of IC3. This in turn gates the existing bit pattern of the joystick to the TRS-80's bus. Simple?

It is, if you've ever done this sort of thing before. Still, one or two inconsistencies rear their ugly heads. No big deal, but you have to be careful.

One notable oddity is the fact that no 40-pin card edge connector in the world has pin designations corresponding to the TRS-80's pin numbers. The TRS-80 numbering is always one digit different than the connector mating with it, thus the discrepancy (see Fig. 2 for proper orientation of TRS-80 and connector pin designations).

Another minor hassle concerns the power needed to run the thing. If you do not have an expansion interface, power your unit from the +5 and ground pins available from the bus extension at the keyboard. The expansion interface does not provide +5 volts, but improvising is easy. Cut the trace between pins 37 and 39 (pin 39 is an unnecessary ground, see Fig. 3). Then jumper +5 volts from the reverse side of the PC board (Fig. 4). The LS chips consume very little power, so don't worry about burdening your power supply.

Construction

The easiest approach is to wire-wrap the interconnections after mounting the parts on a suitable PC board. I chose the parts listing in Fig. 1 for ease of assembly and to keep the unit's size to a minimum. There are not many connections to be made and construction goes quickly.

Software

How easy it is to develop routines to interface your joystick with your programs depends on your skill as a programmer and what it is you want to do.

As a simple example, and to test your newly completed interface, type in the Basic program in Listing 1. An asterisk should appear and move in directions determined by the paddle.

Pressing the fire button causes the word Fire to blink on the screen for as long as it is depressed.

An INP command examines the bit pattern on the data lines. The A variable takes on the complement of the input port ANDed with 31 to mask the lower five bits. A is checked for set bit positions. Depending on the outcome of the check, it either processes Fire or moves the asterisk. Lines 120-140 keep you from cruising off the screen, while line 150 keeps the screen from scrolling. Line 190 does the actual printing, then sends execution back to the polling routine at line 60.

The program is given as an example; the interface is certainly not limited to such trivia. The Atari paddle can operate with two of its internal switches de-

pressed at the same time by moving the stick diagonally. Diagonal movement is provided by sequentially checking each bit position.

Once you get the hang of using Basic's INP command and can successfully read your joystick's port, you are free to do whatever you want. And you are not stuck with Basic, either.

The joystick subroutine can be POKED into memory. For the ultimate in realism, patch machine-language routines into existing arcade-style games. The results are amazing. See Program Listing 2 for a general Z80 routine.

Listing 2 is a typical machine-language module for computer control via the joystick. Line 10 copies the input port to the A register. Line 20 looks for

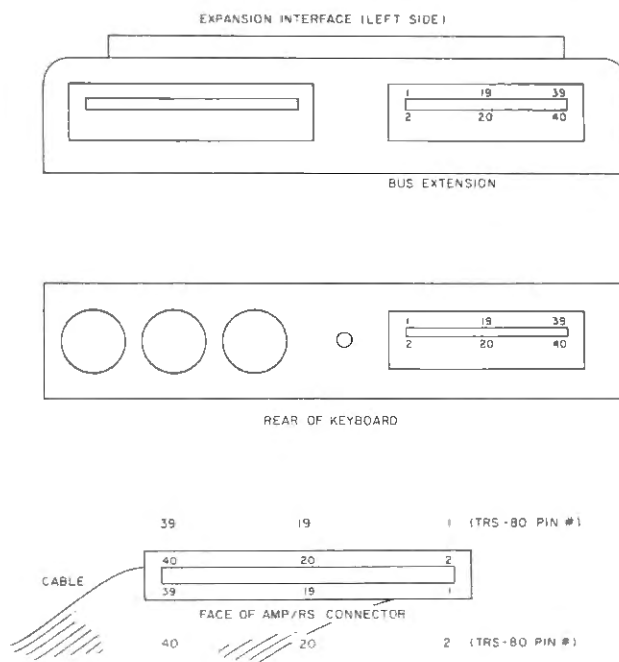


Figure 2

```

10 CLS
20 DEFINT A-Z
30 X1=90
40 Y=7
50 X=30
60 A=NOT(INP(253)AND 31)
70 IF A AND 1 THEN PRINT@0,"FIRE":FOR I=1TO100:NEXT:PRINT@0,"
80 IF A AND 2 THEN X=X-1
90 IF A AND 4 THEN X=X+1
100 IF A AND 8 THEN Y=Y+1
110 IF A AND 16 THEN Y=Y-1
120 IF X<0 THEN X=0
130 IF X>63 THEN X=63
140 IF Y<0 THEN Y=0
150 IF Y>15 THEN Y=15
160 IF Y=15 AND X=63 THEN X=62
170 X2=64*Y+X
180 PRINT@X1," ";
190 PRINT@X2,"*";
200 X1=X2
210 GOTO60

```

Program Listing 1

joystick activity (OFFH indicates no joystick activity). Line 30 continues the program if all bits are set. Line 40 rotates the lowest bit into the condition code register. Line 50 calls the button response routine in the main program. The remainder of the module successfully checks for zero bits and calls the proper response routine in the main program. Line 140 continues the user's program.

Commercially available joysticks will do everything this one does. But you have to shell out considerably more money for a store-bought unit than parts for this one. This interface is easily adapted to any program and is

easy to tack onto your own graphics creations.

Hopefully, you will never again be obliterated by unscrupulous Klingons while frantically fumbling for the up

arrow. Good luck! ■

Donald E. Michel is Chief Engineer at T. J. Electronics. Art May is Senior Electronics Specialist at C. R. C. Wireline.

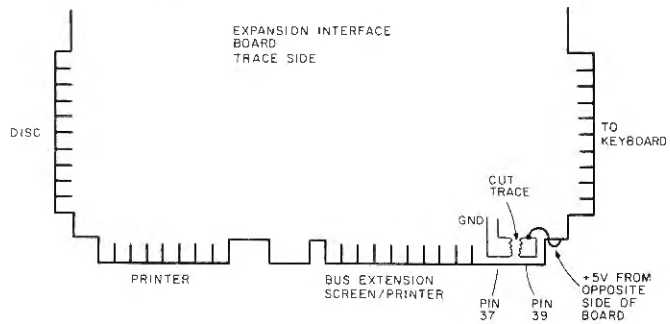


Figure 3

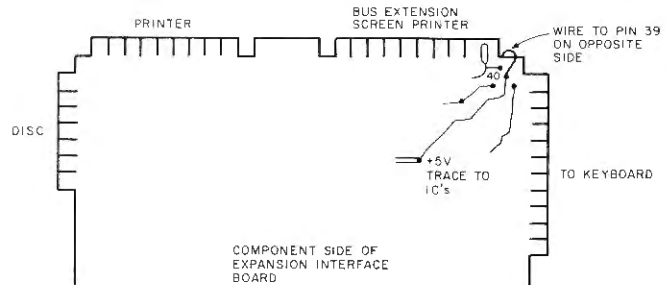


Figure 4

```

10  START  IN  A, (0FDH)
20  CP    0FFH
30  JP    2, CONT
40  RRA
50  CALL NC, BUTTON
60  RRA
70  CALL NC, LEFT
80  RRA
90  CALL NC, RIGHT
100 RRA
110 CALL NC, UP
120 RRA
130 CALL NC, DOWN
140 JP    CONT

```

Program Listing 2

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