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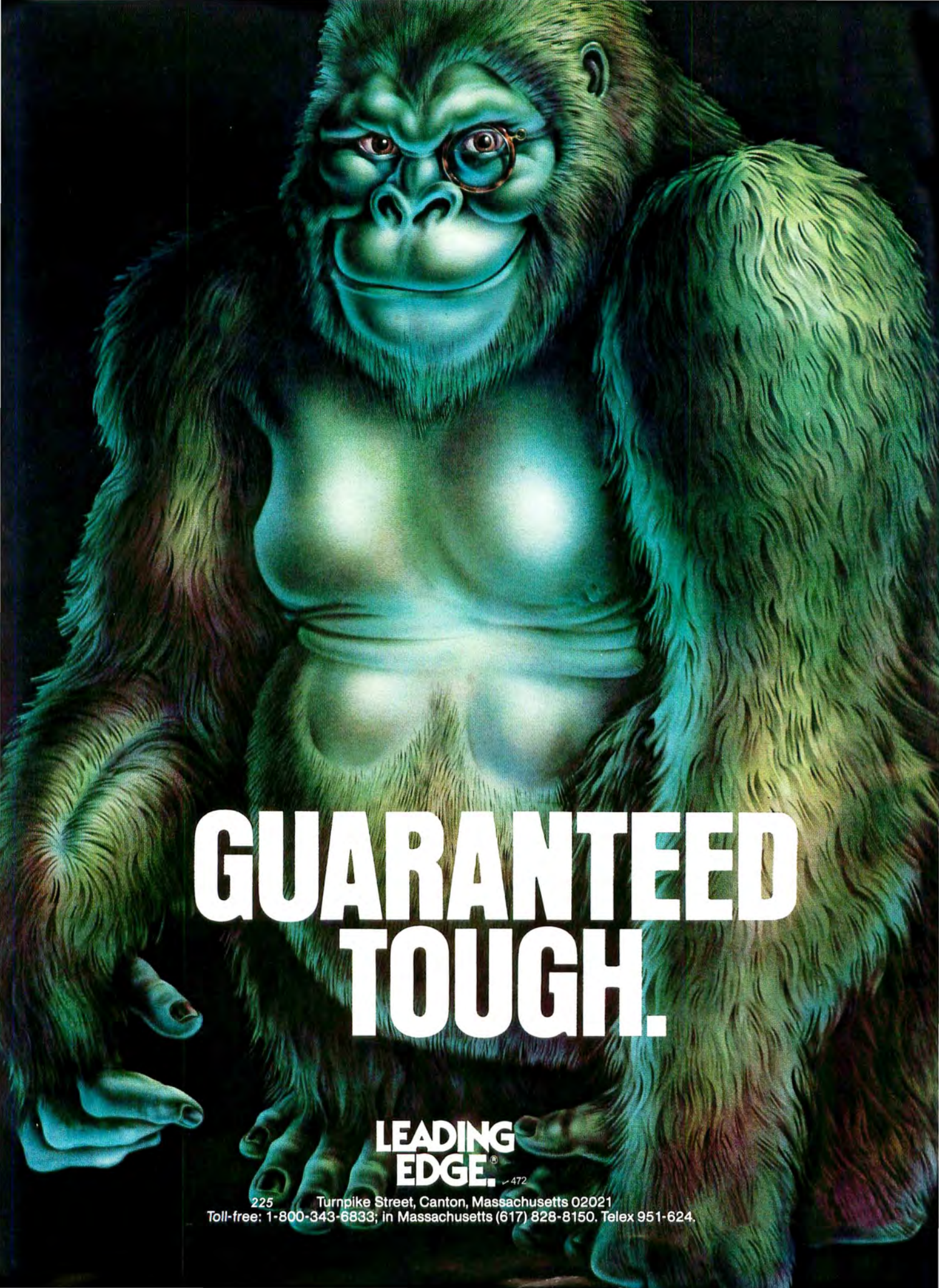
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HOT CoCo

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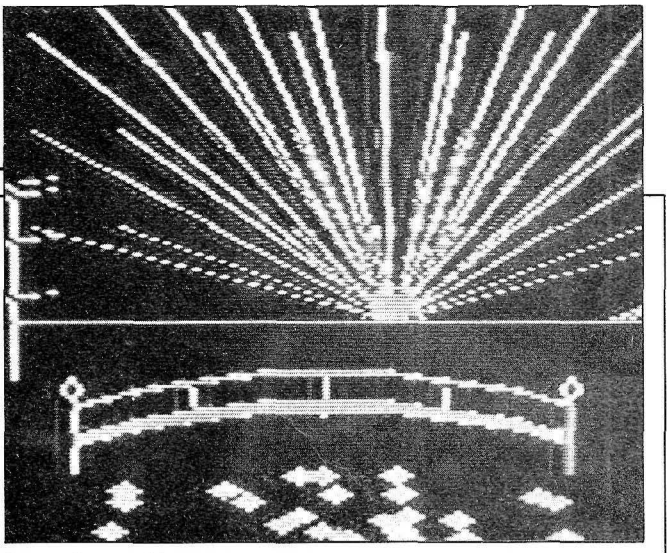

Japanese Scene—p. 84

The newMC-10—p. 8

DEPARTMENTS

Vol. 1 No. 3 August 1983

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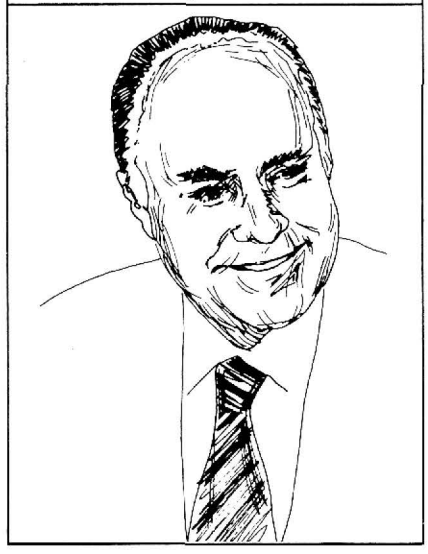
Off Color

MINING THE VEIN

by Wayne Green



You can't be too rich or too thin, the saying goes. Unfortunately the achievement of either goal has, for most people, been beyond reach.

Getting rich has been made a much more reachable goal as a result of the system-specific magazines, particularly those for the TRS-80 computers such as *80 Micro* and *HOT CoCo.* The key, of course, is to develop some product that Color Computer owners will want to buy and then put it on the market, advertising it through this magazine.

The Radio Shack support market is a weird one, and as such offers a truly unique opportunity. The fact is that there have been few such licenses to make money such as Radio Shack has presented us. Let's look at the situation and see how it is tailor made for plucking.

First, there is the wonderfully wide distribution of the CoCo through the network of about 10,000 Radio Shack stores—backed with magazine and television advertising—plus a good deal of local newspaper ads. This gets the computer out there and into the hands of customers. There have been, I'd estimate, over 400,000 CoCos sold to date.

The support of the CoCo by Radio Shack has been less than awesome—for a couple of good reasons. First, there has been their preoccupation with trying to keep up with their other model computers: the Model II, III, 12, 16, 100, and Pocket Computers, for example. Just getting those out—supporting them with modems, printers, plotters, and so on—is a monumental job, even for a firm as huge as Tandy... even with about one third of their $2 billion in sales in the computer products.

Then there is the need to keep inventories at a minimum for the stores. This means that only products that are going to sell like gangbusters can be fed into the pipeline. Each new product has to be supported with advertising, promotion, catalog write-ups, updates, and so on. It is not trivial to bring out a new product. And then each Radio Shack store has to buy and pay for these inventory items. If they don't sell quickly, the stores are not going to reorder. Stuff has to sell fast to stay in the catalog.

Okay, so maybe some of our support products for the CoCo aren't suited to the Radio Shack system of sales. How about the several thousand non-Radio Shack computer stores? That's just as good a market, isn't it? No, it isn't. Unfortunately, there is a rather firm wall out there against anything that has to do with the TRS-80 computer. Since most computer stores can't sell the 80, they want nothing to do with it, other than heap abuse on it and sneer at people who have bought one. This is not a good environment for selling CoCo support products.

Which brings us to *80 Micro* and *HOT CoCo.* Here we have a readership made up of 100 percent TRS-80 owners. Presumably the CoCo readers own a Color Computer, so ads in this magazine will reach precisely the customers for supporting products. The fact is that this is not a bad system. It is, if you think about it, one of the most efficient and effective systems for selling products.

Once you look at the hard facts of marketing products you'll find that mail order—particularly where there is a magazine that reaches a high concentration of prospective customers, and *HOT CoCo* hits CoCo owners 100 percent on target—is one of the most efficient ways to sell a product there is. It's incredibly low cost when compared to advertising in consumer magazines such as *Time* and *Newsweek.* It beats the hell out of direct-mail sales costs.

The bottom line is that if you are interested in getting into business for yourself and doing well, you'd be hard put to find a more effective way to do it than by coming up with a CoCo-related product and marketing it through ads in *HOT CoCo.* Yes, of course this sounds self-serving, which it is. But it is also plain truth. This is why *80 Micro* was able, within the first year of publication, to grow from 128 to 244 pages... and eventually to 600. This growth reflects the sales of about $300,000,000 in support products for the TRS-80 computers, making many entrepreneurs fabulously wealthy.

With the publication *of HOT CoCo* I think we'll see this happening all over again. Now that there is an efficient, low-cost way for small firms to reach eager customers, I think we'll be seeing a wealth of accessories, programs, information, and so on for the CoCo.

Some of these products will compete with Radio Shack products, others will just enhance the CoCo. We're now seeing some of the new 3-inch disk systems for the CoCo. We're already able to buy an improved keyboard at a rather reasonable price...and so it will go.

Thus, if you are looking to get rich, I'd highly recommend that you think in terms of a product in support of the TRS-80 or the CoCo. That's where the money is... and where it's going to be for a while. •

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RADIO SHACK'S NEW MC-10

In case you haven't heard, Radio Shack has a new Color Computer: the Model MC-10, or Micro Color Computer. It's a little white machine with a small, "Chiclet" keyboard, a 6803 microprocessor, and 4K of RAM.

At first, we were not very impressed with it—it just wasn't as capable a machine as the old Color Computer. To really appreciate the MC-10, however, you must view it from the perspective of its intended purpose—a low-end machine to compete with the Sinclair and VIC-20.

At $119.95, it is higher priced than the two above-mentioned competitors. It might never catch up to either in sales, but Tandy will undoubtedly sell many thousands of MC-10s. Let's look at some of its features. (*HOT CoCo* will publish a full review next month.)

In 4K form, the MC-10 has a Color Basic that is compatible with the 6809 Color Basic—almost. The MC-10 has a few keywords that the CoCo Color Basic does not (e.g., LET, which assigns a value to a variable, and EXP, which performs an exponential function).

It also lacks a few Color Basic keywords, such as AUDIO, CLOSE, OPEN, and EXEC. These differences in keywords mean that many of the existing 4K Color Basic programs will need some tweaking to work on the MC-10. A 16K plug-in memory expansion will be available some time this summer; this upgrade will also include an extended Basic in addition to boosting memory to 20K.

Photo 1. A View of the MC-10's Keyboard

The keyboard takes some getting used to, even if the old CoCo keyboard doesn't bother you. It is smaller and arranged differently. A control key rests where the left shift key is on the CoCo, which can be frustrating for touch typists. Also, you activate the arrow keys by pressing the control key and the W, A, S, and Z keys.

The MC-10 is a good machine to learn Basic programming on, and we think this will be its greatest selling point. You can print most of the keywords on the screen by pressing control and another appropriately labeled key, a Sinclair-like feature.

Once you are accustomed to this arrangement, entering a program is much less time consuming and more enjoyable than on the original CoCo. Children who are not touch typists will quickly adapt to this keyboard.

The MC-10 should find a place in education, too. If good software and peripherals are forthcoming, its price will be very attractive to school systems.

Photo 1 shows the MC-10's keyboard arrangement, and Photo 2 shows the back of the computer. From left to right are the ac adaptor (8 volts), TV socket, panel covering the edge connector for the 16K upgrade, reset button, serial I/O, and cassette interface.

Looking at these ports, we can't see an easy way to hook up a disk drive or joysticks. The latter could present a problem, since games are a proven seller for low-end computers. Without joysticks, the MC-10 game library will be limited. Since disk drives cost several times the price of the MC-10,

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The left bracket, [, replaces the up arrow used by Radio Shack to indicate exponentiation on our printouts. When entering programs published in *HOT CoCo,* you should make this change.

HOT CoCo formats its program listings to run 64 characters wide. 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: *HOT CoCo* Submissions Editor, 80 Pine Street, Peterborough, NH 03458. Include an SASE for a copy of our writer's 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 *HOT CoCo* Review Editor, 80 Pine Street, Peterborough, NH 03458.

DIGRESSIONS

though, few people will want them.

A few other notes: The cassette format for the MC-10 is different from the CoCo's, so you cannot load CoCo tapes on it. Also, we see no easy way to program the MC-10 in machine code, but since it's a "beginner's" computer, this is more an observation than a criticism. The MC-10 has no ROM-pack slot, as well.

The MC-10 is a handsome machine that has the look and feel of a well-constructed unit. It is not an upgrade to the old CoCo (that might be coming by the time you read this), but it is a worthy stablemate that should give its competitors, especially the Sinclair, a run for their money. And, yes, we want your articles on the MC-10.

This Month

This month's *HOT CoCo* features graphics. If you are a novice programmer, two of our features ("Introduction to Multicolor Graphics," by Ken Anderson, p. 40; and "Color Computer Art," by William H. Roney, p. 84) should appeal to you. Read what the articles have to say, and then type in the short listings. Both authors have recommendations for altering their programs, so go ahead and experiment with them.

If you are an Assembly-language programmer, you'll like David Meredith's "Displaying Moving Graphics," p. 108. The listing is quite long and requires 32K, but if you don't want to type in the program, read what the author has to say about his techniques; they should provide some insight that will facilitate writing your own, similar program.

After you have absorbed the information in our features, perhaps you will go on to create a graphic masterpiece. Well, Richard Ramella's article, "Photographing a TV Screen," p. 96, shows you how to produce a permanent record of your creation.

Delmar Searls, our Graphically Speaking columnist, introduces the business or statistical minded to bar graphs and histograms on the Color Computer. He demonstrates how to produce multicolor graphs on screen and paper. You should be able to incorporate his techniques into your own applications program.

Next Month

Next month features utilities. Among them is William McArthur's Linkage Editor, which allows you to merge Assembly code with Basic programs.

Peter Stoloff's BSearch program will find any string you want in a Basic listing; you'll find his article to be of great use. Did you just buy a disk system? Richard Esposito and Ralph Ramhoff will have a collection of short, useful routines that all disk users should have.

Edward Kimble has a nice program that lets you examine equations of one variable, and Stephen Hedges will present his short Basic program to list your programs one line at a time.

One final note: The reader input so far has been encouraging. We would like to thank all of you for your compliments and suggestions. We will always listen to what you have to say, so don't hesitate to drop us a line. •

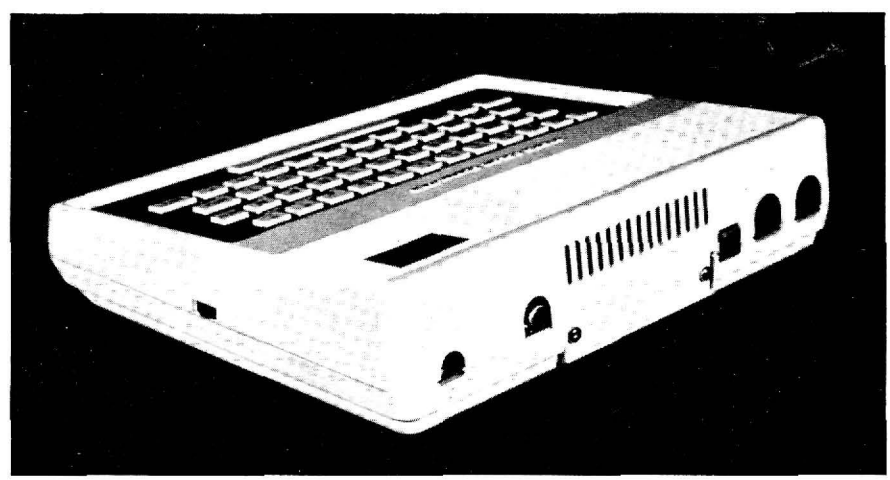

Photo 2. The Rear of the MC-10

↙ See List of Advertisers on page 130

Feedback

Adapting Two 32K Programs to 16K

In my article in July's *HOT CoCo* (p. 76), I had written the Line-Feed and the Graphics Dump programs in Program Listings 1 and 2 for a 32K CoCo. You can assemble them for a 16K machine by changing the ORG statements. Change the Line-Feed program line 210 from ORG $7E00 to $300. The command EXEC &H3E00 executes the program. Changing line 240 from ORG $7A00 to $3A00 changes the Graphics Dump program. The command EXEC &H3A00 executes this program.

If you do not have an assembler, you can use a monitor to enter the object code listed in Listings 1 and 2. Then save the code to tape or disk with a CSAVEM or SAVEM command.

Robert P. Bussell
104 Barley Court
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The Danger With ROM Packs

The article "Demystifying System RAM," by Rusty Le Blang (June, p. 108) refers to Program Listing 4 (p. 112). This turns off the fast interrupt and instructs the reader to plug in a ROM pack with the power on.

Now, the literature that accompanies the Color Computer and all ROM packs sold instructs the user *never* to plug in or unplug a ROM pack with the power on. There is good reason for this injunction. I once burned out my CPU and my SAM by doing just as your author suggests.

It is apparently the wiggling of the ROM pack, as you push it in or pull it out, that causes a shorting of the 12-volt lines into lines going to the CPU, burning out the computer. The fact that Rusty's program turns off the interrupts prior to instructing the user to plug in the pack in no way increases the safety of that maneuver.

One can do as Rusty recommends and get away with it, one, two, three, or even a hundred times. But sooner or later you will blow out your computer.

Respectfully,
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HOT CoCo *will publish an article on the hazards of ROM packs in an upcoming issue.—Eds.*

Different MOM Addresses and Routines

I have the different ROM addresses for the Color Basic 1.2 ROM, as listed in Table 1.

All software will run on the new ROM without patches. The only changes that I can find were minor ones in the character I/O routines and the interpret-integer expression routine.

I also have the different ROM addresses for Extended Color Basic 1.1 ROM, as listed in Table 2.

All software will run correctly on this ROM also. The only differences I saw were in the PCLEAR and some of the graphics commands. The PCLEAR has been fixed so that it no longer gives an ?SN error when you do a PCLEAR at the beginning of a large program. Other than that, I've found no noticeable changes.

There are also some different routines for the Disk Basic 1.1 ROM. The manufacturers have drastically changed the disk ROM, and this can cause some problems as far as compatibility is concerned. They have added a new command, DOS, and moved the whole ROM up to make room. The problem with this is that any software that expects DSCON to be at $D66C will go to the wrong routine; it has been moved to address $D75F.

They've also added the DOS command that boots in an alternate operating system such as OS-9. You can reference this by typing DOS, or JSR [$C00A].

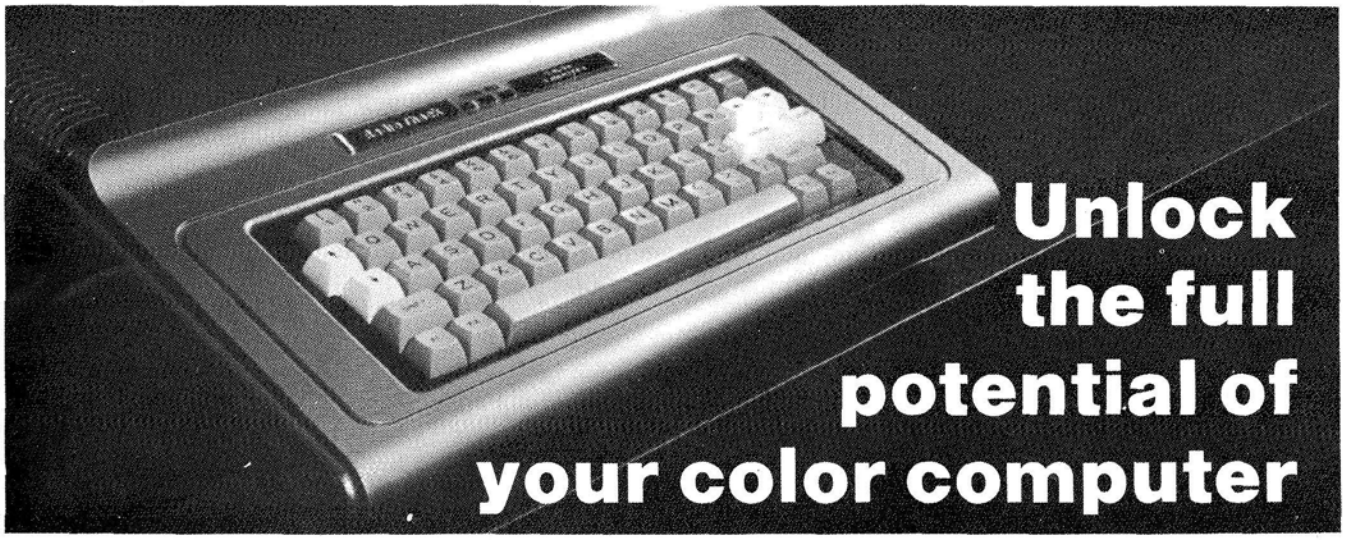
The only other change I could find

```
A001 A114 A155 A15E A1B6 A1C1 A1C2 A1C3 A1C4 A1C5 A1C6 A1C7 A1C8 A1C9 A1CA A1CB
A1CC A1CD A1CE A1CF A1D0 A1D1 A1D2 A1D3 A1D4 A1D5 A1D6 A1D7 A1D8 A1D9 A1DA A1DB
A1DC A1DD A1DE A1DF A1E0 A1E1 A1E2 A1E3 A1E4 A1E5 A1E6 A1E7 A1E8 A1E9 A1EA A1EB
A1EC A1ED A1EE A1EF A1F0 A1F1 A1F2 A1F3 A1F4 A1F5 A1F6 A1F7 A1F8 A1F9 A1FA A1FB
A1FC A1FD A1FE A1FF A200 A201 A202 A203 A204 A205 A206 A207 A208 A209 A20A A20B
A20C A20D A20E A20F A210 A211 A212 A216 A21D A221 A22D A234 A235 A236 A237 A238
A239 A23A A23B A23C A23D A23E A23F A240 A241 A242 A243 A244 A245 A246 A247 A248
A249 A24A A24B A24C A24D A24E A24F A2S0 A2S1 A252 A253 A254 A255 A256 A257 A258
A259 A25B A25B A25C A25D A25E A25F A2B0 A261 A262 A263 A264 A265 A266 A267 A268
A269 A26A A26B A26C A26D A2C3 A2C4 A2C5 A2C6 A2C7 A2C8 A2C9 A2CA A2CB A2CC A2CD
A2CE A2CF A2D0 A2D1 A2D2 A2D3 A2D4 A2D5 A2D6 A2D7 A2D8 A2D9 A2DA A2DB A2DC A2DD
A2DE A2DF A2EB A2E1 A2E2 A2E3 A2E4 A2E5 A2E6 A2E7 A2E9 A2EA A2EB A2EC A2ED A2EE
A2EF A2F0 A2F1 A2F2 A2F3 A2F4 A2F5 A2F6 A2F7 A2F8 A2F9 A2FA A56A ADFD B23F B38E
B3ED B3EE B3EF B3F0 B3F1 B3F2 B3F3 B3F4 B3F5 B3F6 B3F7 B3F8 B3F9 B3FA B3FB B3FC
B3FD B3FE B3FF B400 B401 B402 B403 B404 B405 B406 B407 B408 B409 B40B B40B B40C
B40D B40E B40F B410 B411 B412 B413 B414 B415 B416 B417 B41B B419 B41B B41B B41C
B41D B41E B41F B420 B421 B422 B423 B424 B426 B9D6
```

Table 1. Color Basic 1.2 ROM Address Changes

```
80D0 80D1 80D2 80D3 80D4 80D5 80D6 80D7 80D8 80D9 80DA 80DB 80DC 80DD 80FF 8112
86FB 8C1B 8C1C 8C1D 8C1F 8C20 8C21 8C22 8C51 9179 917D 962C 962D 96A3 96A4 96A5
96A6 96A7 9SB8 96B9 96AA 96AB 96AC 96BD 96AE 96AF 96B0 96B1 96B2 96B3
```

Table 2. Extended Color Basic 1.1 ROM Address Changes



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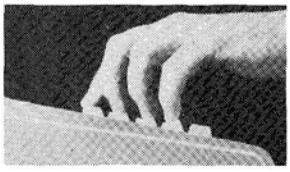

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was the fixing of the COPY command. Instead of locking up when an error occurs and giving an ?OB error, it responds with an I/O error and everything is unchanged.

This new ROM causes definite software incompatibility problems and those having it should be warned that not all software with disk routines will work.

Bob Rosen
Spectrum Projects
93-15 86th Drive
Woodhaven, NY 11421

Serial-to-Parallel Fix

Ed. note: The +5V source to the right of R1 (lower right corner) in Fig. 2 of "Serial-to-Parallel Interface" (June 1983, p. 32) should attach to the opposite end of R1. The foil pattern in Figs. 3 and 4 is correct.

Filecheck Faux Pas

Ed. note: Program Listing 1 of "Filecheck" (July 1983, p. 40) has an error in line 130. This line should read IF F$ = "DIR" THEN DIR: GOTO 120.

"It is apparently the wiggling of the ROM pack... that causes a shorting of the 12-volt lines, burning out the computer."

Iowa City User's Group

I would like to form a Color Computer user's group in the Iowa City area. Interested people can contact me at the address below.

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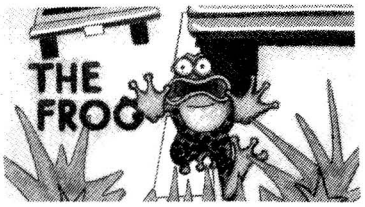

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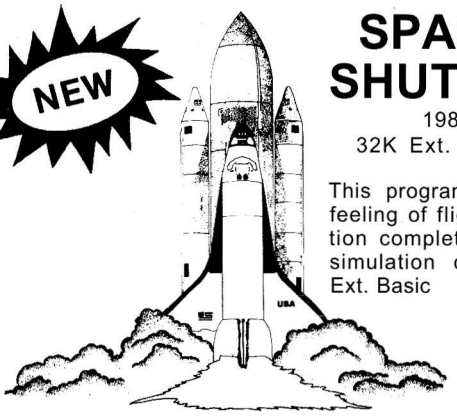

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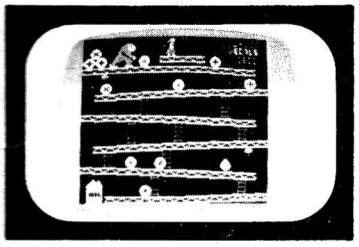

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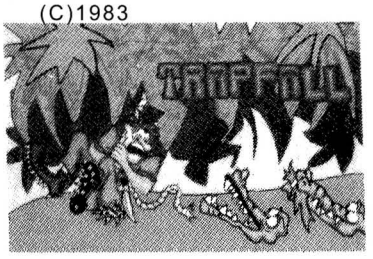

*****ARCADE ACTION*****
The "Pitfalls" in this game are many. Hidden treasures, jump over the pits, swing on the vine, watch out for alligators, beware of the scorpion. Another game for the Color Computer with the same high resolution graphics as "The King."

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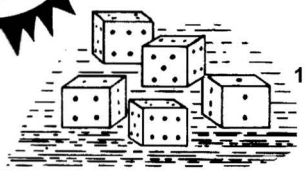
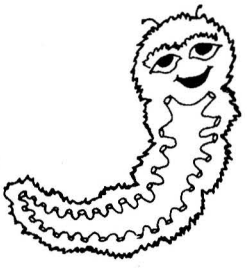
16K MACHINE LANGUAGE
EXT. BASIC



Yaazee is a 2 player game using five dice to get the best poker hand. After game is loaded flashing digit below player number determines which player rolls dice at the start of the game.

KATERPILLAR ATTACK



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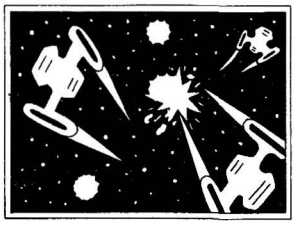

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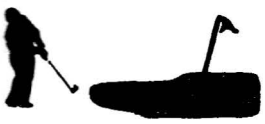

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REVIEWS

REVIEW CONTENTS

Edited by Jan Fiderio

Color Textset-1
Anteco Software
P.O. Box 14728
Fort Worth, TX 76117
16K
$34.95

by William A. Van Nest

Textset is advertised and referred to in the documentation as a word processor, but Color Textset is a Basic program that only operates on one line at a time. By most people's definition, this program is a line editor. In this respect, Anteco has done quite well.

The program includes commands such as DELn and INSn, where n is the line number to which the command applies. I won't list all the commands, as there are 23 of them, and anyone familiar with line editing can imagine most of them. A few of the more interesting commands, however, might have inspired Anteco to call this a word processor.

One such command is the @. When used as the first character in a line, it centers the line within the menu-specified margins. Another command (two, actually) is the draft option. Here you have the option of printing a complete copy of the file with line numbers (DRAFT) or a partial copy of selected lines (PDRAFT).

Color Textset also has a set of immediate commands that can work on the current line (a pointer is maintained), thereby eliminating the need to specify a line number during an operation. The period, translated literally, means "here." Commands such as ./, .D, and .E tell the program to display the current line, delete the current line, and edit the current line, respectively.

If you have 16K, the capacity of any given file is 200 screen lines. The file capacity for 32K is 500 lines. Other options from a cassette or keyboard include replace the current file and append the current file. While there are no disk commands, the fact that Color Textset is written in Basic makes user customization quite easy. In fact, because my printer does not have automatic line feeds, it was easy to add line feeds to the program.

The output menu gives you a few more word-processing options, such as margins, right-justification, line spacing, paging, lines per page, and number of copies. It handles all these slowly, but well. In fact, the right-justification is as good as any I've seen on a printer without proportional spacing.

All in all, Color Textset-1 is a handy line editor and would be useful for creating data or label files. I can't recommend it as a word processor, however, even to a beginner. The reason for this is the $34.95 price tag. Many true, screen-oriented word processors are available for as little as $49. On the other hand, if the price were $10 it could be an excellent editor for a beginner or child.

As a final note, I found what I considered to be a bug in this software and did not receive an adequate response from Anteco. The bug occurs when an @ sign is placed at the beginning of a line to invoke centering and the line width is greater than the margin width. When this happens, the program allows the @ sign to print, thereby destroying the appearance of the text.

The program should trap this error by simply removing the @ sign. I wrote a letter to Anteco describing and even demonstrating the bug, but the response made absolutely no sense to me. I found no real answer to my problem, and the letter referred to a toll-free number that the letter did not contain. (It is listed in their advertising.)

Considering the limitations and price, I would not purchase this program nor would I recommend it. You might, however, find it suitable for your specific needs. •

Pirates Ahoy
Spectral Associates
141 Harvard Ave.
Tacoma, WA 98466
32K
$9.95, cassette
$13.95, disk

by Gary Linwood

Pirates Ahoy is a nongraphic text adventure game for **the 32K** CoCo. You must find all seven hidden treasures to retire.

The first portion of the game requires you to find a way to get to the treasures with sufficient equipment to recover them. You must stow many strange items in a small boat before setting out to find the cave and sunken treasure chest. Ogres and a real-time limit for diving cause more problems as you attempt to raise the treasure.

According to a single printed sheet accompanying **the tape, Pirates Ahoy** recognizes 20 verbs and 63 nouns and contains 83 locations. The program randomly sets the locations of five of the seven treasures **during initialization.**

To begin with, you receive the **clue** "Man's greed lies between the devil

and the angel in the deep blue sea." Pirates Ahoy also shows you a few useful verbs during the start of the program. You can recall these with the VERB command. No other direct hints are available during play. Spectral Associates does offer hints for 50 cents each, and when you get stuck, it is possible to sneak a look at the verbs and nouns that the program accepts. One drawback is that the program does not allow you to save a game in progress.

On a scale of 1 to 10 for nongraphic adventure games (10 being the best), I would give Pirates Ahoy a 7 for keeping my interest and an 8 for challenging me. •

Zaxxon
Datasoft Inc.
9421 Winnetka Ave.
Chatsworth, CA 91311
$39.95 32K Disk or Cassette

by David L. Wasler

Photos by David Williams

Photo I. Zaxxon Robot

Photo 2. Deep-Space Alien Encounter

Envision this: You are a solitary space warrior. Your mission—to maneuver your speedy craft through the darkness of the universe and destroy the dastardly Zaxxon robot. Throughout your odyssey, your deep-space visual radar warns you of oncoming objects. Upon a sighting, you pause, eyeing the CRT wondering if this asteroid houses your opponent, with its deadly robot missile, or is it the alien space fortress, which always precedes and protects Zaxxon. You are sure of only one fact; the battle that beckons will be a challenge.

Zaxxon is a dynamic, three-dimensional game for one or two players. The scrolling, high-resolution graphics are very impressive, and, along with the reproduction of explosion sounds, make for a very entertaining game.

As each game starts, you approach the alien space fortress. It is fortified by a protective wall. From your briefing you have learned this wall has a notch in the upper left corner. To navigate your spacecraft through this notch, you must fire your laser blaster while moving the joystick back and forth and keeping a smart watch where the laser blast hits. The blast tells you if your spacecraft is aligned with the notch in the wall. If the laser blast passes through the notch, you will pass through the notch, also. If the blast hits the wall, so will you.

After navigating through the notch, you must descend to the floor of the fortress to avoid the dangerous homing robot missiles and begin your strafing run on the fuel tanks, gun emplacements, enemy planes, and radar towers. After completing your straf-

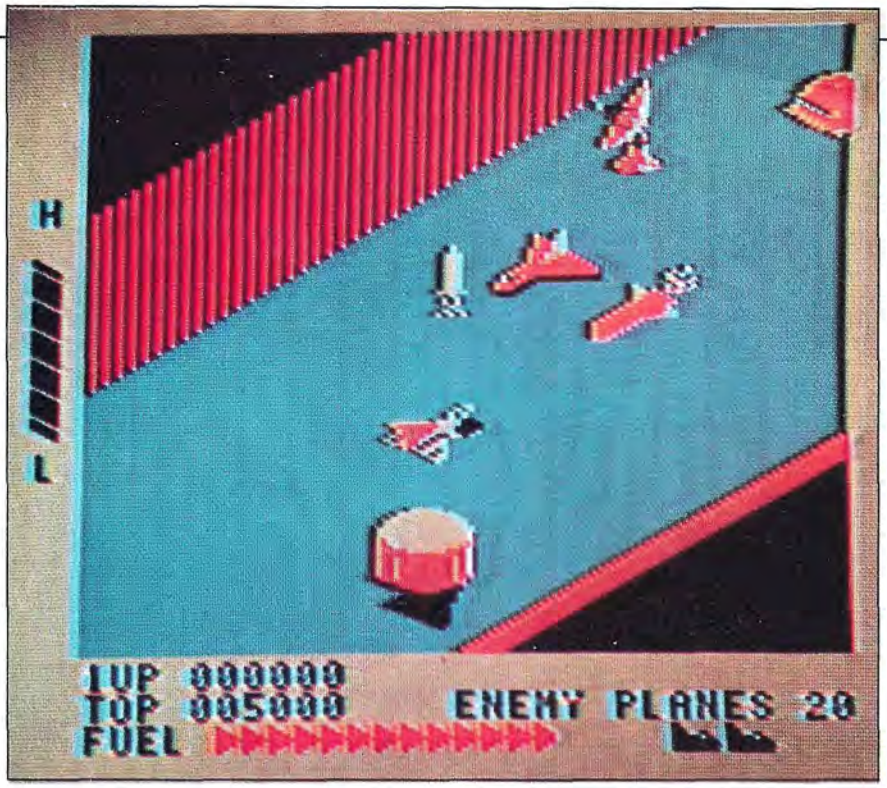

Photo 3. The Fortress Floor

Photo 4. The Force Field

ing run and making it past the first force field, you must make it out of the space fortress. Once again, you are faced with a protective wall with a notch on the right side.

When the space fortress is behind you, 20 alien fighters appear and attack. The object here is to destroy as many alien fighters as possible by moving the joystick and firing your laser blaster when the cross hairs on the nose of your spacecraft appear.

If you are still alive after the alien spacecraft encounter, you enter into Zaxxon's third phase, which tests your navigation and firing skills against the fortress. This fortress is like the first, but with stronger force fields, gun emplacements, radar towers, and, of course, the Zaxxon robot with its homing robot missiles. If you survive the encounter, the game restarts, but at a more difficult level.

Zaxxon features fast action and brilliant colors, and brings the Color Computer to an all-time game high. •

Starship Hercules
Aardvark
2352 S. Commerce
Walled Lake, MI 48088
32K Extended Color Basic
$19.95, cassette

by Vincent E. Perriello

Some interesting new ailments are making the rounds of CoCo owners. Medical authorities across the country have reported infirmities such as Zaxxon wrist and Donkey King elbow, which have generated a demand for a game that won't interfere with the healing process. Those of us who don't possess such high-speed reflexes also want to do more than just work on the CoCo.

Now at least one such program exists. Its name is Starship Hercules, a game in the Stratego/StarTrek mold. It is written entirely in Basic, but avoids using most of the graphics commands by using the special graphics character set in the CoCo. Its basic premise is the same as most computer games: Only you stand between civilization and some belligerent force. If you fail to halt the invasion effort, the entire civilization will perish.

In this game, you pilot a starship for the Confederation of Allied Planets, and your mission is to destroy the fleet that has entered the buffer zone between the Confederation and the Zargon Empire. For your convenience, the buffer zone is laid out in an 8-by-8 matrix, yielding a total of 64 quadrants. Each quadrant is similarly divided into 64 sectors.

The starship has plenty of features to help you in your efforts. It has a tactical scan, which provides visual coverage of the quadrant you are currently in, and a strategic scan, which

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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, TI, 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 EBB! 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 x 24 and 85 x 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.
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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.

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— The RAINBOW, Jan. 1982

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indicates how many stars, starbases, and Zargon battle cruisers are in the neighboring quadrants.

The Hercules has two major weapons systems—phasers and photon torpedoes. Phasers have the advantage of always being able to reach their target (even around obstacles), but cost you a substantial amount of the energy you should be saving for shields. Enemy shields cannot deflect photon torpedoes, but you must have a clear shot at the enemy and also try to avoid firing one at a Starbase.

A library computer on board the Hercules can give you course settings and a status report on your mission. Perhaps most importantly, it remembers the strategic scans you have made, which can be a major help in your effort to cover the entire buffer zone. It automatically calculates target settings for photon torpedoes. You also have the shields you need to protect yourself from the Zargon ships' phasers.

With all this going for the Hercules, you might wonder how much of a chance the Zargon fleet has against your one-ship fleet. Of course, a system can break down and need repairs, or a Zargon attack can damage systems. The Zargons have phasers and a weapon that attacks shield energy directly and can drain considerable amounts of power from the systems. They are also able to maneuver within a quadrant, but fortunately they cannot dodge photon torpedoes.

The game offers 10 difficulty levels. Level 1 is easy and is meant for the new user. At the higher difficulty levels, the shield-disrupting weapon comes into play, the Zargons can retreat from a quadrant to resupply, their phasers are more effective, and the Hercules systems break down more often. Also, the number of Zargons in the invasion fleet and the number of Stardates you have to polish off the Zargons vary as a function of the difficulty level.

The program handles battles very nicely. With the tactical scan on the screen, you can watch your photon torpedoes streak toward the enemy ships. When you fire phasers at the Zargon ships, you will see the glow of the Zargon shields attempting to protect them from your weapons. Likewise, when you come under attack, your shields will glow red when one of their beams reaches you. The sound effects are well matched to this.

The 27 pages of instructions are fairly complete. They are a little rough looking, having been printed on a dot-matrix printer, but they are quite readable.

Starship Hercules is a fine example of a thinking-man's game, but is not too cerebral for the younger set. It does not offer anything you can't handle by careful planning and action. Best of all, the price is reasonable. This would be a welcome addition to your library. •

Super-Pro Replacement Keyboard Kit
Mark Data Products
24001 Alicia Pkwy.
No. 226
Mission **Viejo, CA 92691**
$69.95

by Michael E. Nadeau
***HOT CoCo* staff**

Mark Data advertises its Super-Pro Replacement Keyboard as a "must have" item for Color Computer users. If you do a lot of word processing, data-base management, or typing in program listings, then Mark Data's claim is an understatement.

This "real" keyboard replaces the "Chiclet" keyboard that all CoCos and TDP-lOOs are born with. Installing it in your machine is like putting leather upholstery in your Volkswagen, except the keyboard is much more practical.

The keyboard resembles a standard TRS-80 Model III keyboard, minus the keypad. It also has much the same feel. The keystrokes seem more reliable, especially when using the shift/@ to freeze a program listing. Keybounce is nonexistent with this keyboard, too.

One big advantage to this keyboard is that it fits "naturally." It rests at the same angle as the old keyboard, making typing easier. It also makes for a professional appearance.

Installation

You don't have to be a hardware expert to install the Super-Pro keyboard. (I'm not and it took me about 20 minutes.) Everything you need, except contact cement, comes in the kit. If you have a CoCo manufactured sometime after October 1982, you may need a keyboard plug adapter, which costs $4.95.

The only physical change you need to do to your computer is cut off about half of the center support post under the old keyboard. This allows the Mark Data keyboard to lie at the same angle as the original one.

The keyboard already has adhesive tape on the bottom of its mounting, so once you are sure everything is properly aligned, you just peel off the protective paper, plug in the keyboard, and put it in place.

You must cement two spacer washers to the two side posts, and you must cement a replacement template to the inside of the top of the CoCo's case. (The instructions say this is optional, but I found it was the only way to keep the template in place.)

The installation is very simple, and the brief instructions are more than enough for anyone to perform the task. If your computer is still under warranty, however, replacing the keyboard will void it.

I'm very impressed with the appearance and performance of the Super-Pro keyboard. It could easily pass as original equipment, and it makes working with the Color Computer even more fun.

The only features missing are function keys and a keypad. However, these items are not necessary for most CoCo users. As it stands, the Super-Pro Replacement Keyboard is a great value. •

Protectors
Tom Mix Software
3424 College N.E.
Grand Rapids, MI 49505
32K Extended Basic
$24.95, cassette
$27.95, disk

by Joe Esposito

Protectors is a high-resolution game based on the arcade game Defender. The object of the game is to destroy as many enemy fighters as possible while protecting your city below. Your defenses include a laser cannon and smart bombs, which clear the screen of enemy fighters. Unlike the arcade game, there are no hostages to rescue.

Protectors requires two joysticks. The left joystick controls the direction of your laser's fire and ship's speed, while the right controls the vertical position of your ship and the actual fir-

ing of the laser. To release a smart bomb, you must press both joystick buttons simultaneously.

This can be awkward, especially when objects are swarming toward you. I found it best to fasten both joysticks to a level surface because it becomes necessary to move your hand from one to the other.

You use the joysticks to defend against several different types of fighters. The first to appear are the enemy planes, which constantly drop bombs on your city. The planes are the only fighters to threaten your city. Before long, heat-seeking mines orbit your ship, making maneuvering difficult. The third type of fighter fires heat-seeking blasts at your ship, while emitting an irritating sound. Finally, the mothership sneaks up from behind and tries to destroy you with its laser gun.

The mothership is difficult to destroy because its path is dependent upon your joystick. When you move up, the mothership will also move up. The best way to shoot the mothership is to "confuse" it by moving the joystick up and down while firing.

Operation

After you load and execute the program, the title screen appears. Pressing the joystick button displays the various enemy fighters and buildings along with their corresponding point values.

You select one of three skill levels before beginning. At the start of the game, you receive four ships and a planet value of 20,000 points. Each time a bomb hits the ground or a building, the program subtracts points from the planet value. As you progress in the game, the screen becomes more and more cluttered, and at times it is difficult to move your ship to a clear spot.

The game is very fast paced, and pressing the speed button makes it almost impossible to protect your city and ship. The only break in the action occurs when the program pauses to display the current attack-wave number. The program also displays the high score, current score, and planet value during play.

Protectors awards you with an extra ship every 5,000 points. If the action gets too heavy for you or your finger gets tired from firing, you can stop the action by pressing S on the keyboard.

The explosions, sounds, and graphics are all excellent. There are even a few three-dimensional routines worked into the program. The game is over when you run out of ships or the planet value reaches zero. The machine-language program makes good use of the joysticks, which is not the case in many other programs.

The documentation included with the cassette explains the various controls and enemy fighters. The only discrepancy I found is the number of smart bombs on each ship. The documentation claims that each ship is capable of releasing four smart bombs, but I have been able to use only two.

> *"The planes are the only fighters to threaten your city."*

Protectors is sure to provide hours of fun and entertainment to anyone who enjoys playing video games. •

DISASM
6809 Disassembler-Assembler
Dynamic Electronics Inc.
P.O. Box 896
Hartselle, AL 35640
16K
$19.95, cassette

by Dr. Walter J. Atkins, Jr.

DISASM is a Basic program that allows the assembling and disassembling of machine-language programs in the memory of a 16K or 32K Color Computer. It is cassette based and is designed for the inexperienced programmer.

If you are a new Assembly-language programmer, this program can be entertaining and educational. Although it is not a serious assembler, the disassembler is quite capable.

A unique feature of this program is that it refers to all memory locations in decimal. This feature makes the program easier to use than some others, but it also limits its flexibility.

After you load the program, you

See List of Advertisers on page 130

can enter the assembler mode by entering 1 or the disassembler mode by entering 2. The program is fully prompting, but some prompts are not clear. With a little practice, you get a feel for what the program expects you to enter.

The Assembler Mode

The assembler does not use the standard 6809 mnemonics, which can be a detriment if you are a 6809 Assembly-language programmer. If you are a novice, this won't matter until you decide to move on to a more capable assembler.

The assembler also does not support the use of pseudo-ops. (Pseudo-ops are simple commands that instruct the assembler to generate data or perform other functions.) Commonly used pseudo-ops such as FCC, which generates a text string, and FCB, which programmers often use to build tables of data in memory, are sorely missed. You will find it very difficult to use this assembler to write a program that writes messages on the Color Computer screen.

In the assembler mode, you enter the starting location in memory where the machine-language program is to begin. You then type each instruction. Some instructions require quite a bit of information.

For example, loading the A accumulator register in the 6809 processor with a value from a memory location to which the X index register refers requires you to enter the instruction LDA N and three numbers. The LDA N instruction tells the program that the instruction will be a register load. Next, you must select the X register index, the direct mode, and an automatic X register increment of zero.

If you are an inexperienced programmer, it may be a while before all these options mean anything to you. The program documentation does not help much in this regard. It is not well written and is rather confusing in many places.

Most assemblers allow the use of labels to identify locations in memory. These labels are particularly useful when you refer to subroutines and to the destinations for jump and branch instructions. DISASM does not allow the use of labels. This requires you to keep track 0f where various instructions are located in memory. This is very difficult to do if you write an instruction that jumps or branches to a location higher in memory than the one on which you are currently working.

Instructions for the 6809 processor can vary in length from 1 to 4 bytes. This makes it difficult to predict where a particular instruction will eventually be located.

The best way to learn to use this assembler is through practice. The documentation includes two sample programs to demonstrate how to assemble and use a machine-language program. You can assemble these and then use them as USR routines from Color Basic. If you have Extended Color Basic, you can save the machine-language routines on tape using the CSAVEM statement. You can then load them for later use using the CLOADM statement. Unfortunately, the DISASM documentation does not tell you how to do this.

The Disassembler Mode

The disassembler mode is easier to use than the assembler mode. You must answer only two questions to use it. First, tell DISASM the memory location at which it is to begin the disassembly. Then you indicate whether you want the disassembled program printed on a printer.

Once the disassembly starts, it continues until you press break. There is no way to specify a range of memory locations to be disassembled.

The output of the disassembler is easy to read. The program displays each machine-langauge instruction following its location in memory. It also displays any data associated with the instruction and the addressing mode used.

Shortcomings

The documentation for DISASM is incomplete and confusing. With enough study, you can make enough sense of it to use DISASM, but you should be prepared for considerable self-enlightenment.

In addition, the programmer who wrote DISASM did little to plan screen displays. The author wrote many of the program's prompts on top of characters already on the screen without first erasing them. This gives a very confusing display. It also does not look very professional.

The author could have clarified all the prompts in the program. For instance, when you enter the disassembler mode, the program displays the cryptic prompt "PRINTER?" There is no indication of the desired responses. I can tell you that Y, N, YES, and NO do not work. I finally discovered that entering a zero (0) tells the program that you do not want output to a printer.

I found DISASM interesting, but I would not recommend buying it for the assembler. I think you would be better off buying a full-featured assembler. It will take you a little longer to write your first meaningful program, and you will have to study a little harder, but the added functions and features will be well worth the trouble.

As a disassembler, DISASM is reasonably capable and simple to use. •

Intergalactic Force
Anteco Software
P.O. Box 14728
Fort Worth, TX 76117
16K
$24.95, cassette
$29.95, ROM pack

by **John** Ross

Intergalactic Force is another space shoot-em-up game for the Color Computer and the TDP-100. It requires 16K and one joystick. I tested the program on ROM pack, but a tape version is also available.

To begin the game, you receive an X-wing fighter ship. Your objective is to penetrate the defenses of the Death Star and to fend off the attacks of Imperial Fighters that have been sent to destroy you.

You maneuver your X-wing craft with the right joystick, and the fire button fires your on-board weaponry. Unlike other spaceship games, you have an unlimited supply of fuel, but a limited supply of photon torpedoes. You begin the game with 40 torpedoes, and when they are exhausted, you are allowed to fly to the top of the screen for another supply of 40. The program displays the amount of torpedoes remaining in a bar graph on the side of the screen.

The game screen is the familiar "trench," and your object is to shoot a yellow shaft opening in the Death Star. Your craft fires torpedoes in

your direction of travel. The instructions state that you may fire up at the Imperial Fighter or down at the shaft opening when it appears. I have found that it is far easier to fly at the base of the screen and nail the Fighters and the shaft opening from below. The shaft opening comes from the middle of the trench at the middle of the screen and travels toward the bottom.

There are three levels of play. The first is the easiest. The flight of the Imperial Fighters is predictable, so you can easily destroy them. If one of your six ships is destroyed, it is quite easy to fly another one down from the top of the screen. You must, however, avoid being run over by the Imperial Fighter when you bring your ship into play from the top of the screen.

The other levels become increasingly difficult. Unlike other games, speed is not the only aspect that changes. The maneuvering of the Imperial Fighters becomes less predictable, and it is much harder to bring new ships into play. This change in game strategy from level to level makes the program worth the price.

As an added challenge, your ship must not touch the sides or bottom of the trench, or it will explode. A laser cannon also fires across the screen, and if your ship is at the side of the screen when the beam reaches that point, you lose the ship.

You are awarded an additional ship for each 1,000 points you score, to a maximum of six ships (five in reserve and one in action). The remaining ships are indicated on the edge of the screen as a column of x-wing ships. The score and level of play are also displayed on the side of the screen.

You are awarded 10 points for each Imperial Fighter you manage to blow up and 200 points for hitting the shaft opening. The highest score and the level of play when it was accomplished are also posted. You can change the level of play at any time between games.

The graphics in this game are reasonably good, but not on a par with some of the arcade look-alikes available. You can change the color set by hitting the space bar, but I can't understand why anyone would want to. The normal background is space blue; when changed, it becomes an obnoxious pink.

This is a game for all players. The ease of play at the first level will not frustrate younger gamers, and the upper levels will challenge even the most experienced players. •

Pro-Color-File 2.0
Derringer Software
P.O. Box 5300
Florence, SC 29502
$79.95, 32K, **one** disk drive

by Scott L. Norman

Pro-Color-File is a recent addition to the ranks of advanced data-base-management systems for the Color Computer, and it's a good one. Author Dennis Derringer has produced a powerful set of programs that incorporate all the operations expected of sophisticated data handlers. It enables you to:

• define the structure of the data fields to be used in the data base;
• establish convenient data-entry formats;
• carry out computations for individual records, as well as for larger portions of the data base; and
• define a variety of report formats and prepare reports for the entire data base or for selected portions.

Whenever I mention "data," I am referring to alphabetic and numeric information.

Pro-Color-File (PCF) is a full-featured system and, as a result, it cannot be mastered overnight. It has a few tricky points, and the 31-page manual, although well-written, is densely packed. PCF is worth the time needed to work through its documentation. It offers many features of much larger programs running on minis and mainframes.

System Overview

The unprotected PCF disk includes Basic system programs, along with ASCII data files for three sample data bases. The manual guides you through a complete data-base definition cycle using just one of the sample data bases for an organization's membership roster. You are encouraged to work through the other two data bases to explore the finer points of the system's operation.

PCF users can get by with a single disk drive, but a pair make life much more convenient.

Just what are the PCF system programs, and what do they do? Here's the rundown:

• M/BAS is the main menu program. Whenever you set up a data base, M/BAS creates files that define the data fields, the formats of the video displays (screens) into which you enter the data, and any equations for calculating results from the raw data. Another file keeps track of the names of the data bases and the drive number on which each is to be found.

• CREATE/REP generates reports. It creates up to five files that hold the report formats and another that keeps track of the titles.

• ENTER/REC, the data-entry program, produces up to four "segments" of information for each record in a data base. Each data segment can contain up to 15 fields; all must total 255 or fewer characters. You can specify the drive on which the data will be stored.

• INDEX/REC produces just one file: the index specifying the order you defined into which the data records have been sorted. The records themselves are not rearranged during a sort.

• PRINT/REP controls the printing of specified reports.

• LIMIT/BAS can be used to install a limited menu in a data base whose data entry and report formats have been completely specified. The limited menu allows subsequent users to add, update, or review records; print reports; or change the order according to how the records are sorted. It does not include options for defining new reports or altering the structure of the data base, however. Thus, LIMIT/BAS helps produce a more finished, tamper-proof product.

• MENU/LTD is the version of the master program that contains the limited menu.

• UNLIMIT/BAS lets you retrieve the complete PCF menu after working with a limited-menu data base. You are then free to define a new structure.

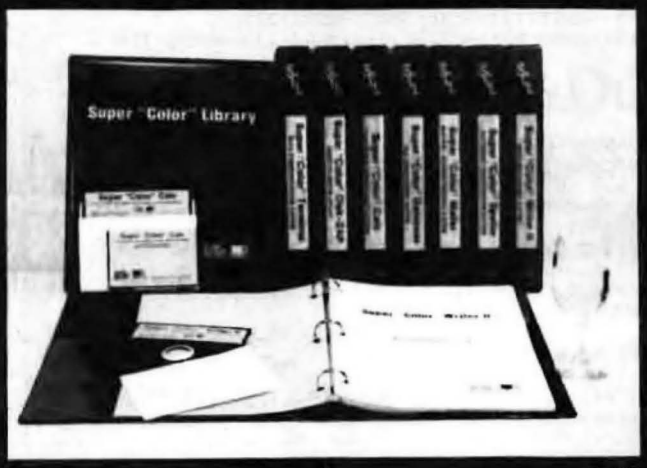
Most of these programs are called by M/BAS or by each other; the user enters RUN "M". You frequently return to the main menu when setting up a data base, and specify the next step; there is plenty of system drive action as the next program is called.

To help clarify some of these concepts and to get some feeling for the operation of PCF, let's walk through the development of a small data base.

I collected some facts about World War II fighter aircraft and set about organizing them. This simple example actually illustrates quite a few of

Super "Color" Library™

For the TRS-80 Color and TDP System 100 Personal Computers



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32x16 & 51-64-85x21&24 WITH REAL LOWERCASE DISPLAY

VERSION 3.0 By Tim Nelson

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By Tim Nelson

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By Peter A. Stark

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ELECTRONIC SPREADSHEET By Kevin Herrboldt

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By Tim Nelson

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PCF's features, as well as a few of its quirks.

Data-base Structure and Data Screen Definition

With PCF, as with many larger programs, it pays to spend a little time planning your data base with paper and pencil. Once away from the keyboard you can make rational choices about which data fields to include, and how much space to allot each—the first information the program needs.

The order in which you define the fields is of little consequence at this point; your data can later be entered in another order, depending on how the screens are defined. The fields can be scrambled once again when you set up report formats, so the important point at this stage is to get a clear picture of what data you will furnish, and what else the programs will have to calculate.

With the paper design of my two-segment data base in hand, I was ready to run PCF. Whenever you make a selection from the main menu, *the program prompts you for a file* (i.e., data-base) name; I used Fighters. At this point, the program asks you to specify the storage drive for each data segment. Drive 0 gets all the action until you begin to enter data.

I entered the name and length of each field in response to screen prompts, with PCF informing me of the remaining space at all times. The setups of my two segments are shown in Fig. 1.

The printouts in this review were obtained through PCF's hardcopy option.

PCF's editing is a bit limited in this part of the program. You can alter the name and length of a field before hitting enter, but any changes after that point involve returning to the main menu, recalling the "Define Data Segment" option, and cycling through the fields. Later program segments let you insert and delete individual spaces and complete lines.

The format 1 chose for aircraft dimensions included wingspan and length in feet and inches, but I also defined a decimal-feet field for each. The sole calculation in Fighters involved the conversion of the former measurements into feet and decimal fractions of feet.

My next task was to define the data-entry screens, the video "forms" that I would use to enter information to flesh out the data base. In principle, a PCF screen can hold 30 fields and, therefore, just one could have sufficed for Fighters. The data-identification prompts would have been awfully brief, though, so I took the easy way out and used a pair of screens. See Fig. 2.

Each screen line contains at least four items: prompts, a left bracket to define the starting point of a data field, a symbol to specify the type of data, and a number to inform the program of the field entered in each position. If you compare Figs. 1 and 2, you'll see the correspondence between these latter numbers and the field numbers assigned when the segments were defined.

Notice that some of the screen prompts have been changed from the official field names. I called for data to be entered in the order originally used to specify the fields, but I didn't need to do so.

There are four types of field identifiers available in PCF: a dollar sign *($) for alphanumerics, a number sign* (#) for integers, a period (.) for numbers carried out to two decimal places, and an exclamation point (!), which serves two purposes. It can specify that a field defined on one screen should be used on another, or identify the fields that are to be derived by calculation, rather than being entered by the user. All calculations are performed after you have entered the data for a given record into all the screens.

PCF makes data entry simple. The cursor automatically positions itself at the start of the first field requiring input; you just key in data for that field and press enter. The cursor then moves to the next available starting point, skipping over any fields that will later be filled in by stored equations.

Pro-Color-File provides some classy touches for the data-base designer. You can give different parts of a screen different background colors, and you can protect each screen against unauthorized access by a different password.

Defining the Equations

Your *next step is setting up the* equations that operate on your data.

FILE NAME: FIGHTERS

DEFINED DATA FOR SEGMENT - 1

FIELD	HEADING	LENGTH
1. --	NAME	15
2. --	MODEL	7
3. --	MFR.	15
4. --	COUNTRY	4
5. --	HORSEPOWER	4
6. --	# OF GUNS	2
7. --	MAX. SPEED	3
8. --	CRUISE	3
9. --	CEILING	5
10. --	MAX. RANGE	4
11. --	WEIGHT	5
12. --	SPAN, FT.	2
13. --	IN.	3
14. --	DECIMAL SPAN	3

Total data space = 79

FILE NAME: FIGHTERS

DEFINED DATA FOR SEGMENT - 2

FIELD	HEADING	LENGTH
15. --	LENGTH, FT.	2
16. --	IN.	5
17. --	DECIMAL LEN.	5
18. --	1ST FLITE,YR	4
19. --	MO.	2
20. --	DAY	2

Total data space = 20

Fig. 1. The Two Segments Defined for the Fighters Data Base

```
WW II FIGHTER DATA--SCREEN 1

NAME [$1
MODEL [$2
MFR. [$3
COUNTRY OF ORIGIN [$4

HORSEPOWER [#5      # GUNS [#6

SPEEDS: MAX. [#7    CRUISE [#8
CEILING, FT.[#9
MAX. RANGE, MI. [#10
```

```
WW II FIGHTER DATA--SCREEN 2

NAME [!1

WEIGHT, LBS. [#11

SPAN: [#12 FT., [.13  IN.
     = [!14     FT.
LENGTH: [#15 FT., [.16   IN.
     = [!17     FT.

FIRST FLIGHT: YEAR: [#18
              MONTH: [#19
                DAY: [#20
```

Fig. 2. Data-Entry Screens

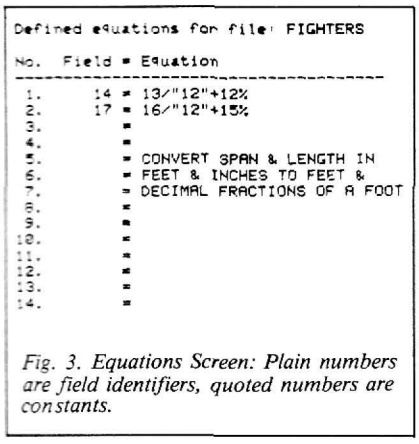

Fig. 3. Equations Screen: Plain numbers are field identifiers, quoted numbers are constants.

Fields are referred to by the numbers assigned them when the segments were defined, while "real" numbers, or constants, are surrounded by quotes. Fields 1-9 must be expresssd as 01,02, and so on.

PCF's notation resembles that of Basic in several respects. Its equations read from left to right: Destination Field = Expression (Fields and Constants), and the four common mathematical operations use the standard symbols. You cannot use parentheses to group terms together, though, and PCF ignores the conventional hierarchy dictating the order in which operations are to be performed. Instead, equations are parsed from left to right and operations are carried out as they are encountered.

Finally, each of the 14 equations permitted for a data base must be followed by a symbol specifying how the results are to be presented. The options are an exclamation point (!) for integer results or a percentage sign (%) for numbers carried out to two decimal places. This can be confusing; it is not consistent with the number symbol and the period employed in screen design.

My calculations, shown in Fig. 3, demonstrate that if you are accustomed to conventional notation, you should rake extra care when defining a PCF equation. My goal was to convert foot-and-inch measurements to feet and tenths and hundredths of a foot. Simple enough—divide the inches figure by 12 to express it as a decimal fraction of a foot, then add it to the number of feet already known. Using the field numbers defined for the wingspan in Fig. 1, this calculation would be: Field 14 = Field 12 + (Field 13)/ 12, or in PCF notation, allowing two decimal places: 14 = 12 + 13/"12" %.

Or so I thought. When I used this format, I found that the program added fields 12 and 13 first, and then divided the sum by the constant 12. That's the sort of trouble you can get into if you assume the conventional hierarchy of operations.

The solution, of course, was to do the division to define the fractional part of the measurement first, and then add the result to the integer portion.

PCF has an additional symbol all its own: the comma, used to designate the total of sequential fields. Thus, 05 , 10 is the shorthand expression for 05+06 + 07 + 08 + 09 + 10.

If used, this must be the first mathematical operation on the right side of an equation.

Like Basic, PCF permits self-referential equations; 20 = 20 + 25 is perfectly acceptable. Should a calculation become very long, intermediate results can be stored in fields that were not used in the defined segments of the data base.

When you enter the equation-definition subroutine, PCF generates a screen with 14 numbered lines and appropriately spaced equals signs. Lines not needed for equations can be used for notes, as Fig. 3 illustrates. In fact, you can place short notes on the same lines as the equations themselves.

Entering Data and Indexing Records

After describing the construction of equations, the PCF manual plunges into report definition. Inexperienced users might do well to put this off, though. By the time you get your data segments, input screens, and equations set up, you will have been at the job for quite a while. I found it more relaxing to settle back with my reference material and start loading the data base.

The Add/Review/Update Records section of PCF is well-supplied with prompts, as is the rest of the system. Data entry is quite simple. When you have completed the first screen, the shift/down arrow takes you to the next. You can use the shifted vertical arrows to jump from one screen to another at any time.

After completing all available screens, you are prompted to record the data by pressing the clear key. A new message, *CALCULATING*, appears as the previously defined equations are invoked, and in a few seconds the blank fields (those marked with a !) are filled in with calculated results.

The disk drives are not engaged after entering every record. PCF apparently establishes a RAM buffer and only engages the drives when it is full. In the case of Fighters, this generally happened every three records or so. A larger data base might involve more disk activity.

You can scan through the recorded data, searching for any specified target string. PCF stores data in direct-access files, so you can "pull" a record for examination by specifying its number, if you know it. Record numbers are displayed at the bottom of the screen during the data-entry process. Once your desired data is on screen, you can obtain a printout.

PCF includes a good system for indexing, or sorting records. You can use as many as three fields from the same segment to index data. The first field specified will be the principal, or key, index. Records having the same value of this index are sorted according to the next one, and so on.

You select indices from the screen menu of each segment in the data base, on which the fields are identified by letters rather than by their original numbers. Although this inconsistency was troubling, it proved to be a minor matter.

PCF also allows you to specify whether the indexing is to be applied to all records or just to those satisfying some other criteria. Allowable criteria include a full range of algebraic and logical equalities and inequalities, and two such criteria can be ANDed or ORed together. I indexed all the records and used the selection option later, when printing reports.

Defining Report Formats and Printing

It does you little good to have a data base crammed with information if you are unable to retrieve it in an orderly manner. A high-caliber data-base management system should allow you to define different report formats to control the order in which records are presented in each report, and to select subsets of the complete data base for analysis.

At the same time, establishing report formats can be one of the most time-consuming parts of data-base management.

PCF lets you define five reports, each with a unique name and each capable of being protected by a different password. The names are just for your convenience and need not appear anywhere on the report itself. You have two other opportunities to put identifying information at the top of your printed output. You can also define screen reports for video output only.

Reports are designed on a video worksheet with separate areas for a printed title and column headings, markers that delineate the data positions, and identification of the data field associated with each position. There is also a print-position scale to help you judge the appearance of the final report.

You must fix two important parameters at the outset: the column width, or number of spaces needed for a complete report line, and the printer width, which is the number of characters per line that your printer can handle. If the former is larger than the latter, you need a multiline report with more than one printed line per record. PCF can handle these, although the formatting can become complicated.

Once defined, the column and printer widths cannot be changed. A miscalculation means you must delete the report format and start over. The most important decision you can make is to determine which fields to include in a given report. Once that is settled, PCF's full-screen editing capability lets you lay out the report sheet in fairly short order. Figure 4 shows two sample reports for Fighters: one that identifies the aircraft and the date of its first flight, and another that summarizes major performance statistics.

The bottom line is called the identifier. The entries here resemble those on the data-entry screens and identify the particular fields to be used. There are a couple of differences, though. All numeric fields, whether user-entered or found by calculation, are identified by a number symbol. Also, the bracket symbols no longer pin down the position of the fields; that is left to the symbols in the next line up, the specifier.

The specifier line uses percent symbols to denote the beginning and end of each alphabetic field. The distance between them, plus the two spaces occupied by the symbols themselves, must agree with the field width you have specified. Positions in numeric fields are denoted by a number sign, with the decimal point explicitly shown.

Once the identifier and specifier lines are laid out and positioned with the PCF editor, your battle is won. Now just set up informative column headings and pick a printed title for your report. Adding a number symbol anywhere in the three-line title area guarantees that page numbers will be printed on the final copy. The print-position scale at the top of the worksheet will not appear, which adds to the appearance of the document.

You can assign a two-line label at the very top of a page when the report is actually printing to provide yet another way of identifying a particular report.

Report Format 1

```
----+----10---+----20---+----30---+----><---+----50---+----60---+----70---+----

                        WORLD WAR II FIGHTER AIRCRAFT
                              ELEMENTARY FACTS
                                                                    PAGE ##

                                                          NAT'L. OR-   1ST FLIGHT
     MANUFACTURER      TYPE & POPULAR NAME IF ANY          IGIN      MO. DAY  YR.
     %                 % %     % %                 %     %   %      ##  ##  ####
C$3                      C$2     C$1                       C$4       C#19C#20C#18
```

Report Format 2

```
----+----10---+----20---+----30---+----><---+----50---+----60---+----70---+----

                          WW II FIGHTER AIRCRAFT
                           PERFORMANCE SUMMARY
                  SORTED IN ORDER OF DATE OF FIRST FLIGHT                PAGE ##

                                  SPEEDS (MPH)   CEILING,   RANGE,
     MANUFACTURER AND TYPE        MAX.  CRUISE     FT.      MILES
     %                 % %     %  ###    ###      #####     ####
C$3                      C$2       C#7   C#8      C#9       C#10
```

Fig. 4. The Two Report Format for Fighters

A Few Points About the Report

The year/month/day indexing worked well, although I rearranged the index fields for printing. I specified a low-to-high sort through the index fields when the report was printed.

PCF uses left-justified alphabetic entries within their assigned spaces, numeric entries are right-justified—a good convention.

PCF has several print options. Numeric columns can be totalled, and the average entry found, by modifying the identifier line. It is also possible to specify the number of lines per printed page and to send up to five control codes to the printer in order to set up a particular font or spacing. You can select a subset of the data base for printing.

Summary

I am impressed by Pro-Color-File. It is one of the most versatile data-base managers available for the CoCo, and I use it to keep track of some of my business affairs. It proves that the Color Computer can be taken seriously for managerial tasks at the small-business level.

At the same time, programs this sophisticated call for a fair level of effort to master. There are a lot of nested menus to face, and some new symbology to learn. The initial effect of the program can be somewhat daunting. The manual is brief, which creates an impression of simplicity, but actually almost every line of documentation is vital. The inclusion of some commented printouts would have been helpful.

I would also like to see more uniformity in the identification of numeric and alphabetic fields in various parts of the program.

PCF's strongest points are its great flexibility and the willingness of author Dennis Derringer to work with his customers and to keep them appraised of bugs, patches, and other developments. Those are pretty good recommendations by themselves. •

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Auto Run it I utility *program* for the TRS-80' Extended Basic Color Computer, ft is used to add convenience end professionalism to your software.

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Basic programs can be set to load anywhere in memory above $600 (the PCLEAR 0 page).

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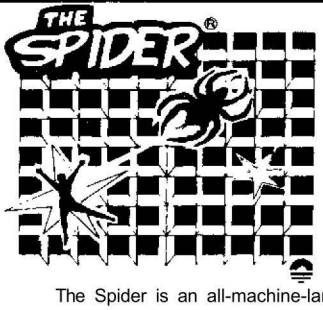

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The Spider is an all-machine-language program with very good sound, excellent graphics and super action.

You zoom along through a vividly-colored tunnel that's loaded with exceptionally realistic spiders, attempting to align them with your laser scope and blast them before they get you. I found it quite difficult to hit them, as my point display disconcertingly reminded all who watched, but then it takes these wicked web-wenders awhile to annihilate you the allotted five times, as well. I found this to my liking, because I enjoyed the prolonged action. You use the right joystick to manipulate the cross-beam of your scope, and, of course, the fire button to activate your laser. The point system is adequately explained in the documentation, so I needn't go into that here, except to say that if you manage 500 points you'll receive an extra life to devote to battling these belicose little beasties.

There's one more point I'd like to add here, and that is that, even though it wasn't mentioned in the documentation, playing The **Spider** while wearing a pair of 3-D glasses gives one of the best **dramatic-depth** effects I've yet seen. You lose some of the vivid colors by doing so, but then you can always take them off whenever you want and go back to playing the straight game.

—Courtney Noe

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The Basic Beat

THE FIRST STEPS TO BASIC PROGRAMMING

by James W. Wood

Another quiz? Yes, but I won't record your grade if you score too low. It's multiple choice. Choose the best answer. The questions are over commands covered in the June and July issues. (See Quiz.)

Can the Color Computer be used without writing programs, as an expensive calculator? Sure can—try these lines without a line number. Remember that ? is an abbreviation for PRINT.

```
?5*7 + 4-20(enter)        ?357*4278 (enter)
? 1/100 (enter)           ?HELLO (enter)
```

The computer should have responded with decimal answers for each line. Why the zero for PRINT HELLO? Since the HELLO was not in quotes, the value of HE was printed.

Last month you learned that in a mixed equation, the computer first performed multiplications and divisions, and then additions and subtractions. However, when parentheses are used in an equation, the computer will solve whatever is within them first.

Run Program Listing 1. Each line of the program has the same numbers and the same math operations, but the four results are different. Work the problems by hand to get the same results. Remember to work inside the parentheses first, then multiply, then add or subtract

Program Listings 2a and 2b do the same task: They print numbers from 1-100. Listing 2b is more efficient, however, because it is faster and takes less memory than Listing 2a.

The FOR command must be followed by a variable, an equals sign, and two numbers with the term TO between them. The second number is usually larger than the first, but it can be made smaller by use of the STEP extension.

Try Program Listing 3. Change line 20 of Listing 3 to 20 FOR A=0 TO 100 STEP 3. A FOR loop can be run through many times. It loops from the FOR to the NEXT command. The variable (A) is given a value that increases (or decreases if the STEP is negative) each time the program reaches the NEXT statement. After the variable becomes larger than the second number, the program will go past the NEXT statement.

Between FOR and NEXT a programmer can use many other statements besides PRINT. Program Listing 4 uses a loop for a pause. Line 20 counts from 1 to 2000, thus causing a

1) Every IF command should have a(n)...
   A) WHERE B) PRINT C) THEN D) ELSE
2) What value would the computer give X in the equation, X=2+5*4?
   A) 220 B) 22 C) 28 D) 14
3) Which command will make more space for string variables?
   A) STRING SPACE B) INPUT C) CONT D) CLEAR
4) How is "A does not equal B" represented in a program?
   A) AXB B) AOB C) BOA D) BXA
5) The number 5.26E4 is expressed in what kind of notation?
   A) hexadecimal B) strange C) binary D) scientific
6) Which punctuation mark separates commands on a program line?
   A) colon B) semicolon C) comma D) period
7) Which recorder key(s) are down when CSAVE"PROGRAM" is executed?
   A) play B) play and record C) fast forward D) none
8) Which of the following pairs of variables could the computer not distinguish?
   A)A,A1 B)A1,AI C)AXX,AXY D) AXY,AYX
9) What command erases memory?
   A) BREAK B) CLEAR C) CLS D) NEW
10) Which of the following variables could be set equal to "WORD"?
   A)X7 B)WO C)A$ D)AX

Quiz

```
10 PRINT2+4*7-1
20 PRINT(2+4)*7-1
30 PRINT2+4*(7-1)
40 PRINT(2+4)*(7-1)
```

Program Listing 1

```
10 CLS
20 FOR A=100 TO 1 STEP-1
30 PRINTA;
40 NEXTA
```

Program Listing 3

```
10 CLS
20 A=1
30 PRINTA;
40 A=A+1
50 IF A<=100 THEN GOTO 30
```

Program Listing 2a

```
10 CLS
20 PRINT"WAIT UNTIL"
30 FOR A=1 TO 2000: NEXTA
40 PRINT"THIS APPEARS"
```

Program Listing 4

```
10 CLS
20 FOR A=1 TO 100
30 PRINT A;
40 NEXT A
```

Program Listing 2b

```
10 CLS
20 FOR A=1 TO 100
30 PRINT"HA HA ";
40 NEXT A
```

Program Listing 5

- COMPUTER SHACK-

COLOR GRAPHICS EDITOR by Soft Sector

Color Graphics Editor (CGE) is a machine language program that any person who does any programming on the COCO must have. It is a tremendous time saver. It makes doing graphics fun. CGE is designed to make writing high resolution graphics programs for the COCO much easier and faster. It allows you to create on the screen high resolution graphics, such as game characters. Then you can copy the numbers that generate the characters into the data area of your program. If you have a disk system, CGE allows you to save the numbers directly to a file in the form of FDB statements or in a basic data statement. The FDB statements can be loaded directly into an editor/assembler. It comes on Cassette but loads to disk easily.
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Best word processor for the Color Computer
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NEW! NEW!

ASSEMBLY LANGUAGE GRAPHICS FOR THE TRS-80 COLOR COMPUTER

ByDonInman $14.95
Written specifically for the TRS-80 Color Computer, this book uses sound and graphics to show how 6809 assembly language can be used to perform tasks that would be difficult or impossible with BASIC. All of the explanations are hands-on, so that the manual can serve as a tutorial. Included are video screen displays which explain each step of the process of creating graphics. 288 pages.

PROGRAMMING THE 6809

By Rodney Zaks & William Labiak $14.95
This book explains how to program the 6809 in assembly language, covering all aspects progressively and systematically. Beginning with the basics of programming, **Programming the 6809** goes on to explain registers and buses, subroutines, the 6809 instruction set, addressing modes, I/O techniques and devices, and finally, data structures. With this knowledge you will be able to give your 6809 processor 16-bit performance with 8-bit economy. No prior programming knowlede is required.

TRS-80 COLOR PROGRAMS

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TRS-80 COLOR COMPUTER GRAPHICS

by Don Inman $14.95
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COMPUTER SHACK

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delay.

Program Listing 5 could be used for a little humor.

Program Listing 6 uses a FOR loop to create a simple game. After playing the game once, you know the secret number. Wouldn't it be great if the computer could think up numbers at random?' Change line 20 of Listing 6 to 20 SN=RND(10) and play the game a few times. Not as boring now, is it?'

Can you add a few lines to tell the player if his guess is too low or too high?' Give it a try.

The command RND is followed by a number in parentheses. Run Program Listing 7 several times to see an example. Try it with other numbers in the parentheses in line 30.

Radio Shack's RND is different from most other brands. If you are typing in a listing that was made for another computer (i.e., the games in *Basic Computer Games*, edited by David Ahl) then you must make a change.

Most other brands use RND(10) to pick a number between zero and 10 (or between zero and whatever number is within the parentheses). If the number is a fraction, then it is multiplied by a number and changed to a whole number. RND(10) on a TRS-80, however, picks a number between *one* and 10 (or between one and whatever number is within the parentheses).

How do you get the TRS-80 to choose a number in a range that doesn't begin with one?' If you wanted the computer to choose a number between 0-10, for example, you would need to enter a line like A=0+RND(10).

How would you pick random numbers between 10 and 20 inclusive?' Those numbers are all larger than nine. Ten is nine plus one, 20 is nine plus 11. Will Program Listing 8 give you the proper results?'

Our CoCos have been quiet so far. Adding sound to a program is accomplished by the command SOUND, which produces musical notes. There is a choice of frequency and length of note.

Let Program Listing 9 bring a little music into your CoCo's life. It is part of a Christmas song. Table 1 is used to determine the first number after SOUND. The second number regulates the length of the note. The range on both numbers is from 1-255. There is a better way to write this program using READ and DATA commands; unfortunately, you don't know them yet. With READ and DATA commands, it would only be necessary to type SOUND once. Program Listing 10 is my CoCo disco program.

Tones do not have to be used for music. In a game or educational program, one could use a high tone such as SOUND 150,1 as a reward and a low tone like SOUND 5,1 as an indication that the player didn't do so well. Program Listing 11 is a number-guessing game with no printed message telling

	1st octave	2nd octave	3rd octave	4th octave
F	5	133	197	229
F sharp, G flat	19	140	200	231
G	32	147	204	232
G sharp, A flat	45	153	207	234
A	58	159	210	236
A sharp, B flat	69	165	213	237
B	78	170	216	238
C*	89	176	218	239
C sharp, D flat	99	180	221	241
D	108	185	223	242
D sharp, E flat	117	189	225	243
E	125	193	227	244

*middle C

Table 1. Musical Notes and SOUND Numbers

```
10 CLS
20 SN=7
30 PRINT"YOU HAVE THREE CHANCES TO GUESS"
40 PRINT"THE SECRET NUMBER."
50 PRINT"IT IS BETWEEN 1 AND 10."
60 FOR N=1 TO 3
70 PRINT"WHAT IS YOUR GUESS";
80 INPUT GU
90 IF GU=SN THEN GOTO 130
100 PRINT"SORRY"
110 NEXT N
120 PRINT"YOU LOSE": GOTO 140
130 PRINT"YOU WIN"
140 PRINT"PLAY AGAIN(Y/N)";:INPUT PS
150 IFPS="Y" THEN RUN ELSE IF PS="N" THEN END ELSE GOTO 140
```

Program Listing 6

```
10 CLS
20 FOR A=1 TO 10
30 B=RND(100)
40 PRINTB;
50 NEXT A
```

Program Listing 7

```
10 CLS
20 FOR A=1 TO 200
30 B=9+RND(11)
40 PRINTB;
50 NEXT A
```

Program Listing 8

```
10 CLS:
20 SOUND147,3:SOUND133,1:SOUND125,2:
30 SOUND108,2:SOUND89,2:SOUND108,2:
40 SOUND125,2:SOUND89,2:SOUND108,1:
50 SOUND126,1:SOUND133,1:SOUND108,1:
60 SOUND125,3:SOUND108,1:SOUND89,2:
70 SOUND78,2:SOUND89,4
```

Program Listing 9

ing when you are correct. A tone is a quicker and more efficient way of telling you that you're correct than reading a printed message would be.

Graphics on the computer screen consist of nonalphanumeric (not numbers or letters) characters.

Low-resolution graphics on the CoCo are little rectangles that are taller than they are wide.

There are several methods of displaying graphics. The first method involves the SET command. The screen is divided into 2,048 little SET rectangles. Each one has a unique set of coordinates with which it is located. The screen is divided horizontally into 64 regions numbered from 0-63. Vertically, there are 32 regions numbered from 0-31.

The SET command is followed by three numbers. The first two numbers determine the location. The upper left corner is location 0,0. The third number represents the color of the SET position. The colors and corresponding numbers are shown in Table 2.

Program Listing 12 colors the upper left corner green. Line 30 tells the computer to go 63 positions to the right of location 0,0 and 31 positions down, thus coloring the lower right corner yellow.

The SET command can be used in a FOR loop to draw straight vertical or

```
10 CLS
20 SOUND RND(220),RND(3)
30 GOTO10
```

Program Listing 10

```
10 CLS
20 A=RND(5)
30 INPUT"GUESS A NUMBER
(1 TO 5)";B
40 IF B=A THEN SOUND 150,1: GOTO
20
50 SOUND 5,1:GOTO 30
```

Program Listing 11

```
10 CLS0
20 SET(0,0,1)
30 SET(63,31,2)
40 GOTO 40
```

Program Listing 12

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horizontal lines. Program Listing 13 draws a horizontal line across the middle of the screen. The FOR loop is a lot easier than typing SET(, ,) 64 times.

For a pair of vertical lines, try Program Listing 14.

If you set a lot of points on your screen, especially if they are close together, you may notice positions turning colors other than what you intended. Program Listing 15 is a program to color four SET positions in four different colors—but only one color results. Program Listing 16 does result in four colors touching.

So, what's the secret? There are four SET positions in one PRINT® position. You cannot use two different colors in one PRINT© position; you must use black and one other color.

Figure 3 shows how to tell if SET coordinates are in the same PRINT© position. Next month you'll learn how to locate the PRINT@ positions. This month, just worry about setting colors within each PRINT® position.

As shown in Fig. 1, the SET coordinates within any PRINT® position are both even in the upper left corner and both odd in the lower right. Keep this in mind when designing a multicolored graphic. For variety try Listings 15 and 16 again, with line 10 being 10 CLS8.

Program Listing 17 shows how to use RESET to turn a colored rectangle off. RESET doesn't use a number to represent color.

Run Program Listings 18a and 18b. Interestingly, they look the same, but 18a printed -1 and 18b printed 1. POINT is a command used to ask the color of a particular SET position. It is often used in video games to determine if an object is hit.

CLS prepares the screen for letters and numbers and PRINT POINT returns a - 1. CLS1 is a graphics green and PRINT POINT returns a +1. Someday, I hope to find a use for this discovery. POINT returns a number for a SET position that tells the position's color.

I've tried to design a short graphics game for my readers. Unfortunately, I haven't taught you enough commands yet. In order to have an arcade-type game, you need a command to feed information into the computer while the graphics continue to move.

INPUT is the only command these lessons have covered that feeds information into a program while it is running. INPUT stops all other functions; therefore, you could not use INPUT to shoot at a moving object.

A little rearrangement of next month's schedule will let you learn how to use INKEYS to program a small version of an arcade type game.

For this month, take a look at a graphics demo. Program Listing 19 flies an airplane across the screen to hit a randomly placed stationary bomb. The collision results in a rapid flashing of colors. Follow the lines carefully to

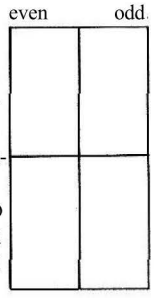

Fig. 1. SET Coordinates Within a PRINT© Position

1 green	5 buff
2 yellow	6 cyan
3 blue	7 magenta
4 red	8 orange

Table 2. Colors and Corresponding Numbers

```
10 CLSO
20 FOR X=0 TO 63
30 SET(X,15,8)
40 NEXT X
50 GOTO 50
```

Program Listing 13

```
10 CLS0
20 FOR Y=0 TO 31
30 SET(20,Y,2):SET(40,Y,2)
40 NEXT Y
50 GOTO 50
```

Program Listing 14

```
10 CLS0
20 SET(20,20,1):SET(21,20,2)
30 SET(20,21,3):SET{21,21,4)
40 GOTO 40
1010 CLS0
```

Program Listing 15

```
10 CLS0
20 SET(21,21,1):SET(22,21,2)
30 SET(21f22r3):SET(22,22,4)
40 GOTO 40
```

Program Listing 16

Answers to Quiz

1) Sometimes an IF doesn't need a THEN. However, I believe it's good programming practice to use a THEN with every IF. It only uses a few bytes of memory and can prevent errors. ELSE is an optional extension to an IF . . . THEN statement. The correct answer is C.

2) 2+5*4=22. Answer B. The computer knows that multiplication or division is performed before addition or subtraction.

3) CLEAR is used to clear more string space. If an OS (out of string space) error comes up, use CLEAR followed by a number of spaces to reserve for string variables, i.e., CLEAR 400. Correct answer is D.

4) They are all correct. Bonus points for having them all down.

5) The answer is D, scientific notation. The E is one of the letters used in the hexadecimal system, but I hope I never see it on the right side of a decimal point. 5.26E4 represents 5.26 times 10 raised to the fourth power which is 5.26*10,000 or 52,600.

6) Correct answer A, the colon. It is used in my programming examples (listings).

7) CSAVE is the command that saves the Basic program in the computer's memory on cassette tape. To record the information, the PLAY and RECORD keys will need to be down, answer B.

8) The computer only looks at the first two characters of a variable's name. The first must be a letter, the second can be a letter or a number. It could not tell AXX and AXY apart. Answer C.

9) NEW erases memory. On the Color Computer it doesn't erase the program on the screen, but it can't list that program again either.

10) "WORD" is a string. It can be set equal to a string variable, answer C, A$. The dollar sign is used to distinguish string variables from variables set equal to numbers.

study how the program works.

Here's your assignment for next class: use FOR loops and SET to create an on-screen picture. It can be a still picture, but animation earns extra points. Use sound to add a little music. You may try creating your house, school, farm, apartment, or perhaps your name.

And finally, here's something flashy to end lesson three. Program Listing 20 might go nice with a little music. •

Write James Wood c/o HOT CoCo, *Pine St., Peterborough, NH 03458.*

```
10 CLS2
20 RESET(31,15)
30 GOTO 30
```

Program Listing 17

```
10 CLS
20 PRINTPOINT(0,0)
```

Program Listing 18a

```
10 CLS1
20 PRINTPOINT(0,0)
```

Program Listing 18b

```
10 CLS0:X=RND(40)+20:SET<X,8,8)
20 FOR A=0TO60
30 SET(A,8,2):SET(A+1,8,8)
40 SET(A+2,7,2):SET(A+2,8,2)
50 SET(A+2,9,2):SET(A+3,8,2)
60 SOUND40,1
70 RESET(A,8):RESET(A+2,7):RESET
(A+2,9)
80 IF POINT(A+5,8)=8 THEN GOTO
100
90 NEXT A
100 FORW=0 TO 8:CLSW:NEXTW
110 GOTO 10
```

Program Listing 19

```
10 CLS0
20 FOR A=1 TO 100
30 SET(RND(63),RND(31),RND(8))
40 NEXT A
50 GOTO 10
```

Program Listing 20

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Elmer's Arcade

ROBOT RUBBER DUCKIES FROM HYPERSPACE

by Richard Ramella

My friend Elmer runs an arcade filled with old-fashioned mechanical games. He thinks the video-game fad will run its course sometime next year and the Great Herd of Consumers will return to his little joint on the crest of a wave of nostalgia.

On my last visit to Elmer's Arcade, I thought his prediction had come true. There was actually a crowd of whooping players grouped around a game I couldn't see. "What is this?" I asked.

Elmer smiled. "A new game. A new *old* game, I should say. Word-of-mouth advertising has been bringing them in all week."

"What is it? I want some!" I said.

"Get in line."

"Come on, Elmer, I'm your best customer. Let me at it!"

He shook his head. "Fair's fair, so you'll have to wait."

Wounded and still unable to see the game because of the crowd around it, I got Elmer to change my quarter into pennies and uneasily wandered among the familiar old games. I tried a little mechanical golf, fed a few coins into an ancient pinball machine and resisted the impulse to try the Grappler. I'd already lost more than 30 cents on previous visits in the effort to hook a plastic horse worth a dime.

Finally, the crowd melted away. "Come on and show me this," I called to Elmer, and he waddled around the counter with a smile.

The machine looked like a cross between a bagatelle or pachinko game and a gear box. "Can you tell what it does?" Elmer asked.

"No idea," I said. "Besides, the writing seems to be in Japanese."

"Of course, it's from Japan," said Elmer. "Translated with some elegance, the name of the game is Killer Robot Entities from Beyond the Reaches of Human Existence."

"I can't call it that when I put it in the computer. I'm kind of an electronic pacifist."

"You can't put this one in the computer!"

"Uncle Elmer, I can put *anything* into the computer!"

"Confident lad, ain't he?" Elmer said to the ceiling.

It was a good game. There was a vertical board with three horizontal lines of oddly spaced, half-moon holders containing ball bearings. At the bottom was a shooter. The rows above moved continuously either left or right. To play, you whammed ball bearings up toward the targets. Hitting a target in the top row tipped its steelie backward out of its holder for a score. But if you hit the cups in the lower two rows, they opened and dropped their ball bearings (the killer robots). If a bearing hit your shooter, you were out of business.

Elmer went back to get more coins three times before I was sated. "I think I understand it now," I said.

"What's not to understand?" Elmer asked. "It's a shooting gallery that shoots back."

"It's like those video games that involve invasions from space."

"I wouldn't know about those," Elmer sniffed, "except there are about

Program Listing. Robot Rubber Duckies from Hyperspace

```
100 REM * ROBOT RUBBER DUCKIES FROM HYPERSPACE / TRS-80 EXTENDED
 BASIC 16K
110 REM * ELMER'S ARCADE / AUGUST / R.RAMELLA
120 CLS0
130 CLEAR 2000
140  DATA FEATHERHEAD,PADDLEFOOT,DUCKLING,DUKE,DUCKESS,DRAKE,DONA
LD,WEBFOOT FIRST CLASS,SUPER DUCK,EL DUCKO SUPREMO
150 FOR A=0 TO 9
160 READ F$(A)
170 HH=(RND(2)*.25)+.50
180 ZZ=RND(4)*.25
190 UU=RND(4)*.25
200 NEXT A
210 S=-100
220 G$=STRING$(5,128)
230 C=32
240 V=30
250  A$(1)=CHR$(139+16)+CHR$(131+16)+CHR$(134+16)
260  A$(2)=CHR$(137+48)+CHR$(131+48)+CHR$(135+48)
270  A$(3)=CHR$(139+80)+CHR$(131+80)+CHR$(134+80)
280 FOR A=1 TO 3
290 B$(A)=STRING$(255,128)
300 NEXT
310 FOR A=1 TO 30
320 B(1)=RND(250)+1
330 B(2)=RND(251)+1
340 B(3)=RND(251)+1
```

Listing continued

AARDVARK

TRS-80 COLOR COMMODORE 64 VIC-20 SINCLAIR/TIMEX TI99

QUEST – A NEW IDEA IN ADVENTURE GAMES! Different from all the others. Quest is played on a computer generated map of Alesia. Your job is to gather men and supplies by combat, bargaining, exploration of ruins and temples and outright banditry. When your force is strong enough, you attack the Citadel of Moorlock in a life or death battle to the finish. Playable in 2 to 5 hours, this one is different every time. 16k TI99, TRS-80 Color, and Sinclair, 13K VIC-20. $14.95 each.

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Adds a second level with dungeons and more Questing.

CATERPILLAR

O.K., the Caterpillar does look a lot like a Centipede. We have spiders, falling fleas, monsters traipsing across the screen, poison mushrooms, and a lot of other familiar stuff. COLOR 80 requires 16k and Joysticks. This is Edson's best game to date. $19.95 for TRS 80 COLOR.

ADVENTURES!!!

The Adventures below are written in BASIC, are full featured, fast action, full plotted adventures that take 30-50 hours to play. (Adventures are interactive fantasies. It's like reading a book except that you are the main character as you give the computer, commands like "Look in the Coffin" and "Light the torch.")

Adventuring requires 16k on Sinclair, TRS-80, and TRS-80 Color. They require 8k on OSI and 13k on VIC-20. Sinclair requires extended BASIC. Now available for TI99. Any Commodore 64.

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New winner in the toughest adventure from Aardvark sweepstakes. This one takes place on an alien ship that has been deserted for a thousand years – and is still dangerous!

Dungeons of Death – Just for the 16k TRS-80 COLOR, this is the first D&D type game good enough to qualify at Aardvark. This is serious D&D that allows 1 to 6 players to go on a Dragon Hunting, Monster Killing, Dungeon Exploring Quest. Played on an on-screen map, you get a choice of race and character (Human, Dwarf, Soldier, Wizard, etc.), a chance to grow from game to game, and a 15 page manual. At the normal price for an Adventure ($14.95 tape, $19.95 disk), this is a giveaway.

WIZARDS TOWER – This is very similar to Quest (see above). We added wizards, magic, dragons, and dungeons to come up with a Quest with a D&D flavor. It requires 16k extended color BASIC. $14.95 Tape, $19.95 Disk. VIC 20 Commodore 64.

NEW

PLANET RAIDERS – Not just another defenders copy, this is an original program good in its own right. You pilot a one man ship across a planetary surface dogfighting with alien ships and blasting ground installations while you rescue stranded troopers. Rescue all the troopers and be transported to another harder, faster battle. Joysticks required. ALL MACHINE CODE! EDSONS BEST! 16K Tape TRS80COLOR $19.95 – 32K Disk $21.95.

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AT LAST AN AFFORDABLE COMPILER!

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$14.95 Tape - $19.95 Disk.

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Listing continued

```
350 FOR Y=1 TO 3
360 IF MID$(BS(Y),B(Y)-1,5)=G$ THEN MID$(B$(Y),B(Y),3)=A$(Y)
370 NEXT Y
380 NEXT A
390 CLS0
400 H=251
410 U=251
420 Z=1
430 PRINT @ 495,CHR${135+112)+CHR$(143+112)+CHR$(139+112);
440 IF INKEY$<>"" THEN F=F-5: GOSUB 540
450 PRINT @ 0,F;
460 PRINT @ 15,S;
470 IF S>F THEN 740
480 S=S+1
490 IF Q=5 GOSUB 550
500 PRINT @ 64,MID$(B$(1),H,32);: H=H-HH: IF H<1 THEN H=255
510 PRINT @ 128,MIDS(B$(2),Z,32);: Z=Z+ZZ: IF Z>255 THEN Z=1
520 PRINT @ 192,MID$(B$(3),0,32);: U=U-UU: IF U<1 THEN U=255
530 GOTO 440
540 Q=5
550 SET(C,V,8)
560 IF P0INT(C,V-1)=6 THEN FOR T=1 TO 2: SOUND 32,2: SOUND 32,2:
 SOUND 45,2: SOUND 45,2: NEXT: F=F-30: RESET(C,V): Q=0: V=30
570 IF P0INT(C,V-1)=4 THEN F=F-30: GOSUB 640: RETURN
580 IF P0INT(C,V-1)=2 THEN PRINT @ C/2+64,"DING";: FOR T=1 TO 5:
 SOUND 200,1: NEXT: F=F+75
590 RESET(C,V)
600 V=V-4
610 IF V<1 THEN V=30: Q=0
620 RETURN
630 SET(30,30,1): GOTO630
640 L=240
650 G=128+(C/2)
660 MID$(B$(2) ,Z+(C/2)-3,5)=G$
670 PRINT @ G-2,STRINGS(7,128);
680 PRINT @ G,A$(2);
690 SOUND L,1
700 L=L-15
710 IF G>492 AND G<498 THEN PRINT @ G-7 0,"PRESSED DUCK";: SOUND
1,10: GOTO 740
720 PRINT @ G,STRING$(3,128);
730 IF G>480 THEN RESET(C,V): Q=0: V=30: RETURN ELSE G=G+RND(3)+
30: GOTO 680
740 FOR T=1 TO 500
750 NEXT T
760 IF F<0 THEN F=0 ELSE IF F>1800 THEN F=1800
770 PRINT @ 480,"GAME OVER"?
780 SOUND 204,3
790 SOUND 204,3
800 SOUND 193,3
810 SOUND 210,3
820 SOUND 204,6
830 SOUND 193,6
840 PRINT @ 266,"RATING:";:PRINT @ 298,F$(INT(F/200));
850 GOTO 780
860 END
```

a jillion of them already, so why write another?"

"Because my version isn't going to cost 30 bucks," I said. "It will just involve typing in about 76 single-statement lines on the CoCo with Extended Color Basic."

Rubber Duckies

And so was born Robot Rubber Duckies from Hyperspace. It's G-rated. The worst that can happen to you is to be hit by a falling duck.

There are three rows of flying **ducks. Yellow** ducks in the top row and green ducks in the bottom row fly eastward. Red ducks in the middle row fly westward. At the bottom is an orange shooter. Tap any key to shoot.

You get 75 points every time you hit a yellow duck. It costs 5 points for each shot. If you hit a red or green duck, you lose 30 points. Also, a hit red duck falls from the sky, and if it lands on the shooter, that's a *pressed duck* and the game ends.

One other feature complicates things nicely. At the top of the screen are two numbers. The one on the left is the score, and the one on the right is a timer. Score starts at zero and timer starts at minus 100. If the timer catches up with the score, you lose the game. This means you have about 14 seconds at the start to score some points or lose the game.

Here are the ratings for your total score: under 200, Featherhead; 200-399, Paddlefoot; 400-599, Duckling; 600-799, Duke; 800-999, Duckess; 1,000-1,199, Drake; 1,200-1,399, Donald; 1,400-1,599, Webfoot First Class; 1,600-1,799, Super Duck; 1,800 an over, El Ducko Supremo.

Programming Notes

The program creates the lines of ducks in three steps. In lines 250-270, the program assembles each color duck from CHRS graphics elements. If you have trouble seeing my graphic ducks for what they are, try squinting. Lines 280-300 create three strings of 255 blanks. The loop from lines 310-380 packs the ducks into their respective strings. Line 360 says: If the five spaces of the string starting one before the random number are blank, then put a duckie there. This keeps the ducks from trying to occupy taken space and prevents quackery among them.

Lines 500-520 ensure the flight of the lines of ducks by printing a line of 32 characters from each string in sequence. For example, line 500 prints B$(l) characters, first printing a MID$ string of characters 1 to 32, then 2 to 33, and so on. It makes the ducks appear to move. When the end of the string arrives, the program sets the MID$ values at the beginning and it starts all over.

The red ducks fly in a different direction than the other two colors of ducks because their string is printed from end to beginning rather than beginning to end. It's all in lines 500-520.

Also, the program randomly selects the speed of the duckie rows for each game, which eliminates predictable situations. That happens in lines 170-190, which set the values to determine how fast the MID$ strings in 500-520 will change—i.e., once every one, two, three, or four times the PRINT@ command is given. •

If you have trouble making an Elmer's Arcade program work, write to Richard Ramella, 1493 Mt. View Ave., Chico, CA 95926. Send a self-addressed stamped envelope (Canadians 40 cents in coin and addressed envelope). If you have a line printer, send a listing of the program on your machine. If not, include the error message and the line in which it occurs or describe what the program seems to be doing wrong.

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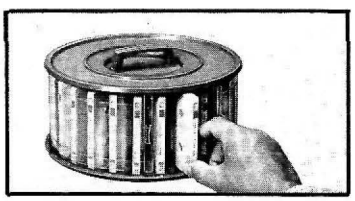

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BY KENNETH C. ANDERSON

INTRODUCTION TO MULTICOLOR GRAPHICS—PART I

Producing color graphics on the CoCo isn't what it used to be—it's better than you ever imagined!

How many colors does a Color Computer have? Although Radio Shack says the answer is eight, I say that the number is almost infinite.

You can actually count up to nine different colors if you are using PMODE 4 with the white border. In addition, if you believe Radio Shack's assertion that you can use its eight colors only in the text mode, what I have to say will come as a pleasant surprise.

Why, Picasso never had it so good. And Vincent? He would have given his left, uh, ear, for a palette like this.

Teaser

Do you think I am putting you on? Just enter the little Teaser program in Listing 1. Its 12 lines of Basic code accomplish something more expensive units cannot come close to matching.

Before you go any farther, let me point out a common problem that might affect the visual quality of these programs. Unfortunately, owners often connect Color Computers to TV sets or monitors that are not properly adjusted for the computer. The best adjustment for normal program reception is seldom the optimum adjustment for a computer.

In this case, proper adjustment is critical, so please follow the instructions below, even if you are confident that you have already adjusted your set.

Using the contrast and brightness controls, adjust for the deepest black border and the clearest (i.e., cleanest) text. Next, change the color-intensity control for a strong, rich green text screen. You have gone too far if the green "bleeds" across the border or a blue fringe appears around the edge.

Finally, use the CLS 1-8 command to display each color, then adjust the color with the tint control. These colors will not always be exact because all TV sets and computers have minor variations. For instance, my yellow is more like ivory when all the other colors are at their best. These minor variations will not affect the results, but an out-of-adjustment set surely will.

Color Whirlpool

Program Listing 2, Color Whirlpool, explains the theory behind multicolor graphics. If you have not yet seen Color Whirlpool, enter and run it now. Watching it will help you to understand how it works.

The program contains three sections. The opening lines to line 100 set up the variables so that you can easily alter them later for a variety of effects. The second section, from lines 160-500, makes some minor changes and asks for the main loop(s) in the third section to repeat. What appears to be a series of repeated commands is not.

The two subroutines in the third section do all the work. The first begins at line 540 and ends at line 630. The second loop includes lines 670-740 and is merely a shorter version of the first.

With these sections in mind, consider the theory involved. I generated all the colors by using one or more of the three concepts below.

First, buff-on-black in PMODE 4 always generates additional colors. The colors you see depend on the direction,

System Requirements

16K RAM
Extended Color Basic

```
10    '     T E A S E R
20 '
30  PMODE  4,1:PCLS3:SCREEN1,1:PM0DE  3,1
40 X1=0: Y1=0: X2=0: Y2=38
50  COLOR RND(4),0
60  LINE  (X1,Y1)-(X2,Y2),PSET
70 X1=X1+1: X2=X2+1
80  IF X1=>255 THEN 90 ELSE 50
90 Y1=Y1+38: Y2=Y2+38
100  IF X1=X2 THEN X1=0:X2=0:ELSE X1=38:X2=Ø
110  IFY2=>191 THEN 120 ELSE 50
120  IF X1<>X2 THEN 40
130  X1=38:X2=0:Y1=0:Y2=38
140  GOTO 50
```

Program Listing 1. Teaser

or slant, of the lines being drawn. Some colors in other modes often do the same thing, but to a lesser extent. In essence, this is the idea: Colors will undergo some modification when the slant of a line is altered.

Second, in the other graphics modes colors placed close to each other some-

```
18 '         C O L O R
20 '      W H I R L P O O L
30 '
40 '  INITIAL   VARIABLES
50 '
60 V=2
70 C=2
80 HW=.35
90 ST= .67
100 EN= .63
110 '
120 '  CONTROL   INSTRUCTIONS
130 '
140 ' MODE 3, GREEN SCREEN
150 '
160 PMODE 3,1
170 PCLS
180 SCREEN 1,0
190 GOSUB 540
200 '
210 ' MIXED, MODE 4 ON 3
220 '  GREEN    SCREEN
230 '
240 PMODE 4,1
250 GOSUB 670
260 '
270 '   MODE 3, BUFF SCREEN
280 '
290 PMODE 3,1
300 PCLS
310 SCREEN 1,1
320 GOSUB 540
330 '
340 '  MIXED, MODE 4 ON 3
350 '      BUFF SCREEN
360 '
370 PMODE 4,1
380 GOSUB 670
390 '
400 '   MODE 4, BLACK SCREEN
410 '
420 SCREEN 1,1
430 GOSUB 670
440 '
450 '  MIXED, MODE 3 ON 4
460 '     BLACK SCREEN
470 '
480 PMODE 3,1
490 GOSUB 540
500 GOTO 180
510 '
520 '  MAIN   SUBROUTINE
530 '
540 FOR R=300 TO 25 STEP -V
550 CIRCLE  (246,92),R,C,HW,ST,EN
560 NEXT
570 C=C+1
580 IF C=>9 THEN C=1
590 IF V=8 THEN V=2:C=1:GOTO 620
600 V-V+1
610 GOTO 540
620 FOR T=1 TO 400*10:NEXT
630 RETURN
640 '
650 '   ALTERNATE SUBROUTINE
660 '
670 FOR R=300 TO 25 STEP -V
680 CIRCLE(246,92},R,C,HW,ST,EN
690 NEXT
700 C=C+1:IF V=3 THEN V=2:C=2:
    GOTO 730
710 V=V+1
720 GOTO 670
730 FOR T=1 TO 400*5:NEXT
740 RETURN
```

Program Listing 2. Color Whirlpool

See *List of Advertisers on page 130*

```
10 '     F L Y ' S   E Y E
20 '
30  PMODE4,1:PCLS:SCREEN1,1:PMODE3,1
40  FORI=1TO10
50  C(I)=RND(4)
60  NEXT
70 P=0
80  IF C(10)=4THENBC=3ELSEBC=4
90  FORI=1TO10:GOSUB320
100  FORX=P TO250STEP10  'NEEDS A SPACE AFTER "P"
110  COLORC(I),0
120  LINE(X,0)-(X,191),PSET
130  NEXT
140  P=P+1
150  NEXT
160  P=0:T=0:X2=T+1:X1=T-190:Y1=X2:Y2=X1-64
170  IFC(10)=4THENBC=3ELSEBC=4
180  FORI=1TO10:GOSUB 320
190  COLORC(I),0
200  IFX2=>255THENX2=255
210  IFX1=>68THENX1=X1-1
220  IFXK=0THENX1=0
230  IFY1=>191THENY1=191
240  IFY2<=0THENY2=0
250  LINE(X1,Y1)-(X2,Y2),PSET
260  T=T+10:X2=T+1:X1=T-190!Y1=X2:Y2=X1-64
270  IFT=>440THEN290
280  GOTO200
290  P=P+1:T=P:X2=T+1:X1=T-190:Y1=X2:Y2=X1-64
300  NEXT
310  GOTO40
320  IF BC=4 THEN IF BC=C(I-1)  THEN BC=3:GOTO 340
330  IF BC=3 THEN IF BC=C(I-1)  THEN BC=4
340  CIRCLE(127,96),124,BC,  .76,1,1
350  PAINT  (2,2),C(I),BC
360  RETURN
```

Program Listing 3. Fly's Eye

times generate a third color—again, often depending on the degree of slant. This program illustrates how many ways you can combine the available primary colors to get extra colors.

The third concept deals with mixing modes. The control portion of the program (lines 160-500) illustrates how it works. Although Radio Shack tells you about the four graphics modes, it does not tell you that you can mix these modes. You do this by superimposing one mode over another, or "fooling" the computer. The standard syntax fcr a graphics mode is this:

PMODE 4,1 :PCLS:SCREEN 1,1

To superimpose another mode, you need one more instruction, PMODE 3,1.

Do *not* add SCREEN 1,1. If you use this command, the computer will give you PMODE 3 without mixing. You " fool" the computer into mixing modes by leaving out the command it "expects."

This mixed mode, 3 on 4, offers three new primary colors, depending on slant. In this mixed mode, the numbers 1-4 (or 5-8) select these colors: (1) black or blank; (2) red-orange; (3) blue or cyan; (4) buff, yellow, or blue. The Color Computer sometimes switches colors 2 and 3, but this is not much of a problem unless you want to file colors or paint with them.

"... Radio Shack ... does not tell you that you can mix these modes."

Other mixed modes are quite useful, but not nearly so dramatic. PMODE 1 on PMODE 4 yields the same colors. PMODE 4 on 3, with either SCREEN 1,1 or SCREEN 1,0, uses the short subroutine to produce a different effect.

The **Nitty-Gritty**

If you are familiar with the main program divisions and you understand the three concepts involved—slant, grouped primary colors, and mixed

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modes—you are ready for the nitty-gritty. The surprise is how simple it is.

The first problem—different line slants—is easy to solve. A circle covers all possible slants. Solving the third problem, mixed modes, is a breeze. All you have to do is omit one instruction.

The second problem—groups of adjacent primary colors—is the one that requires special consideration.

The only real difficulty is making sure you have used all the color combinations, from groupings of two to groupings of seven colors. Even then you cannot be sure that groupings of more than seven colors are not possible.

A related problem is that a color placed to the left of another yields a different secondary color than when it is placed to the right. Not only must you use each color with every other color, but you must also place it to the left and to the right of every color. Fortunately, there is a simple solution.

One variable, V (line 60), takes care of the entire process. In the two subroutines, lines 540 and 670 draw a series of circles from a radius (R) of 300 to a radius of 25, in steps of - V.

Each time you add a new color, V (the distance between circles) is increased by one step (lines 600 and 710). The result is that every color appears on both sides of every other color once, and then the program repeats the sequence with a new V and a new color. Table 1 clarifies the technique. A checkmark shows where the program draws

```
10 '  C R A Z Y   Q U I L T
20 '
30 PCLS4
40 X=0:Y=0
50 I=6:V=5:MA=6:HD=6
60 S=RND(6)-RND(6):IFS=0THEN60
70 FOR CO=1TOI
80 C(CO)=RND(4)
90 NEXT
100 PMODE4,1:SCREEN1,1:PMODE3,1
110 IP X+S<0 THEN X=X+1:GOTO110
120 GOSUB180
130 X=X+((MA*I)+MA)+6
140 IFX+((MA*I)+MA)=>255THENX=0
150 IFX=<1THENY=Y+(MD*V)+3
160 IF Y+(MD*V)=>191 THEN Y=0
170 GOTO 60
180 Y1=Y+V:Y2=Y
190 FORF=1TOMD
200 X1=X:X2=X+S
210 FORG=1TOMA
220 GOSUB280
230 X1=X1+1:X2=X2+1
240 NEXT
250 Y1=Y1+V:Y2=Y2+V
260 NEXT
270 RETURN
280 FORCO=1TOI
290 COLOR C(CO)
300 LINE(X1,Y1)-(X2,Y2),PSET
310 X1=X1+1:X2=X2+1
320 NEXT
330 RETURN
```

Program Listing 4. Crazy Quilt

```
10 '  H E A D B A N D S
20 '
30 PCLS4
40 DIM C(63),CO(63)
50 X=0:Y=0
60 I=63:V=5:S=4:MA=4:MD=6
70 FOR CO=1TOI
80 C(CO)=RND(4)
90 NEXT
100 PMODE4,1:SCREEN1,1:PMODE3,1
110 GOSUB160
120 X=X+((MA*I)+MA)+1
130 IPX+((MA*I)+MA)+1=>255THENX=0
140 IFX=<1THENY=Y+(HD*V)+6
150 IF Y+(MD*V)+6=>191 THEN Y=0
155 GOTO 70
160 Y1=Y+V:Y2=Y
170 FORF=1TOMD
180 X1=X:X2=X+S
190 FORG=1TOMA
200 GOSUB260
210 X1=X1+1:X2=X2+1
220 NEXT
230 Y1=Y1+V:Y2=Y2+V
240 NEXT
250 RETURN
260 FORCO=1TOI
270 COLOR C(CO)
280 LINE(X1,Y1)-(X2,Y2),PSET
290 X1=X1+1:X2=X2+1
300 NEXT
310 RETURN
```

Program Listing 5. Headbands

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Radius	V=2	V=3	V=4	V5
300	✓	✓	✓	✓
299				
298	✓			
297		✓		
296	✓		✓	
295				✓
294	✓	✓		
293				
292	✓		✓	
291		✓		
290	✓			✓
289				
288	✓	✓	✓	
287				
286	✓			
		(✓)		(✓)
One Sequence Requires:	2 Circles	6 Circles	12 Circles	60 Circles

Table 1. Illustration of Color Whirlpool Circle Subroutine Technique

the circle, and a box encloses one complete sequence.

I have carried this procedure as far as seven colors. At that point, it takes 420 circles to complete just one sequence—but that's about twice the number of circles you can put on the screen.

To see all the colors, make the three adjustments described below.

To reverse the order of the colors, make the following line changes, but be sure to save the original program first:

```
 70 C = 8
570 C = C - 1
580 IFC<=0THENC = 8
590 IF V = 8 THEN V = 2:C = 8:GOTO 620
700 C = C - 1 : IF V = 3 THENV = 2:
    C = 8:GOTO730
```

Save the reversed version.

To see the order of colors skip, make the following changes to the *original* program:

```
570 C = C+3
575 IF V/2 = INT(V/2) THEN C = C - 1
```

To view colors in reversed skipping order, change these lines in the *reversed* program:

```
570 C = C - 3
575 IF V/2 = INT(V/2) THEN C = C + 1
```

These changes will yield over 1,000 colors. You can get more if you increase the value of the fist V in line 590.

You can make other changes to achieve interesting effects. For instance, you can raise the variable HW in line 80 to a limit of 4. This gives you a closer look, especially at the *inner* circles. Before you do that, though, you might be more interested to see where all this can lead.

Demo Programs

I have included three demo programs to give you some idea of the potential of multicolor graphics. In all three cases, the computer still chooses colors at random.

Program Listing 3, Fly's Eye, is based on the same techniques described in the first program, but it uses only vertical and diagonal lines. Horizontal lines do not generate other colors, so I do not use them. I chose a mixed mode, but you may try others by changing line 10.

Choose the colors at random, 10 times (lines 40-60). Using these colors, the computer first draws vertical lines (lines 70-150), then adds diagonal lines (lines 160-280). It draws each color every 10 steps. It then adds the next color one step to the right of the previous one for vertical lines, and one step to the right plus one step down for diagonal lines. You may notice that vertical lines generate different colors than diagonal lines from the same order of primary colors.

"You can make other changes to achieve interesting effects."

To create the eye effect, I used the CIRCLE and PAINT commands. The LINES are drawn in the same primary color that it used to paint around the eye. Knowing this will help you visualize how each new primary color affects the others.

Crazy Quilt (Program Listing 4) and Headbands (Program Listing 5) give you an idea what you can do with multicolor graphics. The final goal is to be able to control which color you want to use. The last two programs prove this is possible.

Next month I will have a utility program that will help you start a file of colors in each mode. As it turns out, next month's utility is also a good program generator. Crazy Quilt and Headbands just "happened" while I was working on my file. •

Address correspondence to Ken Anderson, 1055 Zophi St., Nashville, TN 37216.

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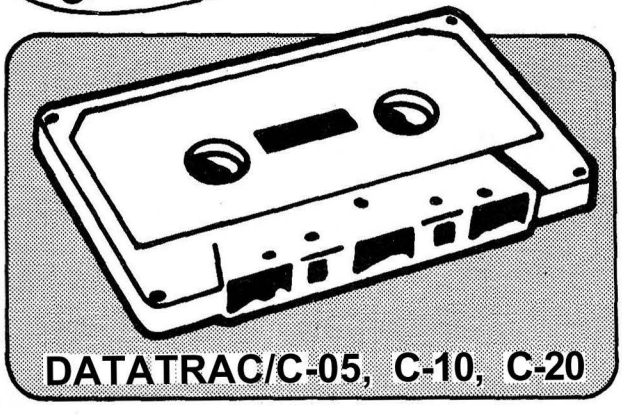

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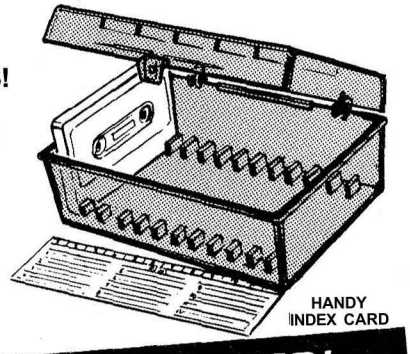

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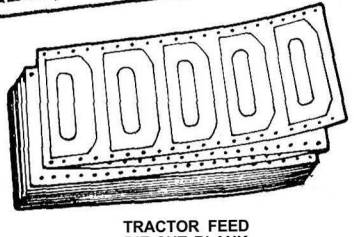

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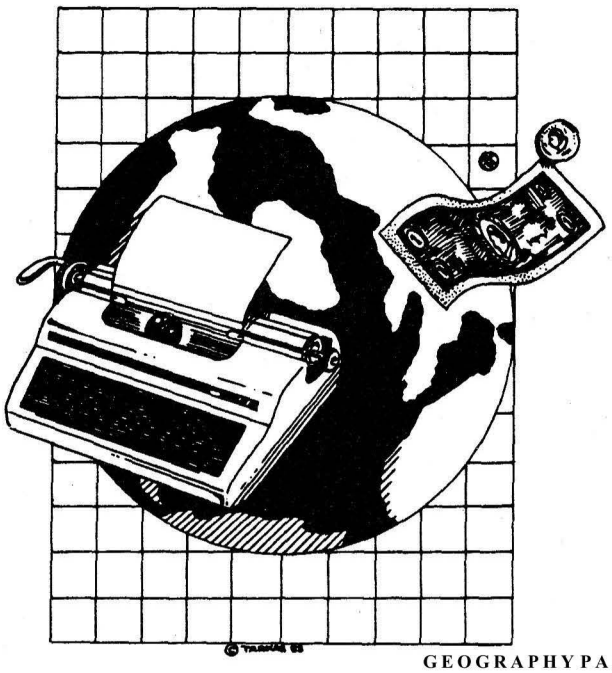

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BY JOHN L. NICOLETTOS

CoCo LIST CONTROL

If speed reading isn't your forte, try this easy method of slowing down the CoCo LIST function.

Faster than a speeding bullet. Able to leap tall video screens at a single bound. It's a bird! It's a plane! No! It's the Color Computer's LIST command.

I am convinced that Tandy engineers had Superman in mind when they programmed the LIST function into the Color Computer. For mere mortals, the LIST command offers little more than a challenge in speed reading.

To its credit, Tandy did include the shift @ command to stop the scrolling, but using it is a bit like playing Russian roulette. Even the LIST (range) command provides only limited relief (15 lines at a time), and you must reenter it to scroll the program listing.

CoCo List Control is an Assembly-language program that corrects these deficiencies. With it you can control the speed at which the program scrolls down the screen, stop the scrolling, and restart scrolling. Best of all, CoCo List Control uses your right joystick as a LIST speed control. Thus, you can review your program listing without having to sit hunchbacked over your keyboard entering LIST commands.

```
7FBC                00100          ORG     32700
7FBC 30   8D 0004   00110 START    LEAX    LIST.PCR
7FC0 BF   8168      00120          STX     $168     PUT LIST ADDRESS IN JMP TABLE
7FC3 39             00130          RTS
7FC4 81   8D        00140 LIST     CHPA    #$0D     IF CHARACTER ISN'T CARRIAGE
7FC6 26   1F        00150          BNE     EXIT          RETURN THEN EXIT
7FC8 34   76        00160          PSHS    A,B,X,Y,U
7FCA BD   A9DE      00170 SP1      JSR     $A9DE    GET JOYSTK VALUES
7FCD 7D   815B      00180          TST     $15B     IF ZERO THEN EXIT
7FD0 27   13        00200          BEG     DONE          ROUTINE WITH NO DELAY
7FD2 B6   015B      00205          LDA     *15B
7FD5 81   3F        00210          CMPA    #$3F     IF JOYSTK AT MAX VALUE THEN
7FD7 27   F1        00220          BEQ     SP1           LOOP UNTIL VALUE CHANGES
7FD9 8E   18FF      00230 DLY      LDX     #$10FF   DELAY PRINTING ROUTINE
7FDC 30   1F        00240 DLY2     LEAX    -1,X      DELAY=$10FF*JOYSTK     VALUE
7FDE 26   FC        00250          BNE     DLY2
7FE0 7A   015B      00260          DEC     *15B
7FE3 26   F4        00270          BNE     DLY
7FE5 35   76        00280 DONE     PULS    A,B,X,Y,U
7FE7 7E   8273      00290 EXIT     JMP     *8273
          0000      00300          END
00000 TOTAL ERRORS

DLY     7FD9
DLY2    7FDC
DONE    7FES
EXIT    7FE7
LIST    7FC4
SP1     7FCA
START   7FBC
```

Program Listing I. Assembly-Language Listing of CoCo List Control

Program Description

CoCo List Control's source code appears in Program Listing 1. Lines 110-130 modify the Color Computer's jump table so that it executes the CoCo List Control program (lines 140-290) prior to printing a character to the screen.

Lines 140-150 check to see if the character is a carriage return (hex 0D). This technique maintains the Color Computer's high-speed LIST capability. If the character about to be printed is not a carriage return, the program returns control to the Color Computer and displays the character on the screen.

If the character is a carriage return, line 170 samples the joystick position. Lines 180-220 test for the two extreme settings of the joystick. If the joystick is as near as possible to the red button (value of 0), the program returns control to the Basic ROM with no further delay. If the joystick is in the farthest position from the button (value of 64), the program loops until you change the joystick position. This loop prevents the computer from printing the character to the screen, thus stopping the listing.

Lines 230-270 add a time delay that is proportional to the position of the joy-

System Requirements

16K RAM
Extended Color Basic
Joystick

stick for values between the two extremes. In essence, the joystick has become a speed control for the LIST command.

Line 230 contains a delay constant (hex 10FF). The program multiplies this constant by the value of the joystick position, which is stored in location 15B, to create the time delay. You can adjust the constant to suit your own needs.

Basic Driver

Program Listing 2 is the Basic driver for CoCo List Control. The driver loads the machine-language program at the top of RAM independent of the amount of memory in your computer. The simple arithmetic check in line 310 makes sure that the DATA statements contain the proper program. If you entered the program correctly, the driver EXECs the machine-language program and protects it from Basic.

You can adjust the speed of CoCo List Control by changing lines 310 and 370 of the Basic driver. The number 10 in the DATA statement of line 370 is the most-significant byte of the delay constant. You can increase the printing speed by decreasing this value. Alternately, if you increase this value, you decrease the printing speed. You can use any value from 0-255, but you must increase or decrease the value of SUM (DEC 4342) in line 310 by an equal amount. Failure to do so will result in a data error message.

Operating Instructions

You must plug in your right joystick and set it to the fastest speed (nearest the red button) position before you load the Assembly-language program. Once you have loaded the program, the joystick controls the printing speed of the LIST command and any other print function.

In this position the LIST command operates at its normal speed. As you move the joystick away from the button, the scrolling slows down. When the joystick is at the position farthest from the button, the scrolling stops. To start the scrolling again, simply move the joystick toward the button.

All the computer's printing functions are now under the control of your joystick. This control includes non-LIST printing to the screen, as well as the output to your printer or RS-232 interface. Therefore, make sure that your joystick is in the fastest speed position when you are not using it. •

Contact John Nicolettos at 8612 Snowden Loop, Laurel, MD 20708.

Program Listing 2. Basic Driver for CoCo List Control

```
10    '              **************************
20        '                        *     *
30    '     *     CO  CO  LIST  CONTROL  *
40                                 *     *
50    '           *          BY           *
60    '     *                              *
70    '       *       JOHN  L.  N1COLETTOS *
80    '     *                              *
90    '     *     ALL    RI6HTS  RESERVED  *
100   '                      *             *
110   '     *         MARCH     1,      1983  *
120               '                  *     *
130       '            **************************
140   '
150   '
160   '
170   CLS
180   PRINT"          CO CO LIST CONTROL":PRINT@32,STRING$(32,131);
190   PRINT"THIS PROGRAM WILL LOAD A MACHINE"; :PRINT"LANGUAGE PROGRAM INTO UPPER R
AM"
200   PRINT"MEMORY.   IT WILL AUTOMATICALLY":PRINT"EXECUTE AND PROTECT THE MACHINE"
210   PRINT"LANGUAGE  PROGRAM.':PRINT
220   PRINT"YOU MUST HAVE THE RIGHT JOYSTICK";:PRINT"CONNECTED TO THE COMPUTER.  A
LSO'i
230   PRINT'YOU MUST HAVE THE JOYSTICK IN":PRINT'THE TOP VERTICAL POSITION"
240   PRINT"(NEAREST TO THE BUTTON)."
250   PRINT@484,"PRESS ENTER TO CONTINUE";:LINEINPUT ZZ*
260    ED=PEEK<39>*256+PEEK(40)
270    ST=ED-45
280   FOR X=ST TO ED
290   READ D:POKE X,D:SUM=SUM+D
300   NEXT X
310   IF SUM <> 4342THEN CLS:PRINT@63,"!!!DATA ERROR!!!":END
320   EXEC ST
330   CLEAR 288,ST
340   DATA 48, 141, 0, 4, 191, 1, 104, 57
350   DATA 129, 13, 38, 31, 52, 118, 189, 169
360   DATA 222, 125, 1, 91, 39, 19, 182, 1
370   DATA 91, 129, 63, 39, 241, 142, 10, 255
380   DATA 48, 31, 38, 252, 122, 1, 91, 38
390   DATA 244, 53, 118, 126, 130, 115
400   CLS
410   PRINT"          CO CO LIST CONTROL":PRINT@32,STRING$(32,131);
420   PRINT"PROGRAM IS LOADED.  TO USE THE"
430   PRINT"LIST CONTROL SIMPLY MOVE YOUR":PRINT"RIGHT JOYSTICK AWAY FROM THE"
440   PRINT"BUTTON.  THE LISTING SPEED WILL":PRINT"DECREASE AS YOU MOVE THE"
450   PRINT"JOYSTICK.  WHEN YOU REACH THE":PRINT"JOYSTICK'S LIMIT THE SCROLLING"
460   PRINT"WILL STOP.  TO CONTINUE SIMPLY":PRINT"MOVE YOUR JOYSTICK TOWARDS THE"
470    PRINT"BUTTON.  REMEMBER TO KEEP THE":PRINT"JOYSTICK AT MAX SPEED WHEN NOT"
480   PRINT"USING THE LIST CONTROL."
```


See List of Advertisers on page 130

BY JAMES J. BARBARELLO

PC BOARD PRIMER—PART II

In Part 1 of this primer, I introduced you to printed circuit (PC) boards, showed you how to make your own, and discussed how to solder the components to it. In Part 2,1 will present a specific example—a simple real-world interface that I call the CoCo I/O.

Before you begin, check Table 1 for the list of items you need to do the construction. If you are not interested in how to design PC boards, jump ahead to the "Making the PC Board" section.

Designing Your Board

After you have determined how your circuit should look, the next step is to "breadboard" the design and make any changes necessary for it to work the way you want. When this is done, you have a verified, stable design that you should document in a schematic diagram.

The CoCo I/O schematic is shown in Fig. 1. Note that all the components are numbered (J1, R4, C2, IC2, and so on), all component values are shown, and the IC pins are identified. In addition, any connectors or switches are labeled according to function. Make sure the schematic is correct. An accurate schematic is the hardware analog of program documentation. Inaccuracies at this point almost always cause problems later on.

Now that you know how to build a PC board, here are some tips on how to use it in the real world.

Now you should make a rough layout using the schematic diagram as a guide. Remember, you will be drawing polarized components such as integrated circuits (ICs) as they appear on the copper side of the board (i.e., with the leads pointing toward you). Lead #1 is still on top, but on your right instead of your left.

On a piece of blank paper, draw the ICs as rectangles with the appropriate number of pins. Then start drawing in the other components near the devices to which you will connect them. Draw a pad (circle) for each lead of each component. Make the connections between the components by drawing in a' 'wire" with your pencil. Remember, wires cannot intersect. You might have to rearrange the components to eliminate potential crossings.

If, however, you cannot eliminate a crossing after one or two rearrangements, you will need a jumper. A jumper is a piece of wire mounted on the component side of the PC board. Show it as a dotted line with the letter J somewhere in its path. Don't be a perfectionist. A medium-sized board with 10 to 20 jumpers is common. For parts mounted externally (like J1), draw a pad for each wire that will connect the part to the PC board.

As I mentioned before, PC lands (wires) cannot intersect. They can, however, cross an area occupied by a component. Figure 2 is the rough layout for the CoCo I/O. Note that I used a jumper between pin 5 of IC2 and V+, PC lands cross the area occupied by R7 as well as the jumper, and I provided pads for R3, J1-J4, B1, and S1. Also, I have identified all components. Now, check carefully to ensure that your rough layout accurately represents the schematic diagram.

The last step is to make the final PC layout. This is a redrawing of the rough layout to scale on 0.1-inch-grid graph paper. The size of each part dictates where you can place the pads. In addition, there must be a minimum clearance between PC lands. Table 2 con-

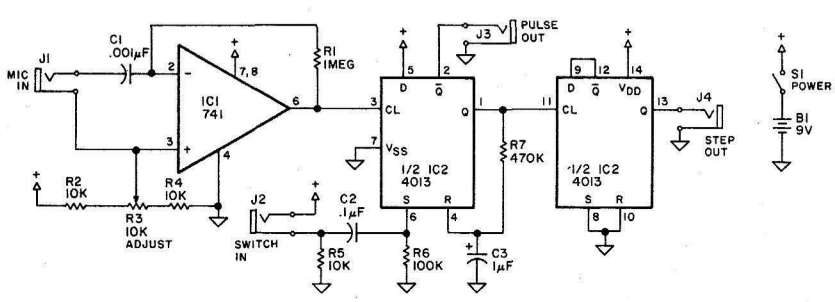

Fig. I. CoCo I/O Schematic Diagram

System Requirements

16K RAM
Extended Color Basic

↙See *List of Advertisers on page 130*

tains a listing of common spacings.

Draw the final layout with the **circle** template using the exact spacing. For IC pads, use 1/16-inch circles. For other components, use 7/64-inch (0.109-inch) circles. Since the **rough layout** was not to scale, you will probably have to do some repositioning. When you are done, locate the perimeter of the PC layout by going one box (0.1 inch) beyond the circuit portion that protrudes farthest from each side of the layout. Then mark the corners with a cross.

The last step is to check the layout. Make a copy of the schematic diagram and the final layout, or place a piece of tracing paper over each original. Using the schematic as your reference, mark each line and its counterpart on the layout. Continue until you have marked all the lines on the schematic. This ensures that you have properly duplicated the design on the layout. Figure 3 shows the final layout for **the** CoCo I/O PC board. Figure 4 shows the same layout as it might appear in an article figure.

Making the PC Board

Make a copy of Fig. 4 or cut it out of the magazine. Remember to leave about a 1-inch border all around. A third alternative is to trace the layout. Place a piece of tracing paper over the layout and make a dot in the center of each pad (the round holes with the void in the center). Also make a dot in the center of each of the eight IC pads. Finally, trace the four corner markers. Make sure you don't miss any pads, because the tracing paper will become your drilling template.

Cut the layout (to form four flaps) and fold the flaps over as I showed in Fig. 2 of Part 1. Now cut a piece of blank PC material to the same size as the layout. Unfold the flaps and place the copper side of the blank directly under the PC pattern. Then refold the flaps tightly and secure them with a small piece of masking tape (see Fig. 3 of Part 1).

Drill each pad (or the dots if you are using the tracing paper) with a #62 drill. When you are **finished, hold the blank** between you and a light. Make sure the light shines through all the pads. If it does not, drill the missed pads. Carefully remove the PC layout. Drill the two large holes shown on the layout (these are mounting holes) with a 1/8-inch drill.

"An accurate schematic is the hardware analog of program documentation."

Using a small file or #00 steel wool, remove any raised copper material around the holes and any rough edges on the end of the PC blank. Using the steel wool, vigorously scrub the copper until it is bright and shiny, and brush off any debris with a paper towel. Carefully place the blank on a table (do not touch the copper area) and secure it with a small piece of masking tape in each of two diagonal corners. Place the PC layout in front of you, and get your etch-resist pen and circle template. Now you are ready to begin drawing.

On a piece of scrap paper, **make** some squiggles with the pen to get the ink flowing freely. Then make a circle around each hole (except the IC holes) using the 7/64-inch circle of the template. Fill in the circle so that it is completely covered with ink. Only the **eight** IC holes remain. Since these are 0.1 inch apart, you have to be careful to draw small circles around them that do not touch each other.

As you use the pen, the tip will spread out, so you will have to judge which circle template hole to use. Depending on the width of your pen tip, use either the **1/16-,** 5/64-, or 3/32-inch **holes.** When you are done, inspect the circles around the IC holes. If they touch, use an Exacto knife or razor blade to scrape a void between adjacent circles. A void about the width of a felt-tip pen line is sufficient.

Now begin drawing the PC lands (lines) between the holes, using the circles as a reference. This is like doing a "connect the dots" picture. Make sure the ink flows freely and the lines are dark. When you are done, check each line and pad against the PC layout and correct any errors. You can also write on the pad, inscribing it with your **name** or the date you made the board. Remove the blank from the table. Now you are ready to begin etching.

Obtain a plastic tray larger than the blank and pour in about 1/8 to 1/4 inch of etchant solution. The etchant is poisonous and corrosive, so avoid contact with the skin and use only a plastic tray.

~See *List of Advertisers on page 130*

Carefully drop in the blank, copper side down. If it sinks to the bottom, use a toothpick to turn it over (copper side up). You want the copper to contact as much etchant as possible.

Agitate the etchant periodically with your toothpick. This removes the residue of copper being etched away from the surface of the board and lets more etchant contact the remaining copper, After about 15 minutes, lift the blank out of the tray with the toothpick and inspect to see if any unwanted copper remains. If so, put the blank back in the tray and continue for another five minutes. Continue this until any copper that is not under the etch-resist ink is gone.

Place the tray containing the blank in a sink. Remove the blank from the tray using your toothpick and rinse the blank under running water. Inspect it again for any remaining copper. If more etching is required, place the blank back in the tray for another five minutes. Otherwise, dispose of the etchant in a toilet. Rinse the tray under running water. Now scrub the blank with a soap-filled scouring pad under running water until all the ink is removed and the copper pattern is bright and shiny. Dry the board.

Construction and Testing

Collect all the required components and tools. Plug in your soldering iron and let it heat up for about five minutes. Now, beginning with the resistors, place each component in the appropriate position as identified in Fig. 5. Solder each lead and clip off any excess.

After you have mounted all the resistors, continue with the capacitors and the ICs. You might want to use IC sockets, which protect the ICs from the heat generated during soldering.

Now mount the battery holder and 13 3-inch pieces of wire on the board as shown in Fig. 5. For each wire, strip about 1/4 inch of insulation from each end. Solder one end to the board and then solder the other end to the appropriate jack or switch.

Check your work for "grainy" joints or solder between two pads that shouldn't be connected (solder splashes). Resolder any grainy joints and remove any solder splashes. You can now mount the completed unit in any suitable case. I mounted my prototype in a plastic case that I marked with transfer lettering, but any case and form of marking are acceptable. Place a control knob on R3 (adjust), snap in a 9-volt battery, and put the power switch in the off position.

You need the CoCo, a microphone (optional), a 1/8-inch phono plug, and a jumper wire to test the CoCo I/O. Unplug the cable connecting the CoCo to your cassette deck. Place the black ("ear") plug in the I/O's step-out jack (J4). Now type in this short program:

```
10A = PEEK(65312)
20 B = PEEK(65312):IF A = B THEN 20
ELSE A = B:PRINT"*";:GOTO 20
```

Turn the I/O's power switch to the on position and run the program. Rotate the I/O's adjust control (R3) until a series of asterisks appears. This indicates that IC1 is in an unstable range (oscillating). Rotate R3 in either direction until the asterisks stop appearing.

"Check your work for 'grainy' joints or solder between two pads that shouldn't be connected (solder splashes)."

Now put the plug in J2 (switch in) and connect the jumper to one of the two plug lugs. Momentarily touch the other jumper end to the remaining lug of the plug. A single asterisk should appear. If not, rotate R3 slightly forward and try again.

When the asterisk appears, relocate the "ear" plug to J3 (pulse out). Again touch the jumper end to the phono plug's free lug. This time two asterisks should appear, the second a short time after the first. You have now verified that IC2 is working correctly.

Plug a microphone into J1 (mic in). Snap your fingers or clap your hands near the microphone. Two asterisks should appear. If not, adjust R3 slightly backward and try again. R3 is a sensitivity control and determines the volume of sound necessary to trigger the I/O. Note that normal talking will not trigger the I/O. Only high-pitched, sharp sounds will trigger it. Turn power switch SI to the off position and hit break. Testing is over.

If you failed to get the proper indications during testing, recheck the parts placement, wiring, and all solder joints. Look for any solder bridges (unwanted solder connection of two points). Correct any errors and retest.

Applications

The I/O provides a pulse (momentary change of voltage level) or step (steady-state reversal of voltage level) when a switch or the high, sharp sound picked up by a microphone triggers it. Memory location FF00 (65312) in the CoCo is actually an input "port," which normally senses the voltage level provided by the cassette's "ear" output.

When you connect the output of the I/O to the cassette cable's black ("ear") plug, you can change the number stored in location FF00. This allows you to tell the computer if the I/O has changed; communication between the outside world and the CoCo has been established.

The first application is intrusion detection. Let's say you want to sense the opening or closing of a number of devices, such as a window, garage door, desk drawer, or refrigerator door, which are some distance away from the CoCo. Also, you want to monitor these items while you are using the CoCo for another task. Because you will not be checking the status of these items continuously, a pulse output is not appro-

- Circle template (1/16 inch to at least 1/4 inch in 1/64-inch increments; Pickett No. 1200 or equal)
- Plastic tray or box
- #62 Drill bit
- Portable drill, drill press, or "Mototool"
- Masking tape
- "Pink Pearl" eraser
- Toothpicks
- #00 Steel wool (or nonsoap-filled scouring pad)
- Soap-filled scouring pad
- Etch-resist marking pen (Radio Shack 276-1530 or similar)
- Etchant solution (Radio Shack 276-1535 or similar)
- Solid copper PC board blank (Radio Shack 276-1586 or similar)

Table 1. List of Materials

See *List of Advertisers on page 130*

priate. The pulse would be gone before you sensed it. Instead, you should use the step output (J4) from the I/O.

You need an appropriate number of normally closed momentary switches (such as Radio Shack P/N 275-1548) and a length of #22-gauge stranded wire. Mount a switch on each item to be monitored so that the switch button is depressed when the item is secured. Then wire the switches in parallel. Route the two free ends of the wire to the CoCo and terminate them in a 1/8-inch phono plug. Connect this plug to J2 (switch in) of the I/O. Connect the black ("ear") casette cable plug to the step-out jack (J4) of the I/O.

When you are ready to begin monitoring, apply power to the I/O. Your main program should include the following subroutine:

```
62000 MO = PEEK(65312):IF MO = BG
THEN RETURN ELSE BG = MO
62010 FOR FI = 1 TO 10:CLS
4:PRINT@235," INTRUDER ";
62020 SOUND 180,3:CLS
3:PRINT@235," INTRUDER ";
:SOUND 120,3
62030 NEXT FI:CLS 0:GOTO 62000
```

Your main program must also include the following statement in its first program line:

```
BG = PEEK(65312)
```

This initializes the value of BG. Each

Component	Spacing
1/4-Watt Resistors	**0.4 inch (4 boxes) between leads**
1/2-Watt Resistors	**0.5 inch (5 boxes) between leads**
Radial Electrolytic Capacitors	0.2 inch (2 boxes) between leads
Disk Capacitors	**0.2 to 0.4 inch between leads, depending on type**
Dual Inline Package (DIP)	**0.1** inch (1 **box) between adjacent leads**
Integrated Circuit	and 0.3 inch (3 boxes) between rows of leads (8-, **14-, or 16-pin devices)**
Transistors	**0.15 inch** *(V/z* boxes) between **leads**
Distance Between PC Lands	**0.05 inch** *(Vi* **box) minimum**
Spacing Between Terminal Pads	**0.05 inch** *(Vi* **box) minimum**

***Table 2. List** of Common Spacing Between Leads*

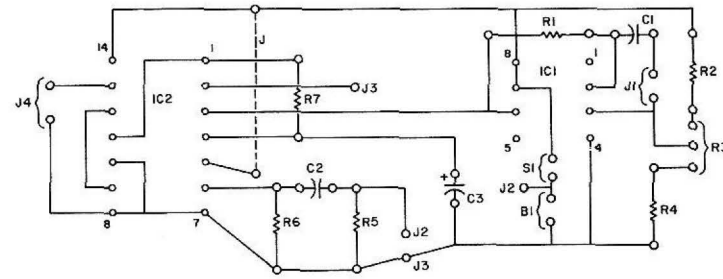

Fig. 2. Rough Layout for the CoCo I/O Board

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time you branch to the subroutine, the program checks memory location 65312 to see if the I/O has changed state. If not (i.e., MO = BG), execution will return to the main program. If any of the items have been disturbed, that switch will close and trigger the I/O.

Lines 62010-62030 will sound an alarm and flash "Intruder" on the CoCo's screen until the item is secure again.

Because the switches provide either 0 or 9 volts to the input of a CMOS device, you can make long wire runs (in excess of 50 feet) without fear of false triggering. Of course, you can modify this system in many ways to suit your own needs.

The second application uses the microphone input. It is an adaptation of the "typewriter" for the handicapped that appeared in *80 Micro* ("Voice-Controlled Typewriter," by Mike Rigsby, December 1982, p. 72). The original application requires the handicapped person to tap on the built-in microphone of the cassette recorder and to protect against false triggering that the noise of the printer causes.

"Since the I/O only responds to high-pitched, sharp sounds, the noise of the printer does not affect it."

My version is somewhat more versatile. Since the I/O only responds to high-pitched, sharp sounds, the noise of the printer does not affect it. In addition, people who cannot use their hands can operate it by making a simple clicking sound or a loud grunt. Of course, you can also operate this application with a simple switch.

Line 20 of the Program Listing senses the initial state of the I/O (BM) and equates it to its current state (FI). Lines 30-70 draw the screen presentation of the full character set and the control functions. Line 80 begins a FOR... NEXT loop that causes a white cursor to point, in turn, to the columns on the screen.

Column 1 contains the control functions. The next column (at position 9) begins the character set. At each column, the cursor pauses, and the program provides an audible signal (beep). It then checks the current status of the I/O. If the I/O has not changed (i.e., FI = BM in line 110), then the cursor moves to the next column.

If the I/O has been triggered (changed state), execution jumps to line 140. The program changes the white cursor to orange and causes a short delay. Then the characters in the column reverse color (green on a black background becomes black on a green background) in turn to highlight each one.

As each character is highlighted, the program produces a beep of a different pitch than the column beep and checks the I/O to see if it has been triggered. If not, line 170 returns the character to green on black. If it is the last character in the column, the program erases the orange cursor, and the sequence begins again at column 1.

If the I/O is triggered while the cursor is on a character in the column, execution jumps from line 160 to line 180. Line 180 checks to see if this is the command column (I = 1). If not, line 190 increases the message count by one and sounds yet another pitched beep. At the end of the currently displayed message, line 200 POKEs the character on the screen in the message area. Line 210 delays a bit, line 220 removes the orange cursor, and line 230 returns the selected character to normal mode. The sequence then begins again at column 1.

Lines 270-400 perform the control functions listed in line 70. These functions are Enter (line 280), Rubout (line 290), Faster (lines 300 and 310), Slower (lines 320 and 330), and End Session (line 350). Faster and Slower speed up or slow down the rate at which the cursor moves by changing the variable SPD. Rubout removes the last character entered into the message line (like a backspace).

Enter and End Session use the subroutine at lines 350-370. Because these functions produce irreversible results, their selection requires verification. The subroutine flashes the message "Signal

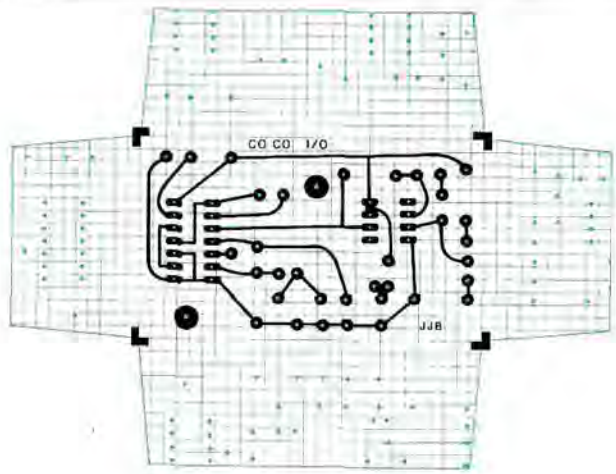

Fig. 3. Final Layout for the CoCo I/O Board

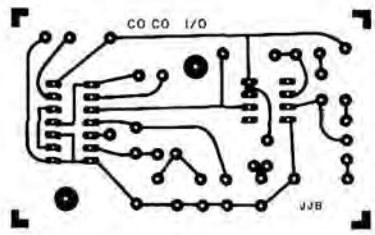

Fig. 4. Article Artwork for the CoCo I/O Board

to Verify" near the selected control function and checks the I/O. If it is not triggered after 10 appearances of the message, the program takes no action and ignores the function (C$ = ""). If the I/O is triggered during the message presentation, the program equates C$ to V (verified), and execution returns to the calling-control function.

If you select End Session, line 340 clears the screen to black, prints a "Program Ended" message, and ends the program. If you select Enter, execution jumps to the Print routine of lines 390 and 400.

The Print routine reads all characters on the message line (by PEEKing the message-line area) and builds a message string (C$). The program adjusts any PEEKed value of 98 or greater to provide the proper character (line 390). The program sends the completed message string to a printer (PRINT#-2 in line 400). Then it reinitializes the count (CNT) and sets C$ to null, since C$ is also used as the verify flag. Finally, execution returns to line 60, where the program clears the message area, and execution continues.

To use the typewriter, connect the cassette's black "ear" plug to the pulse-out jack (J3). Connect a microphone to the mic-in jack (J1) and apply power. Alternately, you can connect a simple momentary push-button normally off switch to the switch-in jack (J2). Run the program. After the screen presentation is completed, the white cursor will appear over the control-function column (upper left of screen), the program will produce a beep, and the cursor will begin moving to the right.

Place the microphone near the typist and have him or her make a sound. The cursor should turn orange, and the characters in the selected column will be highlighted in turn. If this does not happen, adjust R3 (adjust) and repeat the process until the typist's sound produces a result.

"Place the microphone near the typist and have him or her make a sound. "

```
1 REM** PC PRIMER APPLICATION 2
2 REM** TYPEWRITER FOR THE
3 REM** HANDICAPPED.
4 REM** NAME: TYPE
5 REM** REV 1.0, 1 MARCH 1983
6 REM** J.J. BARBARELLO
7 REM**
8 REM"* REQUIRES COCO I/O
9 REM**
10 CLS1:CNT=415:SPD=50
20 BM=PEEK(65312):FI=BM
30 FORI=0 TO 5:FOR J=l TO 11
40 POKE I*64+J*2+1063,I*11+J:NEXTJ,I:POKE 1401,0:POKE 1403,96:PO
KE 1405,96
50 FORI=1408 TO 1439:POKE I,140:NEXT
60 FORI=1440 TO 1536:POKE I,128:NEXT:PRINT@CNT+1,CHR$(197) ;
70 PRINT@33,"eNTER";:PRINTS97,"rUBOUT";:PRINT@161,"fASTER";:PRIN
T@225,"SLOWER";:PRINT@289,"eND THE";:PRINT@321,"SESSION";:PRINT@
194,;:PRINTUSING"*##* ";(50-SPD)/5;
80 FORI=l TO 29 STEP 2:IF 1=3 THEN 1=9
90 PRINT@I,CHR$(207);
100 SOUND 10,1
110 FORJ=1 TO SPD:FI=PEEK(65312) : IF FI=BM THEN NEXT ELSE 140
120 PRINT@I,CHR$(32);:NEXT I
130 GOTO80
140 POKE 1+1024,^55:FORK=1TO200:NEXT:FORJ=I+1056 TO 1+1408 STEP
64:POKE J,PEEK(J)+64
150 SOUND 50,1
160 FOR K=1T0 SPD:FI=PEEK(65312):IF FI=BM THEN NEXT ELSE 180
170 POKE J,PEEK(J)-64:NEXT:POKE i+1024,96:GOTO80
180 IF I=1 THEN 270
190 CNT=CNT+l:SOUND200,1
200 POKE CNT+1024,PEEK(J):POKE CNT+1025,197
210 FORX=lTO SPD*5:NEXT
220 PRINT@I,CHR$(32)?
230 POKE J,PEEK(J)-64:GOTO 80
240 REM************************
250 REM****** CONTROLS ******
260 REM************************
270 SOUND200,1:ON ((J-1057)/64)+1 GOTO 280,290,300,320,340
280 GOSUB 350:IF C$="" THEN 210 ELSE C$="":GOTO 390
290 IF CNT>415 THEN CNT=CNT-1:PRINT@CNT+1,CHR$(197);CHR$(128);:G
OTO 210 ELSE 210
300 IF SPD>0 THEN SPD=SPD-5
310 GOTO330
320 SPD=SPD+5
330 PRINT$194,;:PRINTUSING"*##* ";(50-SPD)/5;:GOTO 210
340 GOSUB 350:IF C$="V" THEN CLS0:PRINT@137," PROGRAM ENDED ";:P
RINT@448,;:END ELSE 210
350 C$="":FORS=1TO200:NEXT:FOR S=1TO10:IF S/2<>INT(S/2)THENPRINT
@J-985,"<«SIGNAL TO VERIFY>>>" ELSE PRINT@J-985," "
360 FOR T=l TO SPD:FI=PEEK(65312):IF FI=BM THEN NEXT T,S:C$="":R
ETURN
370 C$="V":PRINT@J-985," ":RETURN
380 REM** PRINT
390 FOR I=1440 TO CNT+1024:J=PEEK(I):IF J>97 THEN J=J-64
400 C$=C$+CHR$(J):NEXT:PRINT#-2,C$:C$="":CNT=415:GOTO 60
```

Program Listing. Typewriter for the Handicapped

Before selecting the Enter (Print) function, connect a printer to the computer and make sure that it is on-line. You can modify the typewriter program to send the data to other devices such as a cassette recorder or modem. This would allow permanent storage of text or communications with others.

Summing It Up

In this series I have presented information on PC boards that might be new to many CoCo users. If you are one of them, I hope this information has spurred you on to experiment with real-world interfacing of your CoCo and other hardware. •

Address correspondence to James Barbarello, RD #1, Box 241H, Tennent Road, Englishtown, NJ 07726.

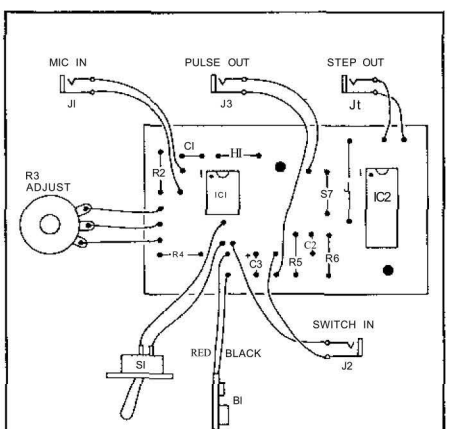

Fig. 5. Component Placement for the CoCo I/O Board

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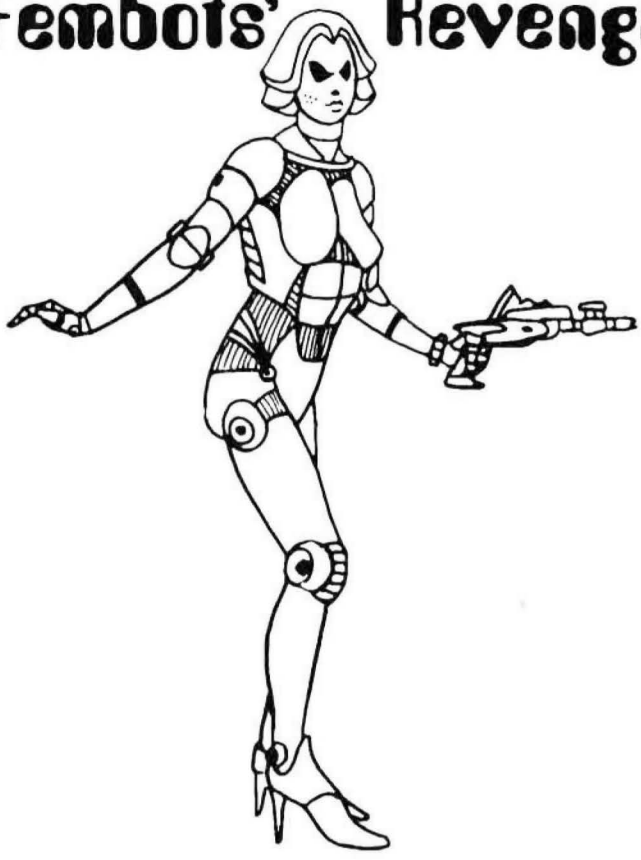

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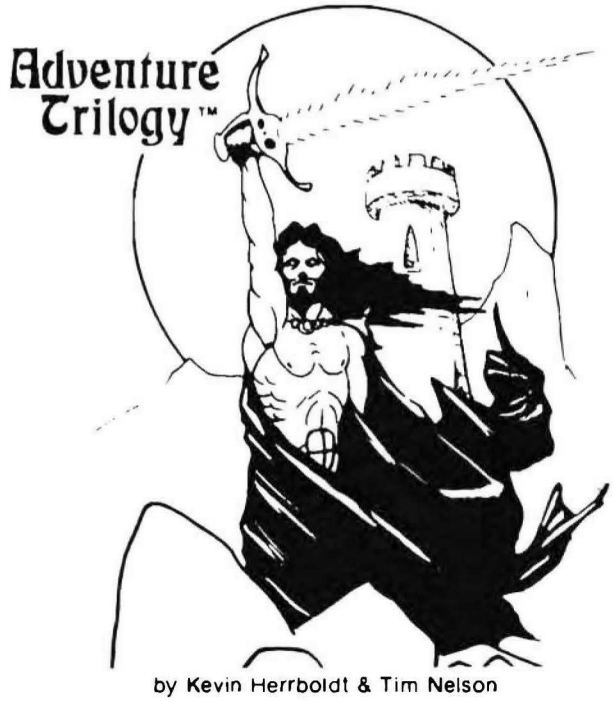

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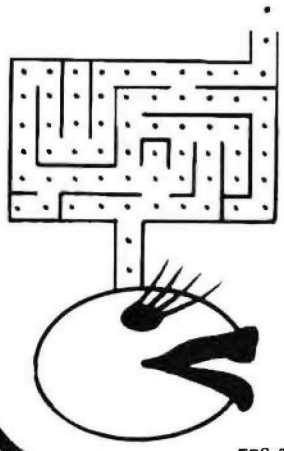

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BY VERNE R. WINTER, JR.

AUTODIAL

Build an interface for your CoCo that will automatically dial your calls, redial, and time them.

If you do a lot of (or even a little) telecommunicating with your CoCo, you'll be interested in this do-it-yourself autodial device. It allows the computer to dial bulletin boards or other phone numbers used for data communications and requires just a few easy-to-find parts (see Table 1).

I have the Radio Shack Modem I, and the circuit described in Fig. 1 is installed inside. The circuit requires a 5-volt supply (Fig. 2) and the modem's power pack, which is rated at 15 volts and 300 ma, can power it. I used a jack that matches the cassette remote plug to connect the interface to the computer. However, there are several pins on the RS-232 connector that I didn't use, but you could use them in place of the jack mentioned above.

You don't need a modem to use the interface. It just makes things, such as the phone's red wire and the ac for the power supply, easier to get to. If you build the interface inside the modem, mount it at the rear and under the circuit board. This is the only place where there is sufficient room.

The part that takes up the most room is C1, the filter capacitor for the 5-volt power supply.

Mount everything as flat as possible and check for proper fit before making everything final.

I also made a cable that stays connected to the modem. When I want to use the cassette or the autodial I just plug in the correct cable in the rear of the computer.

The autodial circuit is built around a 7400 IC and 5-volt SPDT DIP relay. The 7400 is configured so that pin 1 is held high and pin 2 is used as the control. When pin 2 is low, pin 3 is high and tells the relay to break the line (red wire). Lines 190-240 (see the Program Listing) control the condition of pin 2.

The program reads the data from lines 315 on, and determines the number of times to toggle the cassette motor relay. Since the relay in the color computer is only a reed relay and has a low contact rating, it cannot be used to do the actual line interrupt. Line 240 per-

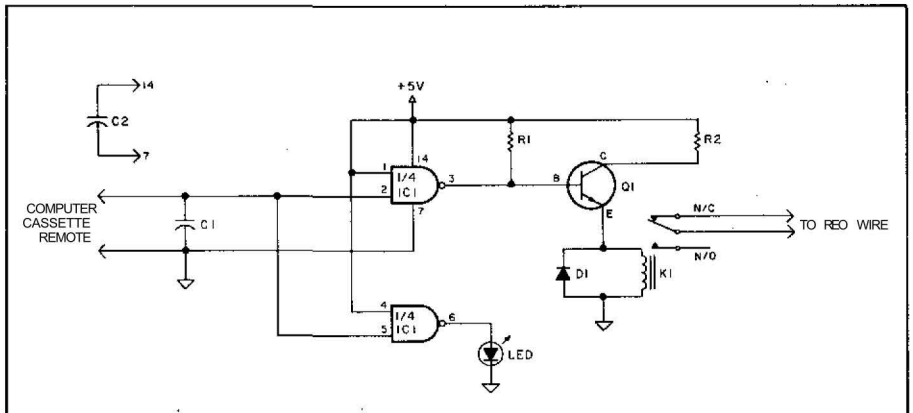

Fig. 1. Autodial Interfacing

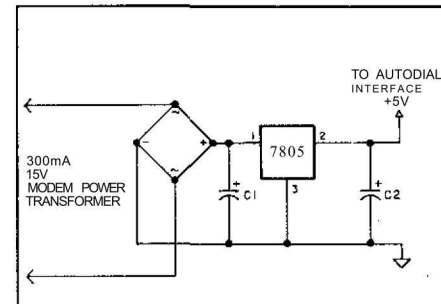

Fig. 2. 5-volt Power Supply

System Requirements

16KRAM
Extended Color Basic

forms a delay. If the delay isn't long enough, the program dials wrong numbers.

One section of 1C 1 acts as a pulse indicator; the LED will flash once for each digit dialed. I replaced the carrier-detect LED on the motherboard with one of two rectangular LEDs (RS part #276-070). Solder one LED in place of the original, making sure you note the proper polarity of the carrier-detect LED.

Use the other LED as the pulse indicator. I used a small piece of heat-shrinkable tubing to hold the LEDs together. Position them so they line up directly beneath the carrier-detect window on top of the modem. Use small-gauge wire, such as wire-wrapping wire, to attach the pulse-indicator LED.

Be sure to mark one of the wires so you know its polarity and where to connect it on the autodial interface. Run this wire through the hole to the right of the LEDs and back to the autodial interface. Using the rectangular LEDs and mounting them together makes for a better-looking arrangement than using round ones.

The carrier-detect LED should function normally and the pulse indicator

Program Listing

```
10 'TRS-80 COLOR COMPUTER AUTO-
11 'DIAL PROGRAM REQUIRES
12 'EXTENDED BASIC
13 'BY V.R. WINTER
14 'ENTER PHONE # AS DATA & MUST
15 'START WITH A LETTER
16 'A '?' WILL DISPLAY NAMES &
17 'NUMBERS IN MEMORY A '^' USED
18 'AFTER A NUMBER HAS BEEN
19 'DIALED WILL RE-DIAL SAME #
20 'TO USE TIMER TYPE 'TIMER ON'
21 'BEFORE ENTERING NAME
22 'TIMER WILL STAY ACTIVATED
23 'UNTIL 'TIMER OFF' IS ENTERED
30 'PROGRAM START
35 CLS
40 RESTORE:INPUT "ENTER NAME OF PERSON YOU WISH TOCALL";X$
45 IF X$="TIMER ON" THEN TT=1:GOTO 35
46 IF X$="TIMER OFF" THEN TT=0:GOTO 35
49 IF X$=CHR$(94) GOSUB 301 ELSE REPEAT$=X$
50 IF X$="?" THEN 290
51 IF X$="MICRO 80" THEN V$="MI":GOTO 110
52 IF X$="ABBS" THEN V$="AB":GOTO 110
53 IF X$="WORK" THEN V$="W0":GOTO 110
54 IF X$="FIRE" THEN V$="FI":GOTO 110
55 IF X$="P0LICE" THEN V$="PO":GOTO 110
56 IF X$="HOSPITAL" THEN V$="HO":GOTO 110
100 CLS:SOUND 170,1:SOUND 170,1:PRINT@3,"-THAT NAME IS NOT ON FI
LE-":PRINT:GOTO 40
110 PRINT:INPUT "PRESS ENTER WHEN DIAL TONE IS   HEARD";A$
120 FOR C=1 TO 400
130 READ N$:IF N$=V$ THEN 150
140 NEXT C
150 CLS:SOUND 190,1:PRINT "TELEPHONE NUMBER IS NOW BEING   DIALE
D.":PRINT:PRINT"TELE # >";
160 READ N$:IF N$="ZZ" THEN 270
170 PRINTN$;
175 IF N$="-" GOTO 160
```

Listing continued

Parts list for S-volt power supply

Part	Radio Shack#	Quantity
Bridge Rectifier	276-1151	1
C1 (100µF/16V)	272-958	1
C2 (l.OµF)	272-1419	1
5-volt regulator	276-1770	1

Parts list for autodial interface

Part	Radio Shack#	Quantity
IC1	276-1801	1
Q1 (NPN)	276-2009	1
or	276-2016	
or	ECG-123	
K1	275-240/275-243	1
LEDs	276-070	1pk
D1 (IN914)	276-1122	1
C1-C2(.1)	272-135	2
R1 1/4 watt	2200 ohms	1
R2 1/4 watt	10 ohms	1
R3 1/4 watt	220 ohms	1
(optional: see text)		

Miscellaneous:

DIN five-pin audio plug #274-003*
Miniature phone plug #274-289*
Miniature phone jack #274-292**

*These parts are for extra cable, otherwise you will need to use cassette cable.
**Phone plug and jacks can be changed to meet your needs.

Table 1

See List of Advertisers on page 130

should only light up when a number is being dialed. If they don't light up as they should, you probably have them mounted wrong. Unplug the modem and all connections and reverse the polarity of the LED that is not working.

I found it unnecessary to use a current-limiting resistor between pin 6 of IC1 and the pulse indicator LED. However, you might want to use one, such as R3, if needed.

One of the contacts of the relay is connected to the red wire from the phone line. This wire is located at the left rear corner of the modem and is marked R. Unsolder the red wire carefully from under the board.

You must drill a hole in the board. Then feed the red wire through this hole and solder it to one lead of the n/c relay contacts. The other lead from the relay would then connect to the same place where the red wire had been before you removed it. It is labeled R on the modem's board, and you can solder it from the bottom of the board.

Be sure you drill the hole in a place where there is no foil on either side of the board. Also check to be sure you solder the other lead from the relay to the correct place on the modem.

You will have to enter your own telephone numbers as data, starting with line 315. The examples in the program should provide the necessary format required to have the data read properly. Also, lines 51-99 will need a name and a 'key' so the program knows what to look for.

There is ample space in lines 51-99 to store names, and the data is stored beginning at line 315. If you need more room, just renumber the program.

Set the number in line 120 high **enough to read** all your data. It is set to 400 now and should be large enough for the average person. Also, I decided to store the numbers in data lines, as opposed to using files (disk or cassette). Unless you have a lot of numbers to be accessed, using files only causes unneeded wear on the disk and drive.

If you enter a name not on file, the program will tell you so. You can turn the timer on or off whenever you are prompted for a name. The timer will stay activated until you turn it off.

The redial feature uses the up-arrow key and you must press it after a number has been dialed. The ?, when entered in place of a name, will display the names on file and some other information. This information is stored starting in lines 290-299.

One note about the timer: It uses timing loops and, hence, is not as accurate as a clock. However, it will give you a good idea of how long you've talked. In fact, you could change the program to signal—or even hang up—when a certain amount of time has elapsed. You could do this by pulsing the line once.

For those who do not want to do the construction, I can supply the printed circuit board or do the entire installation. Send a self-addressed, stamped envelope for more information, or if you have any questions. •

Listing continued

```
180  N=VAL(N$)
190  FOR A=1 TO N:IF N=0 THEN GOTO 260
200  POKE 65313,4
210  FOR 1=1 TO 10:NEXT I
220  POKE 65313,52
230  FOR 1=1 TO 20:NEXT IsNEXT A
240  FOR T=1 TO 200:NEXT TtGOTO 160
250  END
260  N=10:GOTO 190
270 CLS:SOUND 200,2:PRINT@231,""DIALING COMPLETE*"jIF TT=0 GOTO
273
271  IF TT=1 THEN PRINT:PRINT"    TO START TIMER PRESS ENTER";
272  INPUT Z$:PRINT@394,"ELAPSED TIME":GOTO 302
273 FOR G=1 TO 1000:NEXT:CLS:GOTO 40
290 CLS:PRINT@2, "*NAMES AND NUMBERS ON FILE*":PRINT: PRINT "MIC
RO 80, ABBS, WORK, POLICE,   FIRE, ETC."
296  PRINT
297 PRINT"FOR AUTO-REDIAL PRESS •"' KEY    AND PRESS ENTER":PRINT
298 PRINT"TO USE TIMER ENTER  -TIMER ON-  BEFORE ENTERING NAME.
299  PRINT
3 00 GOTO 40
3 01  X$=REPEAT$:RETURN
302  'TIMER ROUTINE
303  A=0:B=0:C=0
3 04  FOR H=A TO 12
305 FOR M=B TO 5 9
306 FOR S=C TO 59
307   PRINT@330,H":"M":"S
308 IF INKEY$=CHR$(13) THEN 10
310 FOR T=1 TO 386:NEXT T
312 NEXT S
313 NEXT M
314 NEXT H
315 DATA   MI,1,-,6,0,3,-,9,2,4,-,9,4,7,1,ZZ
316 DATA   AB,1,-,5,1,5,-,2,2,4,-,1,8,0,1,ZZ
317 DATA  WO,2,5,5,-,1,4,0,4,ZZ
318 DATA  FI,2,4,4,-,3,2,1,2,ZZ
319 DATA  PO,2,8,3,-,4,8,1,1,ZZ
320 DATA  HO,2,8,6,-,3,1,1,1,ZZ
400 END
1000  'THE FOLLOWING PROGRAM WILL
1001  'PRINT A LIST OF VARIABLES
1002  'USE AFTER PROGRAM HAS RUN
1003  'AND VARIABLES HAVE BEEN
1004  'INITIALIZED, PRESS BREAK
1005  '& TYPE -GOTO 1000-
1006  'TYPING RUN 1000  WILL CLEAR
1007  'VARIABLES, OMIT ZX FROM
1008  'LISTING AS IT IS USED IN
1009  'THIS SUBROUTINE
1010 FOR ZX=PEEK(27)*256+PEEK(28) TO PEEK(29)*256+PEEK(30)-5 STE
P7
1015 PRINTCHR$(PEEK(ZX));CHR$(PEEK(ZX+1) AND 127);
1020 IF PEEK(ZX+1)>127 THEN PRINT"$";
1025 PRINT"":NEXT ZX
```

Address correspondence to Verne Winter, 502 Davis Ave., Des Moines, IA 50315.

See List of Advertisers on page 130

BY HOWARD F. BATIE

GALAXY TREK ADVENTURE

Can you get rid of all the aliens who have taken over the Constellation, fix the warp drive, locate your captured crew, and return them safely to the ship before the Constellation's orbit decays and you burn up? Galaxy Trek Adventure gives you the opportunity to answer these questions.

The action theme is based on Hawkins' excellent article for the TRS-80 Model I in *80 Micro* (August 1982, pp. 174-184). Several additions to the game logic result in a real challenge for Color Computer users.

Red Alert! The Klingons are on the attack, and only you can save the Enterprise and your crew.

As you can see, most of the text is encrypted so that the clues, key words, and help statements are not obvious if the program is listed on the screen or sent to a printer. When you run the program, however, the built-in decryptor displays readable text. You can break the encryption system if you understand Basic string-manipulation techniques, but doing so will only deprive you of the satisfaction of deducing them by playing the game. I have included checksum values at the end of each program line to serve as bug catchers. The checksum method is described in *80 Micro* (November 1982, p. 410). When you type in the listing (lines 5-9999), omit the apostrophe and checksum value at the end of each line. Then add lines 63000-63070 and run 63000. You can compare the checksums shown on the screen with those at the end of each line. If they don't agree, check for an error in that line. •

Program Listing. Galaxy Trek Adventure

```
3 ' *** DELETE CHECKSUM AND              APOSTROPHE IN LINES 80,
      212,222,510,1105,8000              BEFORE RUNNING PROGRAM
4 '
5 GOSUB5500:CLS:PRINT@138,"G A L A X Y":PRINT@196,"A D V E N T U
 RE    # 1"'3540
6 GOSUB505:PRINT@418,"COPYRIGHT 1982 HOWARD BATIE          HERND
ON, VA 22070"'4152
10 CLEAR1000:DIMDS$(41),OB$(26),OB(26),DI$(5),VB$(21),NN$(26),DD
$(5):WG=0:CW=0:SC=0:NM=0:CC=0:SP=0:CM$=""'6350
20 SP$=CHR$(13)+"SPOCK SAYS...":CR$="UIF!DPNQVUFS!SFTQPOET!..":N
N$="OPU!0FDFTTBSZ!OPX-!DBQUBJO/":CD$="YOU CANNOT DO THAT":TM$="Z
PV(SF!DBSSZJOH!UPP!NVDI!"'10624
24 DR$="ZPV(MM!IBWF!UP!ESPQ!TPNFUIJ0H/":CP$="CAPTAIN":SH$="UIF!D
SZTUBMT!TIBUUFS!J0UP!EVTU/":EN$="THE ENTERPRISE":NI$="OPUIJOH!IB
QQFOFE/":PF$="TPSSZ-IZPV(SF!PO!ZPVS!PXO"+CHR$(34)'12531
26 DM$="%######&$-#####%##'''###./,####-#,4*-#+###*#####(###))%
#*####0(##(0####.##/###35###45######1####2#);16#2#####5##;>#:##
#9####9#:8##97::####7#4@@?#######>###=>7###A#<####<#;##CB?##A###
#####A##DDDD##FID'##JKE#####'#####KJ##IIII###HF"'10342
27 DM$=DM$+"###H#IF##L'LL##"'1659
80 DATA32,12,13,11,5,10,15,20,25,26,7,14,27,4,8,4,16,19,21,21,21
,27,31,32,1,5'3604
90 F0RI=1T026:READ0B(I):NEXT'1483
95 GOSUB8000:FORI=24TO27:POKEDZ+I,39:NEXT'2355
100 DS$(1)="JO!UIF!DBQUBJO(T!RVBSUFST":DS$(2)="JO!B!DPSSJEPS!PG!
UIF!FOUFSQSJTF":DS$(3)="JO!UIF!USBOTQPSUFS!SPPN":DS$(4)="PO!UIF!
TBOEZ!TVSGBDF!PG!QMBOFU!!UJFSBT!91":DS$(5)="BU!UIF!FOUSBODF!UP!B
!UVSCPHJGU":DS$(6)="J0!UIF!UVSCPMJGU"'15375
115 DS$(7)=DS$(2):DS$(8)="J0!POF!PG!UIF!DSFX(T!RVBSUFST":DS${9)=
DS$(6):DS$(10)=DS$(5):DS$(11)="BU!UIF!0BWJHBUJP0!DP0TPMF":DS$(12
)="BU!UIFIDPNNVOJDBUJPOT!TUBUJPO":DS$(13)="BU!UIF!TDJFODF!PGGJDF
S(T!TUBUJP0"'13491
130 DS$(14)=DS$(2):DS$(15)=DS$(5);DS$(16)="J0!UIF!TIJQ(T!MJCSBSZ
":DS$(17)=DS$(6):DS$(18)=DS$(2):DS$(19)="JO!UIF!TJDL!CBZ"'7599
140 DS$(20)=DS$(5):DS$(21)="JO!UIF!TIJQ(T!TVQQMZ!XBSFIPVTF":DS$(
22)=DS$(2):DS$(23)=DS$(2):DS$(24)=DS$(6):DS?(25)=DS$(5):DS$(26)=
"J0!B!TFDVSJUZ!DFMM!J0!UIF!CSJH":DS$(27)=DS$(2)'11162
150 DS$(28)=DS$(2):DS$(29)=DS$(6):DS$(30)="J0!UIF!F0HJ0FFSJ0H!TF
DUJPO!..!!!BU!UIF!GBS!F0E!JT!UIF!NBUUFS.!!!BOUJ.NBUUFS!XBSQ!FOHJ
OF!ESJWF/"'8814
155 DSS(31)="BU!UIF!EJMJUIJVN!DSZTUBM!QPXFS!!TUBUJPO/":DS$(32)="
```

Listing continued

Write Howard Batie at 12002 Cheviot Drive, Herndon, VA 22070.

"... most of the text is encrypted... so that the clues... are not obvious."

System Requirements

32KRAM
Extended Color Basic

Listing continued

```
BU!UIF!BVYJMJBSZ!QPXFS!TUBUJPO/":DS$(33)="J0!B!HSFBU!TFB!PG!NPWJ
OH!TBOE":DS$(34)="PO!B!TBOEZ!IJMMTJEF"'11077
156 DS$(35)="BU!UIF!XBMM!PG!B!DBNQ!UP!UIF!!!!!!0PSUIFBTU/":DS$(3
6)="PO!B!EVOF!PWFSMPPLJOHINBOZ!!!!LMJOHPOT!UP!UIF!FBTU"'7672
157 DS$(37)="JO!ZPVS!DSFX(T!DBNQ!..!CVU!0PX!!ZPV!NVTU!MFBE!UIFN!
CBDL!UP!UIF!!PSJHJOBM!USBOTQPSUFS!DPPSEJOBUFT":DS$(38)="DBVHIO!J
O!B!SPDLTMJEF!BOE!EJF!!!JO!BO!BWBMBODIF!PG!CPVMEFST/":DS$(39)="B
U!B!HBUF!PG!B!DBNQ!UP!UIF!FBTU/"'14663
158 DS$(40)="BU!UIF!HBUF!PG!B!DBNQ!UP!UIF!!!!OPSUI":DS$(41)=DS$(
4)'4037
160 OB$(1)="BO!VOBSNFE!LMJOHP0!DPNNBOEFS":OB$(2)="B!CVUUP01MBCFH
MFE"+CHR$(14)+"!!..!TIJQ(T!TFOTPST!..":OB$(3)="B!CVTJUP0!MBCFMMFE
"+CHR$(14)+"!!..!TIJQ(T!TUBUVT!..":OB$(4)="B!CVUUPO!MBCFMMFE"+CH
R$(14)+"!!..!GJSF!JNQVMTF!FOHJOFT!.."'15456
170 OB$(5)="B!TJHO!PO!UIF!PQQPTJUF!XBMM":FORI=6T09:OB$(I)=OB$(5)
:NEXT:OB$(10)="NS/!TQPDL!MZJOH!VODPOTDJPVT!!!!!P0!UIF!GMPPS":OB$
(11)="B!LMJOHPO!TPMEJFS":OB$(12)="B!LMJOHPO!HVBSE"'11611
180 OB$(13)="B!LMJOHPO!TFOUSZ":OB$(14)="B!LMJOHP0!PGGJDFS":OB$(1
5)="B!GVSSZ!BOJNBH!DBMMFE!B!USJCCMF":0B$(16)="SBX!EJMJUIJVN!DSZT
UBMT":0B$(17)="UIF!UFDI0JDBM!NB0VBM!GPS!UIF!!!!TUBSTIJQ!FOUFSQSJ
TF"'13051
190 OB$(18)="B!IZQPEFSNJD!OFFEMF!MBCFMMFE"+CHR$(14)+"!!..!BOUJEP
UF!JOKFDUJPO!..":OB$(19)="B!QIBTFS":OB$(20)="B!DPNNVOJDBUPS":OB$
(21)="BO!FMFDUSPOJD!TIVOU":OBS(22)="TQPDL(T!USJDPSEFS"'12234
195 OB$(23)="EJMJUIJVN!DSZTUBM!QPXFS!TUBUJPO-OPX!QSPWJEJOH!POMZ!
B!GSBDUJPO!!!PG!OPSNBM!FOFSHZ!MFWFMT/":OB$(24)="UIF!BVYJMJBSZ!DP
OUSPM!QBOFM!..!!B!LFZ!DPNQPOFOU!IBT!CFFO!SFNPWFEGSPN!UIF!DFOUFS!
PG!UIF!DJSDVJU/"'14165
200 OB$(25)="B!4E!DIFTT!TFU":OB$(26)="TUBS!DIBSUT":DI$(0)="NORTH
":DI$(1)="EAST":DI$(2)="SOUTH":DI$(3)="WEST":DI$(4)="UP  ":DI$(5)
="DOWN"'8809
210 F0RI=1T021:READVB$(I):NEXT'1641
212 DATAOPS,FBT,TPV,XFT,VQ!,EPX,IFM,JOW,TDP,RVJ,MPP,HP!,HFU,ESP,
TBZ,UIS,GJS,QSF,SFB,JOT,JOK'6059
214 F0RI=1T021:CM$=VB$(I):VB$(I)="":F0RJ=1T03:VB$(I)=VB$(I)+CHR$
(ASC(MID$(CM$,J,1))-1):NEXTJ,I'6538
220 FORI=0TO22:READNNS(I):NEXT:PL=1:SP=0:KE=-1:CR=0:SH=0:DE=-1:T
T=0:TD=1'5507
222 DATAFOFS,DPNN,CVUU,CVUU,CVUU,TJHO,TJHO,TJHO,TJHO,TJHO,TQPD,L
MJO,LMJO,LMJO,LMJO,USJC,DSZT,NBOV,OFFE,QIBT,DPNN,TIVO,USJD'8452
224 FORI=0TO22:CM$=NN$(I):NN$(I)="":F0RJ=1T04:NN$(I)=NN$(I)+CHR$
(ASC(MID$(CM$,J,1))-1):NEXTJ,I'6565
240 DD$(1)="CSJEHF":DD$(2)="QFSTPOOFM!TFDUJPO":DD$(3)="UFDIOJDBM
!EFQBSUNFOUT":DD$(4)="TFDVSJUZ!TFDUJPO":DD$(5)="FOHJOFFSJOH!EJWJ
TJPO":NN$(25)="CHES":NN$(26)="CHAR":GOTO500'11611
400 FORZ=1TOLEN(P$)'1343
410 PRINTCHR$(ASC(MID$(P$,Z,1))-1);'2342
420 NEXTZ:RETURN'596
450 GOSUB400:PRINT:RETURN'1033
500 CLS:P$="ZPV!":GOSUB400:IFSP=1THENP$="BOE!TQPDL!":GOSUB400'38
96
501 IFCW=1THENPRINT"AND THE CREW ";'2027
503 P$="BSF":GOSUB450:P$=DS$(PL):GOSUB450:PRINT:IFPL=38THEN1600:
ELSEIFPL=37THENCW=1:GOTO510:ELSEIFPL<>33THEN510:ELSEGOSUB505:GOS
UB505:P$="B!HJBOU!TBOE!TOBLF!JT!TXJNNJOH!!UISPVHI!UIF!TBOE!UPXBS
E!ZPV!..":GOSUB450:GOSUB505:GOSUB505:PRINT'14529
504 P$="JU(T!HFUUJOH!DMPTFS!//":GOSUB450:GOSUB505:P$="ZPV!DBO(U!
FTDBQF!..":GOSUB450:GOSUB505:GOSUB505:PRINT:P$="BBSSSSHII!"+CHR$
(34)+CHR$(34)+"!!!JU!LJHMFE!ZPV+CHR$(34):GOSUB450:GOTO1600'1216
0
505 FORI=1TO1000:NEXT:RETURN'1436
510 PRINT"OBVIOUS EXITS ARE:":GOSUB8000:FORJ=0TO5:IFPEEK(DZ+J)<>
35THENPRINTDI$(J);" ";:NEXT:PRINTELSENEXT:PRINT'6292
514 PRINT:PS="ZPV!DBO!TFF!UIFTF!PCKFDUT;":GOSUB450'2861
515 IFPL=21THENP$="BHM!UIF!TIJQ(T!TVQQMJFT":GOSUB450:GOTO520:ELS
EK=0:FORJ=1TO26:IFOB(J)=PL THENK=1:P$=OB$(J):GOSUB450:NEXTJ:ELSE
NEXTJ:IFPL=30THENP$="I":GOSUB450:ELSEIFK=0THENP$="OPUIJOH":GOSUB
450'12248
516 IFWG=0THEN520ELSEIFCW=1ANDPL=3THEN6000'2474
518 IFPL=37THENSC=SC+250:GOTO1000'2095
520 IFOB(11)=PL OROB(12)=PL OROB(13)=PL OROB(14)=PL THEN3000'380
6
530 IFKE ANDSP=1ANDPL=28THENPRINTSP$:PRINTCP$;:P$="-!J!TFOTF!LMJ
OHPOT!UP!UIFFBTU///!UPP!NBOZ!UP!EFGFBU!XJUI!KVTU!IBOE!QIBTFST/":
GOSUB450'8450
540 IFKE ANDPL=30THENPRINT:PS="ZPV(SF!TVSSPVOEFE!CZ!B!TRVBESPO!P
G!LMJOHPOT-!BOE!IBWF!UJNF!GPS!!POF!BDUJPO!CFGPSF!UIFZ!GJSF"+CHR$
(34):GOSUB450:GOTO3500'9703
1000 GOSUB4000:PRINT:CM$="":INPUT"COMMAND";CM$:CM$=CH$+"
  "'3573
1005 VB$=LEFT$(CM$,3):NN$="":FORI=1TOLEN(CM$)-4:IFMID$(CM$,I,1)=
" "THENNN$=MID$(CM$,1+1,4):I=255'6821
1010 NEXTI:VB=0:FORJ=1TO21:IFVB$=VB$(J)THENVB=J'3119
1020 NEXTJ:IFVB=0THENPRINT:PRINT"CAN YOU REPEAT THAT, ";CP$;"?":
GOTO1000'3967
1030 NN=-1:FORJ=0TO26:IFNN$=NN$(J)THENNN=J'2807
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Listing continued

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Listing continued

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1040 NEXTJ:IF(NN=-1ANDVB>12)ANDVB<>15THENPRINT:PRINT"CAN YOU REP
EAT THAT, CAPTAIN?":GOTO1000'5526
1050 ONVB GOTO1100,1100,1100,1100,1100,1100,1190,1400,1500,1600,
500,1700,1800,1900,2000,2100,2200,2300,2400,2500,2600'5616
1100 IFTT>2ANDPL=4ANDWG=1THENP$=TM$:GOSUB450:P$="GPS!UIJT!QMBOFU
<T!HSBWJUZ/":GOSUB450:P$=DR$:GOSUB450:GOTO1000'7251
1105 GOSUB8000:DX=PEEK(DZ+VB-1):IFDX>35THENPL=DX-35:NM=NM+1:GOTO
500'4976
1110 PRINTCD$:GOTO1000'941
1190 SC=SC-10:IFPL=4THEN1240'1862
1200 IFSP<>1THENP$=PF$:GOSUB450:GOTO1000ELSEONPL GOSUB1220,1220,
1230,4030,1220,1220,1250,1260,1220,1220,1270,1270,1270,1250,1220
,1220,1220,1220,1220,1220,1280,1220,1220,1220,1220,1220,1250,129
0,1220,1220,1300,1295:GOTO1000'11659
1220 P$="J!TFF!OPUIJOH!VOVTVBM-!DBQUBJO/":GOSUB450:RETURN'3418
1230 P$="ZPV!VTVBMMZ!TBZ!(FOFSHJ"+CHR$(91)+"F(!BU!!!UIJT!QPJOU-!
DBQUBJO":GOSUB450:RETURN'5659
1240 P$=PF$:GOSUB450:GOTO1000'1752
1250 KH=0:FORJ=11TO14:IFOB(J)=PL THENKH=1:NEXTELSENEXT'3333
1255 IFKH=1THENPRINT"I SUGGEST YOU FIRE A PHASER.":RETURNELSE122
0'3590
1260 IFOB(15)=8THENP$="EP!ZPV!UIJ0L!UIJT!DSFBUVSF!DPVMECF!VTFGVM
@":GOSUB450:RETURNELSE1220'5533
1270 P$="TIPVME!J!QSFTT!UIF!CVUUPO@":GOSUB450: RETURN' 3172
1280 P$="BMNPTU!BOZ!FRVJQNFOU!ZPV!SFRVJSFJT!BWBJMBCMF/":GOSUB450
:RETURN'4310
1290 IFKE THENP$="XF!OFFE!TPNFUIJOH!UP!GSJHIUFO!!!UIFN!BXBZ/":GO
SUB450:RETURN:ELSE1220'4847
1295 IFOB(1)=32THENP$="UIF!LMJ0HP0.FTF!QISBTF!GPS!!(EP!ZPV!TVSSF
OEFS(!!JT!!(USPYBFUJ(":GOSUB450:RETURN'6097
1300 P$="J!TVHHFTU!XF!DPOTVMU!UIF!TIJQ(T!UFDIOJDBM!NBOVBM/":GOSU
B450:RETURN'4494
1400 PRINT:PRINT"YOU ARE CARRYING:":K=0:FORJ=15T026:IFOB(J)=0THE
NP$=OB$(J):GOSUB450:K=1'5272
1410 NEXTJ:IFK=0THENP$="OPUIJOH":GOSUB450'2419
1420 GOTO1000'632
1500 PRINT:PRINT"YOUR SCORE SO FAR IS";9*(SC-3*NM):GOTO1000'3615
1600 IFPL<>4ANDPL<33ANDWG=1ANDCW=0THENPRINTSP$:PRINT"CAPTAIN, ";
EN$;" IS":P$="TBWFE/!!CVU!XJUIPVU!UIF!DSFX-!!!PVSINJTTJPO!JT!B!G
BJMVSF/":GOSUB450'9146
1605 GOSUB505:PRINT:PRINT"THIS ADVENTURE IS OVER."'2590
1607 PRINT"WOULD YOU LIKE TO TRY AGAIN?"'2214
1610 CM$=INKEY$:IFCM$="Y"THENCLS:RUN10ELSEIFCM$="N"THENCLS:ENDEL
SE1610'3908
1650 RETURN'264
1700 VB$=LEFT$(NN$,3):VB=0:FORJ=1T06:IFVB$=VB$(J)THENVB=J'3919
1710 NEXTJ:IFVB=0THENFORJ=1TO1:GOTO1020ELSE1100'2705
1800 IFOB(NN)=0THENPRINT"YOU ALREADY HAVE THAT":GOTO1000'3132
1805 IFNN<15THENPRINTCD$:GOTO1000'1609
1810 IFOB(NN)=PL ANDTT<5THENPRINT:P$="P/L/!!BEE":GOSUB450:P$=OB$
(NN):GOSUB450:P$="UP!ZPVS!JOWFOUPSZ/":GOSUB450:TT=TT+1:OB(NN)=0:
GOTO1000'8786
1818 IFOB(NN)=PL THENP$=TM$:GOSUB450:P$=DR$:GOSUB450:GOTO1000'36
70
1820 PRINT"I DON'T SEE THAT HERE":GOTO1000'2150
1900 PRINT:IFOB(NN)<>0THENPRINT"YOU DON'T HAVE THAT.":GOTO1000'3
484
1910 IFNN=16ANDOB(16)=0THENPRINT"O.K.":P$=SH$:GOSUB450:OB(16)=4:
SC=SC-150:TT=TT-1:GOTO1000'5910
1915 IFNN=15ANDOB(15)=0THENOB(15)=-1:TT=TT-1:SC=SC-50:P$="P/L/!!
CVU!JU!SB0!BXBZ"+CHR$(34):GOSUB450:GOTO1000'7501
1920 P$="P/L/!!ZPV!ESPQQFE":GOSUB450:PS=OB$(NN):GOSUB450:OB(NN)=
PL:TT=TT-1:GOTO1000'5533
2000 IF(PL=3ANDSP=1ANDNN=0)THENPRINTSP$:P$="BZF!BZF-!":GOSUB400:
PRINTCP$:F0RI=1T025:PRINT"*";:F0RJ=1T010:NEXTJ,I:GOSUB505:PL=4:S
P=0:GOTO500'8459
2005 IFNN=0ANDTT>2THENP$=TM$:GOSUB450:P$=DR$:GOSUB450:GOTO1000'4
063
2010 IFNN=0THENIFOB(20)=0THENIFNN=0THENPRINTSP$:P$="CFBNJOH!ZPV!
BCPBSE-!DBQUBJO/":GOSUB450:FORI=1TO25:PRINT"*";:FORJ=1TO10:NEXTJ
,I:GOSUB505:PL=3:SP=1:GOTO500'9762
2015 IFNN=0ANDOB(20)<>0THENP$="PL/!CVU!XJUIPVU!UIF!DPNNVOJDBUPSZ
PV!BSF!CFBNFE!JOUP!EFFQ!TQBDF/":GOSUB450:GOTO1600'7620
2020 IFPL=3THENIFNN=0THENP$="OFFE!TPNFPOF!GPS1UIF!DPOUSPMT@":GOS
UB450:GOTO1000'5141
2030 IFPL=32THENIFNN$="TROX"THENIFOB(1)=32THENP$="UIF!DPNNBOEFS!
TVSSFOEFST!BOE!!!!TUBUFT!UIBU!UIF!DSFX!JT!VOIBSNFEP0!UIF!QMBOFU(
T!TVSGBDF-!IF!XJMMTVQQMZ!USBOTQPSUFS!DPPSEJOBUFT!!BOE!XJMM!HP!UP
!UIF!CSJH/":GOSUB450:OB(1)=26:SC=SC+150:GOTO1000'16275
2040 P$="P/L/!!ZPV!TBJE!JU-!CVU":GOSUB450'2530
2050 P$=NI$:GOSUB450:GOTO1000'1543
2100 PRINT:IFOB(NN)<>0THENPRINTCD$:GOTO1000'2192
2110 TT=TT-1:IFNN=16THENPRINT"O.K.":P$=CH$:GOSUB45 0:SC=SC-150:OB
(16)=4:GOTO1000'5107
2120 IFNN>16THENPRINT"O.K.":SC=SC-50:IFSP=1THENPRINTSP$:PRINT"A
MOST ILLOGICAL MOVE, ";CP$'5189
2130 IFNN>16THENOB(NN)=PL:GOTO1000'2089
2140 FORI=11T014:IFOB(I)=PL THENPRINT:P$="UIF!LMJOHPO!XBT!TP!BGS
BJE!PG1UIFUSJCCMF!UIBU!IF!SB0!BXBZ"+CHR$(34):GOSUB450:OB(I)=-1:O
B(15)=PL:SC=SC+75:I=15:NEXTI:ELSENEXTI'10933
2142 IFPL>32THEN0B(15)=-1:P$="CVU!UIF!USJCCMF!SB0!BXBZ-!UPP"+CHR
$(34):GOSUB450:GOTO1000*5768
2150 IFOB(1)=PL THENPS="UIF!LMJOHP0!DPNNBOEFS!JT!WFSZ!!!CSBWF!BO
E!IPMET!IJT!HSPVOE/":GOSUB450:OB(15)=PL:GOTO1000'7191
2160 IFPL=30ANDKE THENPRINT:P$="XIFO!UIF!LMJOHPOT!TFF!B!USJCCMF!
JO!UIFJS!NJETU-!UIFZ!SVO!BXBZ!MOBMM!EJSFDUJPOT/":GOSUB450'7704
2165 IFPL=30THENIFKE THENIFSP=1THENPRINTSP$:PRINT"EXCELLENT, CAP
TAIN!":PS="ZPV!SFNFNCFSFE!IPX!JMMPHJDBMMZ!!GSJHIUFOFE!UIFZ!BSF!P
G!USJCCMFT"+CHR$(34):GOSUB400:ELSEPRINT'10377
2170 IFPL=30ANDKE THENKE=0:OB(15)=30:GOTO1000'2796
2180 OB(15)=PL:GOTO1000'1348
2200 IFNN<>19THENPRINTCD$:GOTO1000'1931
2210 IFOB(19)<>0THENPRINTCD$;" YET.":GOTO1000'2506
2220 SC=SC-20:FORI=11TO14:IFOB(I)<>PL THEN2230ELSEPRINT:P$="UIF!
LMJOHPO!IBT!CFFO!SFNPWFE":GOSUB450:SC=SC+100:IFPL>32THENP$="CVU!
ZPVS!QIBTFS!WBQPSJ^FE/":GOSUB450:OB(19)=-1:TT=TT-1'12311
2222 OB(I)=-1:I=15:NEXTI:GOTO1000'2108
2230 NEXTI:IFOB(1)=PL THENPRINT:P$="UIF!DPNNBOEFS!IBT1CFFO!SFNPW
FE/":GOSUB450:IFSP=1THENPRINTSP$:P$="IJHIMZ!JMMPHJDBM!UP!LJMM!BO
":GOSUB450:P$="VOBSNFE!NBO-!":GOSUB400:PRINTCP$:OB(1)=-1:GOTO100
0ELSEOB(1)=-1:GOTO1000'13478
2240 PRINT:PRINT"O.K.";:IFSP=1THENPRINT" BUT WHY WASTE":PRINT"V
ALUABLE PHASER CHARGE, CAPTAIN?":GOTO1000ELSE1000'6221
2300 IFNN<20RNN>4THENPRINT"DO WHAT, CAPTAIN?":GOTO1000'3395
2310 IFPL<11ORPL>13THENP$="XIBU!CVUUPO-!DBQUBJO@":GOSUB450:GOTO1
000'4262
2320 SC=SC-50:IFPL=12ANDKE THENP$=CR$:GOSUB450:P$="TFOTPST!JOEJD
BUF!POF!IVNBOPJE!!!MJGF!GPSN!PO!CPBSE-!POF!WVMDBO-!BOE!NBOZ!LMJO
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Listing continued

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HPOT/":GOSUB450:GOTO1000'9929
2330 IFPL=12THENP$=CR$:GOSUB450:P$="TFOTPST!JOEJDBUF!POF!IVNBOPJ
E!!!HJGF!GPSN!BOE!POF!WVMDBO!BCPBSE/":GOSUB450:GOTO1000'7561
2340 IFPL=13THENP$=CR$:GOSUB450:PRINTEN$;" IS IN ORBIT":PRINT"AR
OUND PLANET TIERAS 80 ... A CLASS M PLANET ...":PRINT"OXYGEN
-NITROGEN ATMOSPHERE ...":PRINT'RICH IN CRYSTALLITE MINERALS.":P
RINT'11294
2350 IFPL=13THENIFDE THENPRINTEN$;:P$="!XJMM!CVSO!VQ!JO!!UIF!BUN
PTQIFSF!WFSZ!TPPO!VOMFTT!UIF!JNQVMTF!FOHJOFT!BSF!GJSFE/":GOSUB45
0'8079
2360 IFPL=13THEN1000'993
2370 GOSUB8000:IFPL=11THENIFSH THENIFCR THENPRINT"THE SHIP SHAKE
S VIOLENTLY ...":P$=CR$:GOSUB450:P$="TUBCMF!PSCJU!BDIJFWFE"+CHR$
(34):GOSUB450:DE=0:TD=1:WG=1:OB(11)=35:OB(12)=39:OB(13)=40:OB(14
)=41:POKEDZ-42,71:POKEDZ-41,69:POKEDZ-40,35'15012
2371 IFPL=11THENIFSH THENIFCR THENIFWG=1THENPOKEDZ-39,76:SC=SC+2
00:GOTO1000'4599
2380 P$=NI$:GOSUB450:GOTO1000'1618
2400 SC=SC-5:IFNN=9AND(INT(PL/5)*5)=PL ANDPL<26THENPRINT"IT SAYS
:":PRINT"STARSHIP ENTERPRISE — NCC 1701":PRINT"DECK";PL/5;"- ";
:P$=DD${PL/5):GOSUB450:GOTO1000'10211
2405 IFNN=22THEN2470ELSEIFNN=17THEN2410'2178
2408 PRINT"READ WHAT, CAPTAIN?":GOTO1000'2136
2410 IFOB(17)<>0THEN2408'1357
2420 IFPL=11THENP$="DIFDL!UIF!EJMJUIJVN!DSZTUBMT!BOEDPOUSPMT!JO!
FOHJOFFSJOH/":GOSUB450:GOTO1000'6252
2430 IFPL=21ANDOB{21)=PL THENP$="UIJT!TIVOU!JT!VTFE!JO!UIF!!!!!!
!FOHJOFFSJOH!DPOUSPM!NFDIBOJTN/":GOSUB450:GOTO1000'7275
2440 IFPL=31THENP$="JOTFSU!UIF!DSZTUBMT!BU!UIF!QPXFSTUBUJPO/":GO
SUB450:GOTO1000'5180
2450 IFPL=32THENP$="JOTUBMM!UIF!TIVOU!JO!UIF!DPOUSPMQBOFM/":GOSU
B450:GOTO1000'5000
2460 P$="JU!EPFT!OPU!NFOUJP0!B0ZUIJ0H!PG!WBMVF!J0!UIJT!TJUVBUJP0
/":GOSUB450:GOTO1000'5511
2470 IFOB(22)<>0THEN2408'1413
2472 IFPL=4ORPL>32THEN2480'1682
2474 IFKE<>0OR(OB(11)>0ANDOB(11)<33)OR(OB{12)>0ANDOB(12)<33)OR{0
B(13)>0ANDOB{13)<33)OR(OB(14)>0ANDOB(14)<33)THENP$="UIFSF!BSF!LM
JOHPOT!PO!UIF!TIJQ/":GOSUB450:GOTO1000'10947
2476 IFKE=0ANDOB(1)<>-1THENP$="JU!JOEJDBUFT!POMZ!POF!VOBSNFE!!!L
MJOHPO!SFNBJOT!PO!UIF!TIJQ/":GOSUB450:GOTO1000'7390
2500 IFPL<31THENPRINTCD$;" HERE":GOTO1000'2243
2510 IFPL=31THENIFOB(16)=0THENIFNN=16THENIFCR THENP$=NI$:GOSUB45
0:GOTO1000'4558
2520 IFPL=31THENIFOB(16)=0THENIFNN=16THENIFCR=0THENP$="B!MPX!WJC
SBUJPO!CFHJOT!///":GOSUB450:P$="QPXFS!MFWFMT!OPX!BU":GOSUB400:PR
INT92+RND(7)+RND(0);"%";:CR=-1:TT=TT-1:OB(16)=-1:OB(23)=-1:SC=SC
+300:GOTO2560'14399
2530 IFPL=32THENIFOB(21)=0THENIFNN=21THENIFSH THENP$=NI$:GOSUB45
0:GOTO1000'4577
2540 IFPL=32THENIFOB(21)=0THENIFNN=21THENIFSH=0THENP$="B!HSFFO!Q
BOFM!MJHIU!HMPXT!///!!!BVYJMJBSZ!QPXFS!OPX!PQFSBUJPOBM":GOSUB450
:OB(24)=-1:TT=TT-1:SH=-1:OB(21)=21:SC=SC+250:GOTO2560'12682
2550 PRINTCD$:GOTO1000'1106
2560 IFCR ANDSH THENTD=-17-RND(3)-RND(0):GOTO1000'3385
2570 GOTO1000'507
2480 PRINT"IT INDISNT!BOE!LMJOHPOT!UP!UIF!OPSUIFBTU///":GOSUB450'7071
2482 IFOB(14)<>-1THENP$="POF!LMJ0HP0!UP!UIF!XFTU/":GOSUB450'3927
2484 GOTO1000'676
2600 IF{NN=18ORNN=10)ANDOB(10)=26ANDOB(18)=0THENSC=SC+200:P$="P/
L/!!TQPDL!BXBLFOT!BOE!TBZT!..!J!BN!XFMM!FOPVHI!UP!IFMQ!ZPV!OPX":
GOSUB400:SP=1:OB(10)=-1:GOTO1000'10708
2610 PRINT"NOT NOW, CAPTAIN.":GOTO1000'1959
3000 IFOB(15)<>0THENIFOB(19)<>0THENPRINT:GOSUB505:P$="XJUIPVU!B!
QIBTFS-!ZPV1NVTU!!!!!!TVSSFOEFS/":GOSUB450:GOTO1600'7199
3010 GOSUB3100:IFC1$=VB$(16)ANDC2$=NN$(15)ANDOB(15)=0THENTT=TT-1
:GOTO2140'4658
3020 IFC1S=VB$(17)ANDC2$=NN$(19)ANDOB(19)=0THEN2220ELSE3520'3431
3100 PRINT:CM$="":INPUT"COMMAND";CM$:CM$=CM$+" "'2829
3110 FORI = lTOLEN(CM$):IFMID$ (CM$,1,1)=" "THENC1$=LEFT$(CM$,3):C2
$=MID$(CMS,I+1,4):I=99'5793
3120 NEXTI:RETURN'474
3500 GOSUB3100:IFC1$=VB$(16)ANDC2$=NN$(15)ANDOB(15)=0THENTT=TT-1
:GOTO2140:ELSE3520'5088
3520 PRINT:P$="UPP!TMPX-!DBQUBJO/!!ZPV!IBWF!!!!CFFO!DBQUVSFE-!BO
E!UIF!TIJQ!IBT!CFF0!MPTU"+CHR$(34):GOSUB450:GOTO1600'7360
4000 IFTD>0THENRETURNELSETD=TD+1+RND{0)'2577
4010 IFTD>0THENPRINT:P$="UPP!MBUF-IDBQUBJO"+CHR$(34):GOSUB450:P$
=EN$+"!XJMM!TPPO!CVSO!!!VQ!JO!UIF!QMBOFU(T!BUNPTQIFSF/!!HPPECZF-
1"+CP$:GOSUB450:GOSUB505:GOTO1600'10443
4020 IFSP=1THENPRINTSP$:PRINT"0NLY";-TD;"MINUTES":P$="V0UJM!PSCJ
U!EFDBZT/":GOSUB450'5139
4030 RETURN'349
5500 CLS:PRINT:PRINT:PRINT" CAPTAIN'S LOG, STARDATE 4295.3":PRIN
T:PRINT" YOU ARE CAPTAIN OF THE STARSHIPENTERPRISE AND AWOKE MOM
ENTS AGOTO FIND AN EMPTY SHIP. NO ONE RESPONDS - SPOCK, CHEKHO
V, SULU,SCOTTY, UHURU ..."'13079
5510 PRINT:PRINT" COULD THIS BE THE KLINGON'S FINAL VICTORY?
":PRINT:PRINT" PRESS ENTER, AND WELCOME TO-";:INPUTTT:RETURN'659
1
6000 CLS:PRINT" CONGRATULATIONS, CAPTAIN! YOU HAVE DEFEATED
THE KLINGONS, REPAIRED THE WARP DRIVE POWER, AND RETURNED THE
CREW SAFELY TO ";EN$?".":PRINT'9608
6010 PRINT"UHURU REPORTS THAT STAR FLEET HAS JUST SIGNALLED TH
AT YOU ARE TO RETURN WITH ";EN$:PRINT"FOR A WELL-EARNED SHORE LE
AVE ONTERRA SATEY, AFTER WHICH YOU ARETO BE PROMOTED TO COMMODOR
E.":PRINT'12712
6020 PRINT"YOUR MISSION SCORE IS"9*(SC-3*NM):GOTO1607'3441
8000 DZ=VARPTR(DM$):DY=PEEK(DZ+2)*256+PEEK(DZ+3):DZ=DY+6*(PL-1):
RETURN'5310
9999 END'192
10000 '
10001 ' TO GENERATE CHECKSUMS,
10002 ' APPEND LINES 63000-63070
10003 ' TO LINES 5-9999.
10004 ' THEN RUN 63000.
10005 '
63000 CL=PEEK(25)*256+PEEK(26}
63010 CLS:BN=BN+1:BT=0:PRINT" LINE","CHECKSUM":PRINT
63020 FORI=1TO10:CS=0:LN=PEEK(CL+2)*256+PEEK(CL+3)
63030 IFLN<63000THENPRINTLN,:NL=PEEK(CL)*256+PEEK(CL+1):ELSEI=11
:GOTO63060
63040 FORJ=CL+2TONL-1:IFPEEK(J)=58ANDPEEK(J+1)=131THENJ=NL:ELSEC
S=CS+PEEK(J)
63050 NEXTJ:PRINTCS:CL=NL:BT=BT+CS
63060 NEXTI:PRINT:PRINT"BLOCK";BN,BT:PRINT:IFLN>62999THENEND
63070 INPUT"PRESS ENTER TO CONTINUE";BT:GOTO63010
63500 P=VARPTR(DM$):K=PEEK(P+2)*256+PEEK(P+3)
63510 FORI=0TO40:PRINT: IFK9THENPRINT" ";
63520 PRINTI+1;"-";:FORJ=0TO5:PRINTPEEK(K+I*6+J)-35:NEXTJ,I
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Listing continued

OUR ISOLATORS FOR YOUR PROTECTION

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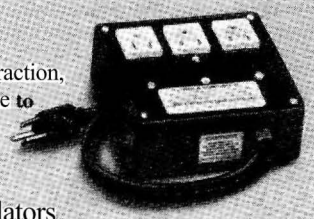

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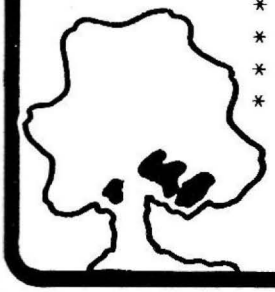

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Colorware researched the word processors available for the Color Computer. We came to the very same conclusion that so many review articles have! Telewriter-64 is, by far, the superior word processor for the Color Computer.

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Telewriter-64 is feature packed. Besides the standard features found in any word processor, Telewriter also includes: user-friendly full-screen editing, rapid cursor and scrolling control, page jump, right justification, menu-driven disk or cassette access, compatability with spelling checkers (such as Spell-and-Fix), and a clever double check that asks the user "Are you sure?" before executing any operation that would kill any sizeable amount of your text.

Telewriter-64 runs on any 16K, 32K, or 64K system (extended Basic not required) and works with any printer. It has all of the control codes necessary to take full advantage of all of the features in any printer. There is even a "typewriter" mode which sends typed lines directly to your printer.

With advanced word processing software such as this, your color computer becomes a truly powerful word processing system, with a price that makes sense for the personal user.

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From Spectral Associates, this "Pac" theme game is the best of it's type. Brilliant color, action and sound, just like an arcade gobble your way to glory, but watch for those ghosts! Get in on the wild fun of this game craze now. Tape: $21.95, Disk: $25.95

GHOST GOBBLER

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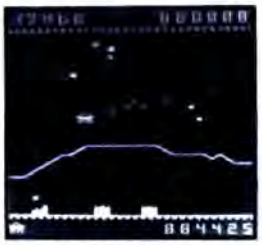
DONKEY KING

You simply can not buy a more impressive game for your color computer than this new wonder from Tom Mix. The graphics, sound, and animation are all just astonishing! There are four different graphic screens and each is endless fun. Requires 32K. Tape: $24.95, Disk: $27.95

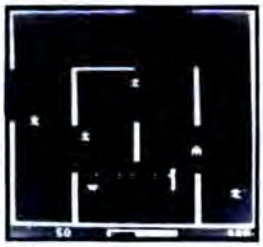


PROTECTORS

There are several good versions of the "Defender" theme available for the CoCo. None, however, rival this one from Tom Mix. No other game matches the detailed graphics and sheer excitement of this top seller. Requires 32K. Tape: $24.95, Disk: $27.95

CREATURE FEATURE

From Color Software, comes a lightening swift shoot & dodge the enemy game. It's clever cross between "Robotron" and "Beserk" themes, with bullets flying everywhere. Solid, shoot-em-up-fun. Requires 16K. Tape: $17.95. Disk: $19.95



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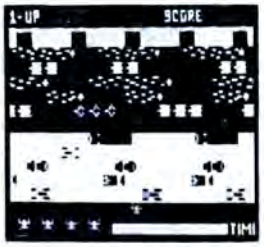
Spectral Associates' very well done "Berserk" type game with some interesting added features. Each cassette contains both the 16K and 32K version. The 32K version has voice output! Plenty of action. Tape: $21.95



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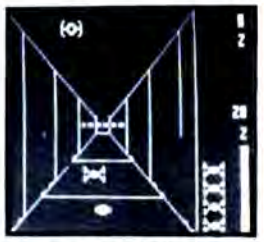
Just released by The Cornsoft Group, this is the officially licensed version from Sega, the arcade manufacturer. It has it all! 4 lane super highway, snakes, turtles, logs, alligators, etc. Lots of action and laughs! Requires 16K. Tape: $19.95



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BY MIKE RIGSBY

TALKING CALCULATOR

This software allows your 32K Extended Basic machine to operate as a four-function calculator that speaks English.

With the program, the computer says the numbers zero through nine, along with the functions plus, minus, times, divided by, and equal to when you press the corresponding key. It handles addition, subtraction, multiplication, or division of any two numbers, but it does not support exponents.

When you enter the first number, the computer says it one digit at a time. As you enter the rest of the operation, the computer says the mathematical operation sign, the second number, the equals sign, and the result. The program also displays the answer on the screen, then resets automatically and awaits the next problem.

Software is the key to teaching your computer to talk. Using this program is as easy as 1-2-3.

Program Listing 1. Talkcal

```
3 PCLEAR 1
5 CLS
10 CLEARS0,11000
15 DEFUSR1=12032
40 A$="":G$="":F$="":H$=""
42 CLS
45 P=0
50 B§=""
60 Y=0
70 A$=INKEY$
75 P=0
80 IF A$="" THEN 70
90 Y=Y+1
100 IF A$="/" THEN GOSUB 2000
110 IF A$="+" GOSUB 2000
120 IF A$="-" GOSUB 2000
140 IF A$="*" GOSUB 2000
150 T9=ASC(A$)
160 IF T9>45 ANDT9<58 THEN GOTO 1000
162 GOTO70
165 B$=B$+A$
170 GOTO 70
500 GOSUB 6550
510 RETURN
520 GOSUB 6710
530 RETURN
540 GOSUB 6630
550 RETURN
560 GOSUB 6590
570 RETURN
580 GOSUB 6150
590 RETURN
600 GOSUB 6190
```

Listing continued

How It Works

Operation of this "talking calculator" requires that you load the Basic program Talkcal (Program Listing 1) **and the** machine-language program Calc.

Developing Calc is rather involved and requires the use of Radio Shack's EDTASM+. In the editor mode, copy Program Listing 2, Talk, which is a modified version of a routine written by Richard Seymour. (See "Teach Your Computer to Talk," *80 Micro* Special Anniversary Issue, p. 472.) Assemble Talk in memory with the A/IM/AO command. Escape to Basic with the Q command.

Now enter Program Listing 3, Teach. Save this program to tape before running it. After loading Teach, make a digital recording of the words that you want the calculator to say. Although you can use a tape recorder for voice input, I had better results with an inexpensive microphone and external amplifier (Radio Shack 277-1008). Input from the amplifier or tape recorder comes through the black plug in the cassette cable.

System Requirements

32KRAM
Extended Color Basic

Listing continued

```
610 RETURN
620 GOSUB 6230
630 RETURN
640 GOSUB6270
650 RETURN
660 GOSUB 6310
670 RETURN
680 GOSUB 6670
690 RETURN
700 GOSUB 6390
710 RETURN
720 GOSUB 6430
730 RETURN
740 GOSUB 6470
750 RETURN
760 GOSUB 6510
770 RETURN
780 GOSUB 6750
790 RETURN
1000 IF A$="1" THEN R=580
1010 IF A$="2" THEN R=600
1020 IF A$="3" THEN R=620
1040 IF A$="4" THEN R=640
1050 IF A$="5" THEN R=660
1060 IF A$="6" THEN R=680
1070 IF A$="7" THEN R=700
1080 IF A$="8" THEN R=720
1090 IF A$="9" THEN R=740
1100 IF A$="0" THEN R=760
1105 IF A$="." THEN R=780
1110 IF R=580 GOSUB 580
1112 IF R=600 GOSUB 600
1114 IF R=620 GOSUB 620
1116 IF R=640 GOSUB 640
1118 IF R=660 GOSUB 660
1120 IF R=680 GOSUB 680
1122 IF R=700 GOSUB 700
1124 IF R=720 GOSUB 720
1126 IF R=740 GOSUB 740
1128 IF R=760 GOSUB 760
1129 IF R=780 GOSUB 780
1130 IF P=0 THEN 165
1135 IF P=2 THEN RETURN
1140 GOTO 2210
2000 IF A$="+" GOSUB 500
2010 IF A$="/" GOSUB 520
2020 IF A$="-" GOSUB 540
2040 IF A$="*" GOSUB 560
2045 R$=A$
2050 Z=1
2060 C$=MID$(B$,Z,1)
2070 D$=D$+C$
2080 Z=Z+1
2090 IF Z=Y THEN 2110
2100 GOTO 2060
2110 C=VAL(D$)
2115 C8=C
2116 PRINT C
2120 Y=0
2130 D$=A$
2140 B$=""
2150 A$=INKEY$
2160 IF A$="" THEN 2150
2170 Y=Y+1
2180 IF A$="=" THEN 3000
2190 T8=ASC(A$)
2200 IF T8>45 AND T8<58 THEN GOTO 2205
2202 GOTO 2150
2205 P=1
2207 B$=B$+A$:GOSUB 1000
2210 GOTO 2150
3000 Z=1
3002 GOSUB6350
3010 F$=MID$(B$,Z,1)
3020 G$=G$+F$
3030 Z=Z+1
3040 IF Z=Y THEN 3060
3050 GOTO 3010
3060 G=VAL(G$)
3065 C=C8
3070 IF R$="*" THEN H=C*G
3080 IF R$="+" THEN H=C+G
3090 IF R$="-" THEN H=C-G
3100 IF R$="/" THEN H=C/G
3110 H$=STR$(H)
3120 PRINT H$
3130 Y=LEN(H$)
```

Listing continued

See List of Advertisers on page 130

Listing continued

```
3140 Y1=2
3150 A$=MID$(H$,Y1,1)
3160 PRINT A$
3170 P=2
3175 GOSUB1000
3180 IF Y1=Y THEN 3
3190 Y1=Y1+1
3200 GOTO 3150
5040 B=&H2F:C=&H44:D=&H32:E=&HC8
5050 RETURN
5060 B=&H2A:C=&HF8:D=&H2E:E=&HDF
5070 RETURN
5080 B=&H32:C=&HC8:D=&H36:E=&HB0
5090 RETURN
5100 B=&H36:C=&HB0:D=&H3A:E=&H98
5110 RETURN
5120 B=&H3A:C=&H98:D=&H3E:E=&H80
5130 RETURN
5140 B=&H3E:C=&H80:D=&H42:E=&H68
5150 RETURN
5160 B=&H42:C=&H68:D=&H46:E=&H50
5170 RETURN
5180 B=&H46:C=&H50:D=&H4E:E=&H20
5190 RETURN
5200 B=&H4E:C=&H20:D=&H52:E=&H08
5210 RETURN
5220 B=&H52:C=&H08:D=&H55:E=&HF0
5230 RETURN
5240 B=&H55:C=&HF0:D=&H5D:E=&HC0
5250 RETURN
5260 B=&H5D:C=&HC0:D=&H61:E=&HA8
5270 RETURN
5280 B=&H61:C=&HA8:D=&H65:E=&H90
5290 RETURN
5300 B=&H65:C=&H90:D=&H6D:E=&H60
5310 RETURN
5320 B=&H6D:C=&H60:D=&H75:E=&H30
5330 RETURN
5340 B=&H75:C=&H30:D=&H7D:E=&H00
5350 RETURN
5980 POKE &H2F16,B
5990 POKE &H2F17,C
6000 POKE &H2F2A,D
6010 POKE &H2F2B,E
6020 RETURN
6030 A=USR0(0)
6040 RETURN
6050 A=USR1(0)
6060 RETURN
6070 GOSUB 5340
6080 GOSUB 5930
6090 INPUT"DIVIDED BY";A$
6100 GOSUB 6030
6110 GOSUB 5060
6120 GOSUB 5930
6130 INPUT"POINT";A$
6140 GOSUB 6030
6150 GOSUB 5040
6160 GOSUB 5980
6180 GOSUB 6050
6185 RETURN
6190 GOSUB 5080
6200 GOSUB 5980
6220 GOSUB 6050
6225 RETURN
6230 GOSUB 5100
6240 GOSUB 5980
6260 GOSUB 6050
6265 RETURN
6270 GOSUB 5120
6280 GOSUB 5980
6300 GOSUB 6050
6305 RETURN
6310 GOSUB 5140
6320 GOSUB 5980
6340 GOSUB 6050
6345 RETURN
6350 GOSUB 5160
6360 GOSUB 5980
6380 GOSUB 6050
6385 RETURN
6390 GOSUB 5180
6400 GOSUB 5980
6420 GOSUB 6050
6425 RETURN
6430 GOSUB 5200
6440 GOSUB 5980
6460 GOSUB 6050
6465 RETURN
6470 GOSUB 5220
6480 GOSUB 5980
6500 GOSUB 6050
6505 RETURN
6510 GOSUB 5240
6520 GOSUB 5980
6540 GOSUB 6050
6545 RETURN
6550 GOSUB 5260
6560 GOSUB 5980
6580 GOSUB 6050
6585 RETURN
6590 GOSUB 5280
6600 GOSUB 5980
6620 GOSUB 6050
6625 RETURN
6630 GOSUB 5300
6640 GOSUB 5980
6660 GOSUB 6050
6665 RETURN
6670 GOSUB 5320
6680 GOSUB 5980
6700 GOSUB 6050
6705 RETURN
6710 GOSUB 5340
6720 GOSUB 5980
6740 GOSUB 6050
6745 RETURN
6750 GOSUB 5060
6760 GOSUB 5980
6780 GOSUB 6050
6785 RETURN
6790 INPUT-HEAR AGAIN",-A$
6800 IF A$="N" THEN 5360
6810 GOTO 6170
```

Teach requests each word, but does not record your voice until you press enter. After you have recorded all the words, the program displays the question "Hear again?". If you answer N, you can record the words again. Any other answer allows you to hear the previous recording. When all the words sound intelligible, press break, and type EXEC 49152. This returns you to the editor mode. Now press Z and enter, and prepare the tape recorder to store a program. Enter the following line:

P CALC 2AF8 7D00 2AF8

Record this two or three times on different tapes to ensure a good save.

Talkcal uses a major part of the code in Teach. Lines 3-15 clear needed memory and define an entry point for the machine-language program. Lines 40-80 monitor the keyboard for input; the program stays here if there is no input. If there is an input, line 90 stores the length of that number. Lines 100-140 move program control to a new area (line 2000) if the input calls for a function. Lines 150-162 test to see if the input is valid (i.e., not a letter) and advance control to line 1000 if they establish validity. Lines 1000-1129 sort the number and branch to a subroutine to cause speech.

For example, if the number is 4, the program goes to line 640, then to line 6270, which sends control to line 5120. This line sets up values for B, C, D, and E. These represent the starting and ending addresses for the memory-storage area that holds the digital recording of the word *four*. Line 5130 returns to line 6280, which then goes to line 5980. Lines 5980-6010 insert the starting and ending address values for *four* into the machine-language program. Line 6020 returns to line 6300. This line goes to line

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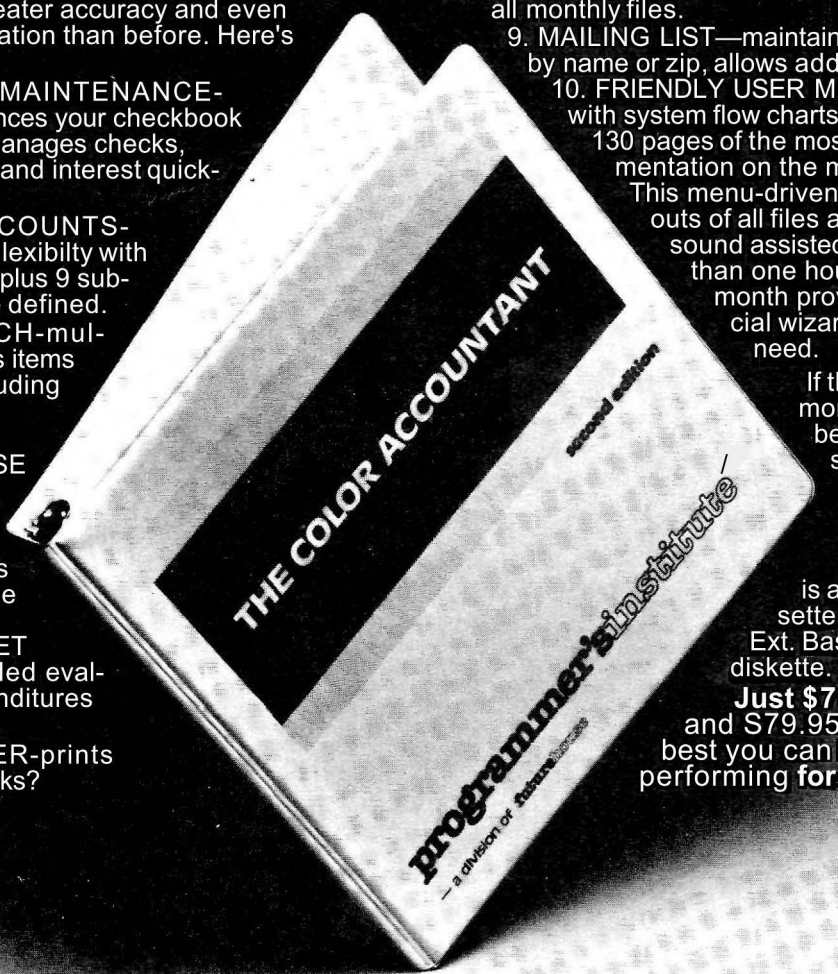

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6050, which executes the machine-language program (speaks the word *four)* and returns to line 6060, which returns to line 6305, which returns to line 650, which returns to line 1118.

Line 1130 returns control to line 165 if you have not entered a function sign. Line 165 adds the latest keyboard entry to the string being held (B$) for calculation. Line 170 jumps to line 70, which waits for another keyboard entry.

If you press a function key (+, -, *, /), control moves you to line 2000. Lines 2000-2040 cause the computer to say the function. Line 2045 stores the type of function in the variable R$. Lines 2050-2110 reverse the order of B$ and store it in D$, then convert this string to a number represented by the variable C. Line 2115 saves C in variable C8. Line 2116 prints C, the first number in the calculation. Line 2130 sets D$ equal to A$, while lines 2140-2202 check the keyboard for input numbers and validity.

If you press the equals sign, control moves to line 3000, which performs the calculation. If you press a valid number, control moves to line 2205, which sets P equal to 1. Line 2207 adds the latest number received to the string (B$) that formulates the second number involved in the calculation. The program passes control to subroutine 1000, which says the number you pressed. Because P equals 1, the program passes through lines 1130 and 1135-1140 and then to line 2210. This line returns you to line 2150, which scans the keyboard.

When line 2180 finds an equals sign, control passes to line 3000, which sets the variable Z. This variable enables the reversal of the B$ string. Line 3002 goes to line 6350 and speaks the word *equals.* Lines 3010-3060 reverse the order of B$ and assign the string value to the variable G. Line 3065 lets C equal C8, the value of the first number. Lines 3070-3100 determine which function to perform and then perform it, with H holding the value of the answer. Line 3110 converts the numeric value to a string, which H$ represents. Line 3120 displays this value (the answer) on the video display. Line 3130 determines the length of the answer, while line 3140 sets the value of the position of the spoken answer. Line 3150 pulls a character from the answer string, and line 3160 prints that character on the video screen.

Line 3170 sets a value of P so that the subroutine at line 1000 (to which line 3175 jumps) returns to line 3180 after speaking the number. If the program has spoken the entire answer, line 3180 sends control to line 3 for a new problem. If the answer is not complete, line 3190 increases the Y1 counter (used to peel numbers from the answer string), and line 3200 moves control to line 3150, where this peeling takes place.

So now you have it—a relatively easy way to create a talking Color Computer, without the expense of a speech synthesizer. •

Address correspondence to Mike Rigsby, 5164 Sunburst Drive, Norcross, GA 30092.

Decimal	Hex	Contents
11000	2AF8	
11999	2EDF	Point
12000	2EE0	
12100	2F44	Talk Program
12100	2F44	
13000	32C8	One
13000	32C8	
14000	36B0	Two
14000	36B0	
15000	3A98	Three
15000	3A98	
16000	3E80	Four
16000	3E80	
17000	4268	Five
17000	4268	
18000	4650	Equals
18000	4650	
20000	4E20	Seven
20000	4E20	
21000	5208	Eight
21000	5208	
22000	55F0	Nine
22000	55F0	
24000	5DC0	Zero
24000	5DC0	
25000	61A8	Plus
25000	61A8	
26000	6590	Times
26000	6590	
28000	6D60	Minus
28000	6D60	
30000	7530	Six
30000	7530	
32000	7D00	Divided by

Table 1. Memory Map of Talkcal

```
2EE0                    00090          ORG     12000
2EE0 1A   50          00100 RECORD ORCC    #$50
2EE2 CE   FF20        00110          LDO     #$FF20
2EE5 8E   2F44        00120          LDX     #12100
2EE8 86   01          00130          LDA     #$01
2EEA 5F               00140 HIGH     CLRB
2EEB 5C               00150 HLOOP    INCB
2EEC A5   C4          00160          BITA    ,U
2EEE 26   FB          00170          BNE     HLOOP
2EF0 E7   80          00180          STB     ,X+
2EF2 5F               00190          CLRB
2EF3 5C               00200 LOW      INCB
2EF4 A5   C4          00210          BITA    ,U
2EF6 27   FB          00220          BEQ     LOW
2EF8 E7   80          00230          STB     ,X+
2EFA 8C   32C8        00240          CMPX    #13000
2EFD 25   EB          00250          BLO     HIGH
2EFF 39               00255          RTS
2F00 1A   50          00260 PLAY     ORCC    #$50
2F02 CE   FF20        00270          LDD     #$PF20
2F05 6F   43          00280          CLR     3,U
2F07 CC   F83C        00290          LDD     #$F83C
2F0A A7   42          00300          STA     2,U
2F0C E7   43          00310          STB     3,U
2F0E CC   B435        00320          LDD     #$B435
2F11 A7   5D          00330          STA     -3,U
2F13 E7   5F          00340          STB     -1,U
2F15 8E   2F44        00350          LDX     #12100
2F18 86   60          00360 HIOUT    LDA     #$60
2P1A E6   80          00370          LDB     ,X+
2F1C A7   C4          00380 HILOOP   STA     ,U
2F1E 5A               00390          DECB
2F1F 26   FB          00400          BNE     HILOOP
2F21 4F               00410          CLRA
2F22 E6   80          00420          LDB     ,X+
2F24 A7   C4          00430 LOLOOP   STA     ,U
2F26 5A               00440          DECB
2F27 26   FB          00450          BNE     LOLOOP
2F29 8C   32C8        00460          CMPX    #13000
2F2C 25   EA          00470          BLO     HIOOT
2F2E 39               00480          RTS
MISSING END
00001 TOTAL ERRORS

HIGH      2EEA
HILOOP    2F1C
HIOOT     2F18
HLOOP     2EEB
LOLOOP    2F24
LOW       2EF3
PLAY      2F00
RECORD    2EE0
```

Program Listing 2. Talk

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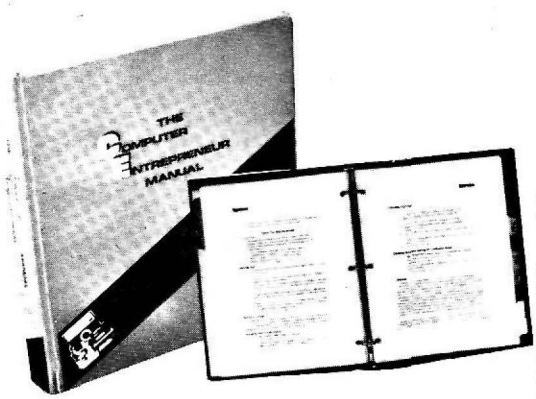

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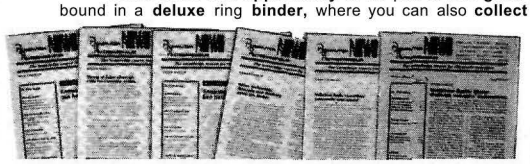

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HC0883

```
5000 CLEAR 200,11000
5010 DEFUSR0=12000
5020 DEFUSR1=12032
5030 GOTO 5360
5040 B=&H2F:C=&H44:D=&H32:E=&HC8
5050 RETURN
5060B=&H2A:C=&HF8JD=&H2E:E=&HDF
5070 RETURN
5080 B=&H32:C=&HC8:D=&H36:E=&HB0
5090 RETURN
5100 B=&H36:C=&HB0:D=&H3A:E=&H98
5110 RETURN
5120 B=&H3A:C=&H98:D=&H3E:E=&H80
5130 RETURN
5140 B=&H3E:C=&H80:D=&H42:E=&H68
5150 RETURN
5160 B=&H42:C=&H68:D=&H46:E=&H50
5170 RETURN
5180 B=&H46:C=&H50:D=&H4E:E=&H20
5190 RETURN
5200 B=&H4E:C=&H20:D=&H52:E=&H08
5210 RETURN
5220 B=&H52:C=&H08:D=&H55:E=&HF0
523 0 RETURN
5240 B=&H55:C=&HF0:D=&H5D:E=&HC0
5250 RETURN
5260 B=&H5D:C=&HC0:D=&H61:E=&HA8
5270 RETURN
5280 B=&H61:C=&HA8:D=&H65:E=&H90
5290 RETURN
5300 B=&H65:C=&H90:D=&H6D:E=&H60
5310 RETURN
5320 B=&H6D:C=&H60:D=&H75:E=&H30
5330 RETURN
5340 B=&H75:C=&H30:D=&H7D:E=&H00
5350 RETURN
5360 GOSUB5040
5370 GOSUB 5930
5380 INPUT"ONE";A$
5390 A=USR0(0)
5400 GOSUB 5080
5410 GOSUB 5930
5420 INPUT"TWO";A$
5430 A=USR0(0)
5440 GOSUB 5100
5450 GOSUB 5930
5460 INPUT"THREE";A$
5470 GOSUB 6030
5480 GOSUB 5120
5490 GOSUB 5930
5500 INPUT"FOUR";A$
5510 GOSUB 6030
5520 GOSUB 5140
5530 GOSUB 5930
5540 INPUT "FIVE";A$
5550 GOSUB 6030
5560 GOSUB5160
5570 GOSUB 5930
5580 INPUT"EQUALS";A$
5590 GOSUB 6030
5600 GOSUB 5180
5610 GOSUB 5930
5620 INPUT"SEVEN";A$
5630 GOSUB 6030
5640 GOSUB 5200
5650 GOSUB 5930
5660 INPUT"EIGHT";A$
5670 GOSUB 6030
5680 GOSUB 5220
5690 GOSUB 5930
5700 INPUT"NINE";A$
5710 GOSUB 6030
5720 GOSUB 5240
5730 GOSUB 5930
5740 INPUT"ZERO";A$
5750 GOSUB 6030
5760 GOSUB 5260
5770 GOSUB 5930
5780 INPUT"PLUS";A$
5790 GOSDB 6030
5800 GOSUB 5280
5810 GOSUB 5930
5820 INPUT"TIMES";A$
5830 GOSUB 6030
5840 GOSUB 5300
5850 GOSUB 5930
5860 INPUT"MINUS";A$
5870 GOSUB 6030
5880 GOSUB 5320
5890 GOSUB 5930
5900 INPUT"SIX";A$
5910 GOSUB 6030
5920 GOTO 6070
5930 POKE&H2EE6,B
5940 POKE&H2EE7,C
5950 POKE&H2EFB,D
5960 POKE&H2EFC,E
5970 RETURN
5980 POKE &H2F16,B
5990 POKE &H2F17,C
6000 POKE &H2F2A,D
6010 POKE &H2F2B,E
6020 RETURN
6030 A=USR0(0)
6 040 RETURN
6050 A=USR1(0)
606 0 RETURN
6070 GOSUB 5340
6080 GOSUB 5930
6090 INPUT"DIVIDED BY";A$
6100 GOSUB 6030
6110 GOSUB 5060
6120 GOSUB 5930
6130 INPUT"POINT";A$
6140 GOSUB 6030
6150 GOSUB 5040
6160 GOSUB 5980
6170 INPUT"ONE";A$
6180 GOSUB 6050
6190 GOSUB 5080
6200 GOSUB 5980
6210 INPUT-TWO"?A$
6220 GOSUB 6050
6230 GOSUB 5100
6240 GOSUB 5980
6250 INPUT "THREE";A$
6260 GOSUB 6050
6270 GOSUB 5120
6280 GOSUB 5980
6290 INPUT"FOUR";A$
6300 GOSUB 6050
6310 GOSUB 5140
6320 GOSUB 5980
6330 INPUT"FIVE";A$
6340 GOSUB 6050
6350 GOSUB 5160
6360 GOSUB 5980
6370 INPUT"SIX";A$
6380 GOSUB 6050
6390 GOSUB 5180
6400 GOSUB 5980
6410 INPUT"SEVEN";A$
6420 GOSUB 6050
6430 GOSUB 5200
6440 GOSUB 5980
6450 INPUT"EIGHT";A$
6460 GOSUB 6050
6470 GOSUB 5220
6480 GOSUB 5980
6490 INPUT-NINE";A$
6500 GOSUB 6050
6510 GOSUB 5240
6520 GOSUB 5980
6530 INPUT"ZERO";A$
6540 GOSUB 6050
6550 GOSUB 5260
6560 GOSUB 5980
6570 INPUT"PLUS";A$
6580 GOSUB 6050
6590 GOSUB 5280
6600 GOSUB 5980
6610 INPUT"TIMES";A$
6620 GOSUB 6050
6630 GOSUB 5300
6640 GOSUB 5980
6650 INPUT"MINUS";A$
6660 GOSUB 6050
6670 GOSUB 5320
6680 GOSUB 5980
6690 INPUT"EQUALS";A$
6700 GOSUB 6050
6710 GOSUB 5340
6720 GOSUB 5980
6730 INPUT"DIVIDED BY";A$
6740 GOSUB 6050
6750 GOSUB 5060
6760 GOSUB 5980
6770 INPUT-POINT";A$
6780 GOSUB 6050
6790 INPUT-HEAR AGAIN";A$
6800 IF A$="N" THEN 5360
6810 GOTO 6170
```

Program Listing 3. Teach

COCOCOPY

This all M/L Program will copy BASIC or M/L programs including most Auto Start Programs. It will supply the beginning, ending and offset addresses and allow you to change the load address for M/L programs. I/O errors are ignored so that bad tapes can be corrected. Programs can be renamed and the motor/audio functions are controlled from the keyboard.
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BY WILLIAM H. RONEY

COLOR COMPUTER ART

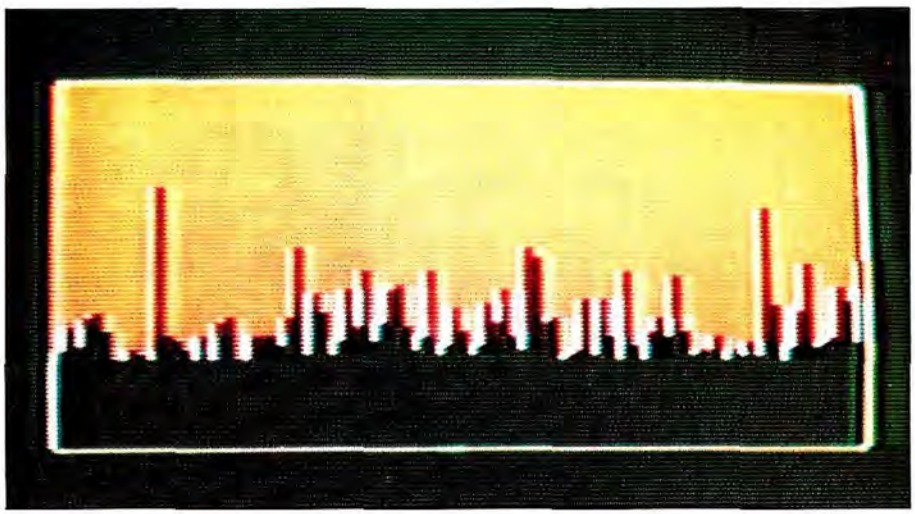

Photo 1. Skyline

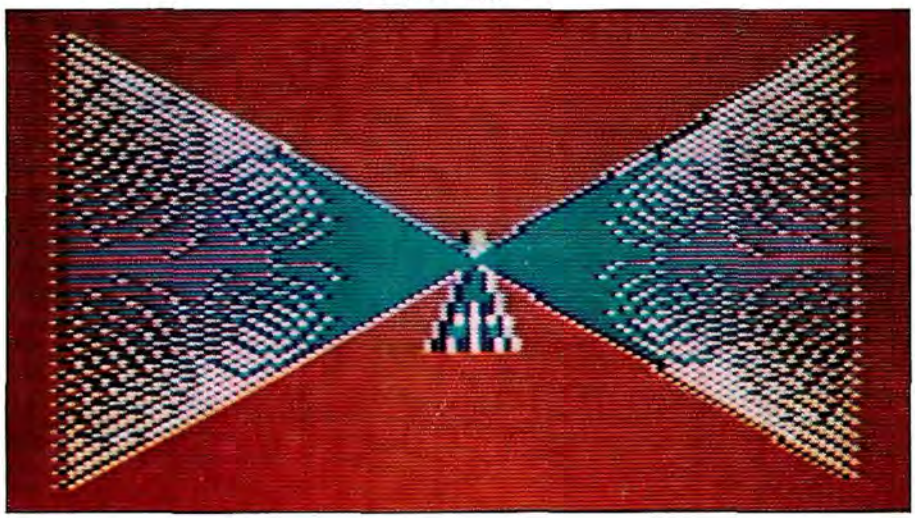

Photo 2. Eagle

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After several years of running graphics programs from computer magazines and books, I was suddenly seized by an attack of videoitis. I had gone almost blind squinting at the small print of program listings. My nervous system had been shattered by the frenzied excitement of galactic encounters, and my right hand suffered jerks and tremblings from clutching the joystick for countless hours on end. I was left with a desperate longing for something else.

I asked myself, "Can't I create anything artistic with my TRS-80 other than Indian blankets, painted lace, useless boxes, and flashing kaleidoscopes? How much longer must I put up with plaids and moires, and ostrich feathers that no ostrich would dare claim?"

My attempt to answer these questions boiled down to a powerful decision: Put

System Requirements

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Extended Color Basic

Setting The Standards

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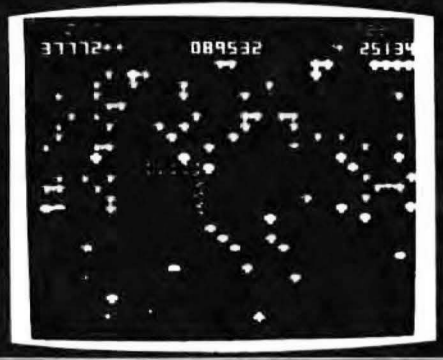

COLORPEDE

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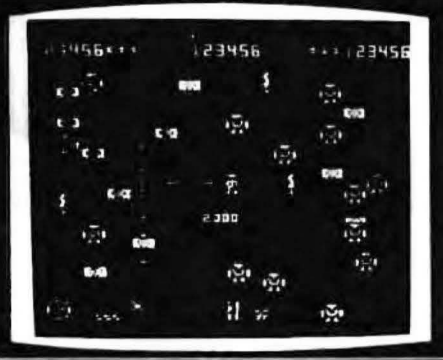

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away those computer magazine programs and strike off on a new course.

Well, this is that new course. I'm presenting eight programs of what I think of as real computer art. Mind you, I don't regard them as being in a class with Rembrandt, Dali, Grandma Moses, or any such gifted soul. They are simply offered as very unprofessional models for computer buffs who want to learn to create their own computer art.

To move in this direction, we should first recognize that in the products of Basic commands such as CIRCLE, LINE, SIN, and COS, there is little that can be called true art. At best, they are simply the tools of the computer, but they are also the materials that go into an artistic creation. They are like the brushes, paints, and canvas that an artist uses.

```
10 REM***LISTING 1  SKYLINE
20  PMODE 4,1:PCLS:SCREEN 1,1
30  LINE(10,10)-(245,180),PSET,B
40  LINE(30,30)-(225,110),PSET,B
50  FOR X=30 TO 225 STEP 2
60  FOR Y=30 TO RND(90)  STEP 1
70  LINE(X,Y)-(X,Y),PSET
80  NEXT Y,X
90  GOTO 50
```

Program Listing 1. Skyline

Too many programs produce doodling just for the fascination of doodling. Other programs create an exhibit of technical skills, flashy color patterns, and exotic special effects.

When you are in the mood to create mature computer art, I suggest that you visualize a scene or other subject, first in your mind, and then on the TV screen. You don't have to be an artist; the computer can compensate for your artistic deficiencies.

"... visualize a scene or other subject."

What you visualize doesn't have to be elaborate. It can be just a plain fence running across the screen. Then decide what Basic commands, functions, and statements will approximate the elements that will compose your subject. You can refine it later. Avoid special effects that are likely to draw undue attention to themselves. If you do use these effects (such as a hunchbacked caterpillar made with a trigonometry formula), do so purposefully to enhance your creation.

Preferably use the simplest program commands and statements that will do the job. If you learn simplicity of programming now, you'll be better able to write understandable programs for others, if you become so inclined.

With these thoughts in mind, try out the examples I have given. But take care to understand their logic and application as you go along, else you'll be doing a lot of copying, but you'll learn little.

The eight programs in the listings all employ PMODE 4,1:PCLS:SCREEN 1,1 to produce a velvety black background and a buff (white) graphics foreground. This not only gives a striking effect, but the highest resolution (sharpest detail and clarity) on the TRS-80 Color Computer. It precludes coloring with the PAINT command. However, there is a lot of color introduced by a "color fringe effect" of

```
10 REM***LISTING 2  OVER THE MOON
20  PMODE 4,1:PCLS:SCREEN 1,1
30  LINE(10,15)-(240,175),PSET,B
40  REM**MYTHICAL BIRD:BODY, NECK, HEAD
50  LINE(40,45)-(165,45),PSET
60  LINE(45,44)-(55,44),PSET
70  LINE(47,43)-(53,43),PSET
80  LINE(49,42)-(51,42),PSET
90  REM**WING(S)
100  FOR Y=46 TO 100 STEP 5
110  LINE(60,46)-(165,Y),PSET
120  NEXT Y
130  REM**MOON
140  FOR R=0 TO 30
150  CIRCLE(125,95),R
160  NEXT R
999  GOTO 999
```

Program Listing 2. Over the Moon

```
10 REM**LISTING 3  EAGLE
20  PMODE 4,1:PCLS:SCREEN 1,1
30  REM**FRAME
40  LINE(10,15)-(245,175),PSET,B
50  REM**BODY
60  FOR R=0 TO 5 STEP 2
70  CIRCLE(128,95),R,1,1.5
80  NEXT R
90  REM**LEFT WING
100  FOR Y=45 TO 145 STEP 3
110  LINE(128,95)-(30,Y),PSET
120  NEXT Y
130  REM**RIGHT WING
140  FOR Y=45 TO 145 STEP 3
150  LINE(128,95)-(220,Y),PSET
160  NEXT Y
170  REM**TAIL
180  FOR X=118 TO 138 STEP 3
190  LINE(128,95)-(X,115),PSET
200  NEXT X
999  GOTO 999
```

Program Listing 3. Eagle

Program Listing 4. Japanese Scene

```
10 REM***LISTING 4  JAPANESE SCENE
20  PMODE 4,1:PCLS:SCREEN 1,1
30  REM**BRIDGE:RAIL AND DECK
```

↙See *List of Advertisers on page 130*

Listing continued

```
40 FOR Y=135 TO 136
50 CIRCLE(125,Y),90,1,.25,.6,.9
60 NEXT Y
70 FOR Y= 143 TO 146
80 CIRCLE(125,Y),90,1,.25,.6,.9
90 NEXT Y
100 REM**BRIDGE: POSTS AND BRACES
110 LINE(51,120)-(51,140),PSET
120 LINE(52,120)-(52,140),PSET
130 LINE(195,120)-(195,140),PSET
140 LINE(197,120)-(197,140),PSET
150 LINE(124,113)-(124,125),PSET
160 LINE(125,113)-(125,124),PSET
170 LINE(85,118)-(85,126),PSET
180 LINE(86,118)-(86,126),PSET
190 LINE(160,118)-(160,126),PSET
200 REM**BRIDGE:POST LAMPS
210 CIRCLE(51,118),3
220 CIRCLE(196,118),3
230 REM**HORIZON
240 LINE(5,100)-(12,100),PSET
250 LINE(17,100)-(33,100),PSET
260 LINE(35,100)-(250,100),PSET
270 REM**WATER LILLIES (RERUN UNTIL SATISFIED WITH
280 REM**NUMBER AND PATTERN
290 X=55 + RND(140)
300 Y=140 + RND(45)
310 FOR R=2 TO 6 STEP 2
320 CIRCLE(X,Y),R,1,.4
330 NEXT R
340 REM**CONTROL OF NUMBER AND PATTERN OF LILLIES
350 IF X<65 THEN GOTO 370
360 GOTO 290
370 REM**SHRINE GATE
380 LINE(15,115)-(15,65),PSET
390 LINE(35,115)-(35,65),PSET
400 R=80
410 CIRCLE(25,5),R,1,.75,.21,.30
420 CIRCLE(25,8),R,1,.75,.21,.30
430 CIRCLE(25,20),R,1,.75,.21,.30
440 CIRCLE(25,35),R,1,.75,.21,.30
450 REM**SETTING SUN
460 FOR R=0 TO 10 STEP 2
470 CIRCLE(145,100),R,1,1,.5,0
480 NEXT R
490 REM**MOUNTAIN
500 FOR X=205 TO 255 STEP 3
510 LINE(255,80)-(X,100),PSET
520 NEXT X:REM**STOP HERE IF FOLLOWING SUNRAYS
530 REM**NOT DESIRED, AND FINISH WITH 999 GOTO 999
540 REM**SUNRAYS (OPTIONAL FOR SUN RISE)
550 FOR X=40 TO 250 STEP 25
560 FOR Y=0 TO 100 STEP 25
570 LINE(X,Y)-(145,100),PSET
580 NEXT Y,X
999 GOTO 999
```

Listing continued

most TVs. (Jake Commander explains this effect nicely on page 114 of the June/July 1982 issue of *80 Micro.)* You can control it only to a limited extent, by such means as adjusting the color controls of your TV.

At the end of the textual coverage of Eagle, Program Listing 3; Japanese Scene, Program Listing 4; and Cottage Program Listing 6 are instructions for brief modification of each program, to enable you to color the scene. This modification uses the COLOR command rather than the PAINT command, which requires tightly closed boundaries of the areas to be painted. Most of the other programs have few if any such boundaries. Even if they did, you would probably have to include as many PAINT statements as there are areas to be painted, which would be impractical.

Also, the PAINT procedure can get tricky and confusing if you are not moderately familiar with it. Using the COLOR command is much simpler, and for some types of art it produces even more striking effects. But if you insist on painting, do so at the high risk of the paint leaking into forbidden areas, and sometimes even covering your entire TV screen.

A Few More Points

Again, when you create your own art programs, first visualize what you have in mind. It will often be necessary to make a rough drawing of your idea on graph paper so that you can readily identify coordinate points when you compose the program.

Sometimes, however, just doodling with odd Basic statements gives ideas that aid in producing good art results. This is doodling with a purpose, but don't stop with just doodling. Keep a record of your purposeful doodles; they can become handy as parts of a composite art program.

Don't assume that you need complex program statements, such as mathematical formulas. Once in a while they have their place, but I don't see them used frequently. They are rarely necessary for effective art results in Basic.

Keep in PMODE 4 if you want high-resolution graphics; PMODEs 1 and 3 are necessary for coloring and painting, but lack fine detail appropriate to some types of art.

Finally, I strongly recommend *Color Computer Graphics* (Tandy Corp., 1982) by William Barden, Jr., one of the most informative publications on color graphics to come to my attention. Digest the fundamentals of this work as

✓See *List of Advertisers on page 130*

a basis for your computer art, get your imagination to work, and you'll be on your way to creating mature computer art.

The Programs

Program Listing 1, Skyline, lets you imagine you are inside a building, looking out a window and viewing a developing city skyline. It is quite simply made by using the LINE command and RND function.

The buildings are not directly produced. Rather, the spaces between them are carved out with line 70. What's left are the silhouetted buildings of random heights. Let the program run a few times to reduce the tall buildings to more realistic heights.

To give different effects, change the step interval of line 60 to STEP 2, which will cause it to appear as though you are looking through a Venetian blind. Then change the steps of lines 50 and 60 to STEP 1, which will produce multicolored, tall fantasy buildings reflecting the setting sun.

For each combination, again let the program run a few times to reduce the heights of the buildings. In all cases, adjust the color controls of your TV to suit your taste.

This program develops very slowly. But remember, patience is one of the ingredients of art. This is no video arcade game of lightning speed.

Program Listing 2, Over the Moon, is more fanciful, and is simply created by the LINE and CIRCLE commands. I have the feeling the queer bird emerged from Greek mythology. The freckles on the face of the moon are not my idea. My TV thought they would look splendid and color-fringed them.

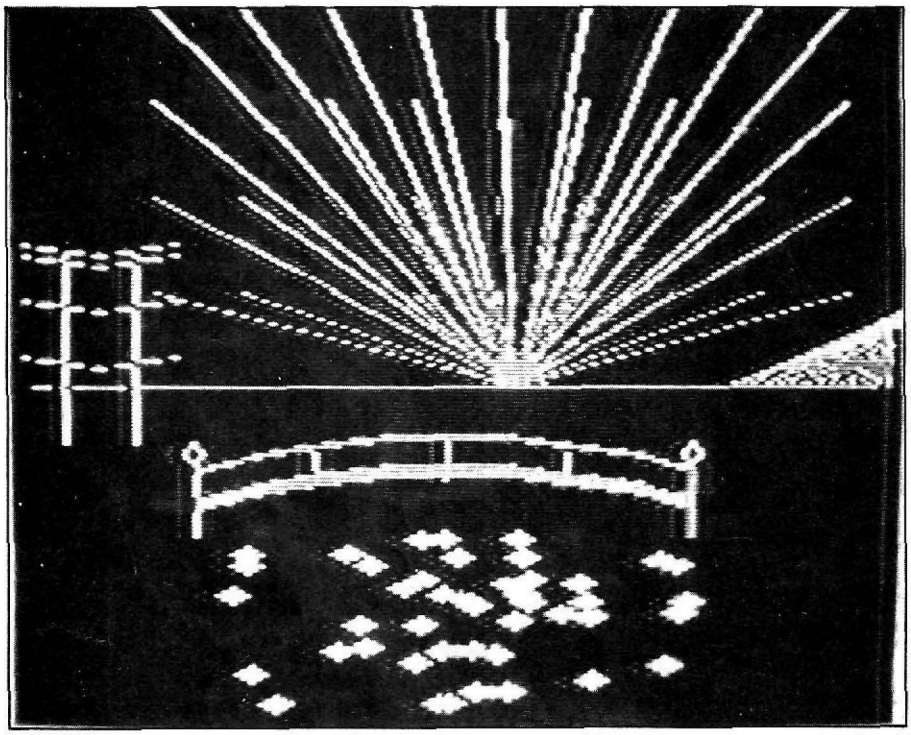


Photo 3. Japanese Scene

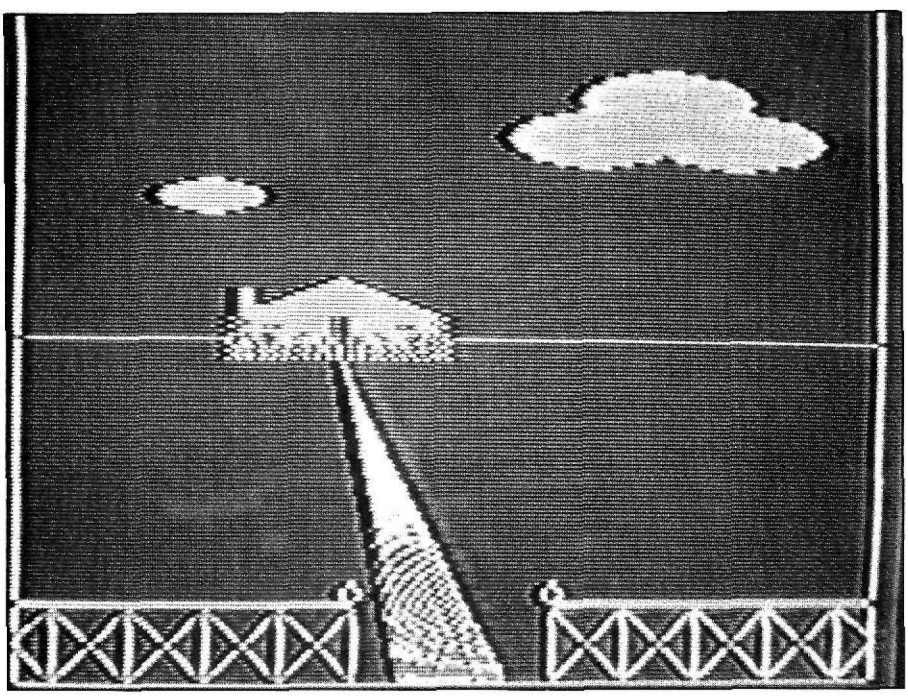


Photo 4. Cottage

".. .patience is one of the ingredients of art."

Program Listing 3, Eagle, is another example of what I think of as "scanning." (Maybe there ought to be a key word "SCAN" in Basic.) The eagle is another queer bird, numbered among the endangered species, so handle him carefully. He basically requires just three LINE commands to scan his wings and tail, and a CIRCLE squeezed into an ellipse for his body.

If you change the step intervals of lines 100 and 140 to STEP 4 or more, he'll become more feathery. You might try to alter this bird to look more like a real eagle. His wings do need a clipping here and there.

For a different color effect, change line 20 to PMODE3,1:PCLS 3:SCREEN 1,0, and add line 25 which should read COLOR 2,3. For a variation of this effect, adjust your TV color tint control.

Program Listing 4, Japanese Scene, is more elaborate than the first three. Yet, it is made chiefly by CIRCLE and LINE commands. Note that the deck and rail of the bridge are formed by wide arcs of two ellipses derived from CIRCLE commands, each circle having a very large radius. Part of the shrine gate also employs elliptical arcs, and the water lilies are elliptical figures.

Note that the number and pattern of the water lilies are controlled by the RND statements of lines 290 and 300, and the limiting statement in line 350. The number and pattern of the lilies can

be partially controlled by running the program a few times to suit your taste. They can become prolific if the RND command doesn't soon plant one of them close to the invisible shore of the lake.

You can have a setting sun (line 450), or a sunrise (line 540), at your option.

You might choose to omit the mountain and add other things to the scene, such as a cloud or two. (Hint: to make clouds, see Listing 6.) It's yours from here on out. Experiment with it.

For different color effects, change line 20 to PMODE 3,1:PCLS 4,: SCREEN 1,0, and add line 25, which should read COLOR 3,4. Or, change this PCLS to PCLS 3, and the COLOR to COLOR 2,3. You can produce further color variations of both of these by adjusting your TV tint control.

Program Listing 5, Butterfly, is fairly uncomplicated, despite its appearance. The only tricky part of the CIRCLE (ellipse) statements is adding the circle radius to, or subtracting it from, the (X,Y) coordinates, which produces the unusual texture of the wings. This illustrates the great potential of the CIRCLE command.

Try modifying the butterfly program to produce a four-leaf clover. It was my discovery of the clover leaf that led me to the butterfly. Hint: Enlarge the lower wings to the same size as the upper wings by increasing the circle radii to the value of the upper wings. Change the body of the butterfly to a small circular flower center. And don't forget the stem, using a LINE command.

If this insect resembles a moth rather than a butterfly, convert it to a true butterfly. This exercise should suggest programs for other winged insects, perhaps even a dragonfly.

Adjust your TV color controls for various color effects.

Program Listing 6, Cottage, brings us to a more complex level. But it is still relatively uncomplicated, using only LINE, DRAW, and CIRCLE commands. Observe that clouds are easily formed by simply increasing the value of the radii of CIRCLE (ellipse) statements, which makes the clouds a solid white.

The tedious part is the fence. But programming the cross pieces (starting with line 470) should be an instructive exercise in handling coordinates of the LINE statements. If you prefer something other than the fence, try a hedge. Frankly, I haven't yet found a procedure that will make one satisfactorily. Here is where some exploratory doodling comes in.

Curiously, the door and windows of the cottage are accidental, caused by TV color fringing. If you don't like a colored path, just change STEP 2 in line 140 to STEP 1.

There's plenty of space left for you to add more clouds, a pond in the front yard, or a tree. If you discover a simple way to make a leafy tree, let me know.

```
10 REM***LISTING 5  BUTTERFLY
20 PMODE 4,1:PCLS:SCREEN 1,1
30 REM**FRAME
40 LINE(10,15)-(245,175),PSET,B
50 REM**UPPER RIGHT WING
60 FOR R=0 TO 30
70 CIRCLE(120+R, 98-R),R,1,1.5
80 NEXT R
90 REM**LOWER RIGHT WING
100 FOR R=0 TO 23
110 CIRCLE(120+R, 98+R),R,1,1.5
120 NEXT R
130 REM**LOWER LEFT WING
140 FOR R=0 TO 23
150 CIRCLE(124-R,98 +R),R,1,1.5
160 NEXT R
170 REM**UPPER LEFT WING
180 FOR R=0 TO 3 0
190 CIRCLE(120-R,98-R),R,1,1.5
200 NEXT R
210 REM**BODY
220 FOR R=0 TO 8
230 CIRCLE(125,100),R,2,2
240 NEXT R
999 GOTO 999
```

Program Listing 5. Butterfly

```
10 REM***LISTING 6  COTTAGE
20 PMODE 4,1:PCLS:SCREEN 1,1
30 LINE(10,10)-(245,180),PSET,B
40 REM**COTTAGE
50 FOR X=65 TO 125 STEP 3
60 FOR Y=90 TO 100 STEP 2
70 LINE  (95,80)-(X,Y),PSET
80 NEXT Y,X
90 REM**CHIMNEY
100 FOR Y=83 TO 88
110 LINE(67,Y)-(72,Y),PSET
120 NEXT Y
130 REM**PATH
140 FOR X=113 TO 143 STEP 2
150 LINE(95,100)-(X,180),PSET
160 NEXT X
170 REM**HORIZON
180 LINE(12,95)-(65,95),PSET
190 LINE(126,95)-(244,95),PSET
200 REM**CLOUDS
210 FOR R=0 TO 25
220 CIRCLE(185,35),R,1,.3
230 NEXT R
240 FOR R=0 TO 25
250 CIRCLE(165,45),R,1,.3
260 NEXT R
270 FOR R=0 TO 25
280 CIRCLE(205,45),R,1,.3
290 NEXT R
300 FOR R=0 TO 15
310 CIRCLE(60,60),R,1,.3
320 NEXT R
330 REM**STOP HERE IF FOLLOWING FENCE NOT PREFERRED, AND
340 REM**FINISH WITH 999 GOTO 999.
350 REM**FENCE
360 DRAW"BM10,160;R90": REM**LEFT RAIL
370 DRAW"BM10,161;R90":REM**DITTO
380 DRAW"BM155,160;R90":REM**RIGHT RAIL
390 DRAW"BM155,161;R90":REM**DITTO
400 REM**LEFT POSTS
410 FOR X=100 TO 20 STEP-20
420 LINE(X,161)-(X,180),PSET:NEXT X
430 REM**RIGHT POSTS
440 FOR X=155 TO 235 STEP 20
450 LINE(X,161)-(X,180),PSET:NEXT X
460 REM**LEFT CROSS PIECES
470 FOR X=100 TO 40 STEP-20
480 LINE(X,161)-(X-20,180),PSET:NEXT X
490 LINE(20,161)-(10,170),PSET
500 FOR X=20 TO 80 STEP 20
510 LINE(X,161)-(X+20,180),PSET:NEXT X
520 LINE(10,170)-(20,180),PSET
530 REM**RIGHT CROSS PIECES
540 FOR X=155 TO 215 STEP 20
550 LINE(X,161)-(X+20,180),PSET:NEXT X
560 FOR X=235 TO 175 STEP-20
570 LINE(X,161)-(X-20,180),PSET:NEXT X
580 LINE(235,161)-(245,170),PSET
590 LINE(235,180)-(245,170),PSET
600 REM**LAMPS ON END POSTS
610 CIRCLE(99,158),3
620 CIRCLE(155,158),3
999 GOTO 999
```

Program Listing 6. Cottage

For a different color effect, change Line 20 to PMODE 3,1:PCLS 3: SCREEN 1,0, and add line 25 to read COLOR 2,3. Adjust your TV color controls to get a more colorful effect.

Program Listing 7, Saturn, is for the amateur astronomers who want to escape from video war games. No, there aren't four Saturns in the sky. This just depicts the planet in four successive positions as it whirls along its orbit toward us.

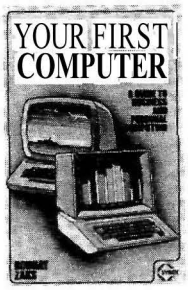
Forming two rings in the nearest two positions employs a procedure not used in the previous listings. Each ring is cre-

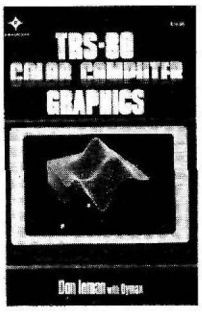
```
10 REM***LISTING 7  SATURN
20 PMODE 4,1:PCLS:SCREEN 1,1
30 LINE(10,10)-(245,180),PSET,B
40 REM**SATURN IN REMOTE, 1ST POSITION
50 REM**THE PLANET
60 X=215:Y=35
70 FOR R=0 TO 5
80 CIRCLE(X,Y),R
90 NEXT R
100 REM**RINGS (MERGED)
110 FOR R=9 TO 13
120 CIRCLE(X,Y),R,1,0.25
130 NEXT R
140 REM**SATURN IN 2ND POSITION
150 REM**(1) THE PLANET
160 X=165:Y=50
170 FOR R=0 TO 10
180 CIRCLE(X,Y),R
190 NEXT R
200 REM**(2) RINGS (MERGED)
210 FOR R=15 TO 20
220 CIRCLE(X,Y),R,1,0.25
230 NEXT R
240 REM**SATURN IN 3RD POSITION
250 REM**(1) THE PLANET
260 X=110:Y=80
270 FOR R=0 TO 15
280 CIRCLE(X,Y),R
290 NEXT R
300 REM**(2) INNER RING
310 X=110:Y=80
320 FOR R=20 TO 23
330 CIRCLE(X,Y),R,1,0.25
340 NEXT R
350 REM**(3) OUTER RING
360 FOR R=28 TO 31
370 CIRCLE (X,Y),R,1,0.25
380 NEXT R
390 REM**SATURN IN 4TH POSITION
400 REM**(1) THE PLANET
410 X=70:Y=130
420 FOR R=0 TO 20
430 CIRCLE(X,Y),R
440 NEXT R
450 REM**(2) INNER RING
460 FOR R=30 TO 35
470 CIRCLE(X,Y),R,1,0.3
480 NEXT R
490 REM**(3) OUTER RING
500 FOR R=40 TO 45
510 CIRCLE(X,Y),R,1,0.3
520 NEXT R
530 REM**STARS (RE-RUN UNTIL SATISFIED WITH DENSITY)
540 X=12+RND(233)
550 Y=12+RND(167)
560 PSET(X,Y,5)
570 REM**CONTROL OF STAR DENSITY
580 IF X<14 THEN GOTO 999 ELSE 540

999 GOTO 999
```

Program Listing 7. Saturn

HOT CoCo BOOKS





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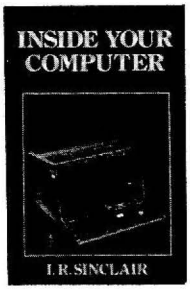

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ated by giving a range to the variable R (radius), which determines the width of the rings. The rings are elliptical to provide perspective. The star field is made and controlled in the same manner as the bed of lily pads in Listing 4.

```
10 REM***LISTING 8  DOUBLE DISASTER
20 CLS(0)
30 PRINT @ 228, "    DOUBLE DISASTER
40 FOR T=1 TO 1000:NEXT T
50 PMODE 4,1:PCLS:SCREEN 1,1
60 REM**A CITY
70 DRAW"BM 0,162;R130
80 DRAW"BM 130,170;R125
90 DRAW"BM 132,171;R125
100 REM**1ST BUILDING
110 FOR X=130 TO 150 STEP 3
120 FOR Y=170 TO 155 STEP-5
130 LINE(130,170)-<X,Y),PSET,B
140 NEXT Y,X
150 REM**2ND BUILDING
160 FOR X=155 TO 175 STEP 3
170 FOR Y=170 TO 135 STEP-5
180 LINE(165,170)-(X,Y),PSET,B
190 NEXT Y,X
200 DRAW"BM 165,135;U15
210 REM**3RD BUILDING
220 FOR X=180 TO 205 STEP 3
230 FOR Y=170 TO 145 STEP-5
240 LINE(190,170)-(X,Y),PSET,B
250 NEXT Y,X
260 REM**4TH BUILDING
270 FOR X=210 TO 230 STEP 3
280 FOR Y=170 TO 155 STEP-5
290 LINE(210,170)-(X,Y),PSET,B
300 NEXT Y,X
310 DRAW"BM 220,155;U10
320 REM**5TH BUILDING
330 FOR X=235 TO 255 STEP 3
340 FOR Y=160 TO 125 STEP-5
350 LINE(245,170)-(X,Y),PSET,B
360 NEXT Y,X
370 DRAW"BM 245,125;U20
380 REM**PYRAMIDS
390 DRAW"BM 5,162;E5;F5;E10;F10;E15;F15
400 REM**STARS: RE-RUN TO GET DESIRED NUMBER AND DENSITY
410 X=RND(255)
420 Y=RND(145)
430 PSET(X,Y,5)
440 IFY=> 145 THEN 460 ELSE 410
450 FOR T=1 TO 1000:NEXT T
460 REM**LOOK! A COMET
470 DIM V(20,20)
480 FOR R=0 TO 3
490 CIRCLE(15,15),R
500 NEXT R
510 GET(15,15)-(25,25) ,V,G
520 FOR I=0 TO 150
530 PUT(15+I,15+I)-(25+I,25+I),V,PSET
540 NEXT I
550 REM**COMET HITS AND EXPLODES
560 FOR R=0 TO 85 STEP 2
570 CIRCLE(170,170),R,1,1,.50,1
580 NEXT R
590 FOR T=1 TO 1000:NEXT T
600 PCLS
610 REM**PYRAMIDS RESTORED AFTER PCLS ERASURE
620 DRAW"BM 0,162;R255
630 DRAW"BM 5,162;E5;F5;E10;F10;E15;F15
640 FOR T=1 TO 500:NEXT T
650 REM**IT'S A NUKE THIS TIME!
660 FOR R=0 TO 2
670 CIRCLE(175,15) ,R
680 NEXT R
690 GET(170,10)-(180,20) ,V,G
700 FOR I=1 TO 145
710 PUT(170-I,10+I)-(180-I,20+I),V,PSET
720 NEXT I
730 REM**NUKE EXPLODES
740 FOR R=0 TO 100 STEP 2
750 CIRCLE(35,162),R,1,1,.5,1
760 NEXT R
770 PCLS
780 DRAW"BM 0,162;R255
790 FOR T=1 TO 1000:NEXT T
800 CLS(0)
810 PRINT @ 225, "          THE END
999 GOTO 999
```

Program Listing 8. Double Disaster

If you are not happy with the unreal picture of Saturn with only two rings, try programming additional rings—with smaller widths, of course. But be careful of your realistic impulses. Actually, Saturn's rings number in the hundreds.

Finally, Program Listing 8, Double Disaster, brings us to a simple example of animated art. It's probably the shortest documentary on record, taking only 30 or more seconds to record what might happen in the year 2001, but which I fervently hope won't happen. Who wants to see the famous pyramids vaporized?

If you are still wrestling with Basic, you'll do well to become familiar with GET and PUT. These commands and procedures are an important key to moving objects such as missiles and rabbits chasing dogs from one point to another. It's no snap to persuade GET and PUT to cooperate at first. But you'll finally get a thrill seeing your displays in vibrant motion.

Observe how the five buildings of the doomed city are formed by the LINE commands using variable (X,Y) coordinates and terminating with a B to form multistory buildings and windows. (Try deleting the B sometimes and get a surprise.)

The field of stars is made and controlled in much the same manner as in Listing 7. On any run of the program, only a few or too many stars may appear. If you are particular about stars, rerun the program until you are satisfied with their pattern. You might even get the Big Dipper sometimes.

The comet and nuke (ICBM) scenes, short of the explosions, employ the GET/PUT procedures. If you should choose to modify the program to hit the city and pyramids, or any other targets, from different angles and distances, I suggest that you first map out the circles and GET/PUT arrays (squares or triangles invisible on the TV screen) on graph paper representing the dimensions of the TV screen. It's tough to ad-lib precise animation without such a guide.

If you wish to content yourself with a program short of the comet and ICBM explosions, stop with line 450 and end the program with 999 GOTO 999. Or, if you complete the entire program and later wish to stop short of the explosions, add line 465 to read GOTO 999. You'll then see the city, pyramids, and stars overhead, all in peaceful stillness. •

Address correspondence to William H. Roney, 309 North Virginia Ave., Falls Church, VA 22046.

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SYSTEMS SOFTWARE

MACRO-80C

This is a disk-based editor, macro assembler and monitor, written for Color Computer by Andy Phelps. THIS IS IT — The ultimate programming tool!

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The screen-oriented text editor is designed for efficient and easy editing of assembly language programs. The "Help Key" feature makes it simple and fun to learn to use the editor. As the editor requires no line numbers, you can use the arrow keys to position the cursor anywhere in the file. MACRO-80C allows global changes and moving/copying blocks of text. You can edit lines of assembly source which are longer than 32 characters.

DCBUG is a machine language monitor which allows examining and altering of memory, setting break points, etc.

The editor, assembler and monitor — as well as sample programs — come on one Radio Shack compatible disk. Extensive documentation included. **MACRO-80C Price: $99.95**

SOFTWARE DEVELOPMENT SYSTEM

The Micro Works Software Development System (SDS80C) is a complete 6809 editor, assembler and monitor package contained in one Color Computer program pack! Vastly superior to RAM-based assemblers/editors, the SDS80C is non-volatile, meaning that if your application program bombs, it can't destroy your editor/assembler. Plus it leaves almost all of 16K or 32K RAM free for your program. Since all three programs, editor, assembler and monitor are co-resident, we eliminate tedious program loading when going back and forth from editing to assembly and debugging!

The powerful screen-oriented Editor features finds, changes, moves, copys and much more. All keys have convenient auto repeat (typamatic), and since no line lumbers are required, the full width of the screen may be used to generate well commented code.

The Assembler features all of the following: complete 5809 instruction set; conditional assembly; local labels; assembly to cassette tape or to memory; listing to screen or printer; and mnemonic error codes instead of numbers.

The versatile monitor is tailored for debugging programs generated by the Assembler and Editor. It features examine/change of memory or registers, cassette load and save, breakpoints and more. SDS80C Price: $89.95

MICRO WORKS COLOR FORTH

- Forth is faster to program in than Basic
- Forth is easier to learn than Assembly Language
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Forth is a highly interactive language like Basic, with structure like Pascal and execution speed close to that of Assembly Language. The Micro Works Color Forth is a Rompack containing everything you need to run Forth on your Color Computer.

Color Forth consists of the standard FORTH Interest Group (FIG) implementation of the language plus most of FORTH-79. It has a super screen editor with split screen display. Mass storage is on cassette. Color Forth also contains a decompiler and other aids for learning the inner workings of this fascinating language. It will run on 4K, 16K, and 32K computers. Color Forth contains 10K of ROM, leaving *your* RAM for *your* programs! There are simple words to effectively use the Hi-Res Color Computer graphics, joysticks, and sound. The 112-page manual includes a glossary of the system-specific words, a full standard FIG glossary and complete source listing. COLOR FORTH ... THE BEST! From the leader in Forth, Talbot Microsystems. Price: $109.95

MICROTEXT: COMMUNICATIONS VIA YOUR MODEM!

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- — Communications with other computers
- — Using your computer as a general-purpose 300-baud terminal
- — Downloading programs from other computers

The Microtext module is a program pack containing not only firmware but a second serial port so that both your printer and modem can be connected at the same time. Microtext can be configured for any serial printer that will work with the Color Computer, even if it requires line feeds! But even if you don't have a printer, you can keep a permanent copy of your data by storing to cassette tape. Also, any Radio Shack/Centronics-compatible parallel printer may be used by adding the Micro Works' PI80C parallel interface.

For those of you with special terminal applications, Microtext has selectable parity; it sends odd, even, mark or space. With mark parity (which is default) you can send to computers requiring either seven or eight bits. All 128 ASCII codes can be sent. Exchange programs with other Color Computer users! Basic programs may be downloaded from other computers or timesharing systems.

You'll find many uses for this versatile module! Available in ROMPACK, ready-to-use, for **$59.95.**

MACHINE LANGUAGE

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MONITOR ROM: The same program as above, supplied in 2716 EPROM. This allows you to use the entire RAM space. And you don't need to re-load the monitor each time you use it. The EPROM plugs into the Extended Basic ROM Socket or the Romless Pak I. **CBUG ROM Price: $39.95**

SOURCE GENERATOR: This package is a disassembler which runs on the color computer and generates your own source listing of the BASIC interpreter ROM. Also included is a documentation package which gives useful ROM entry points, complete memory map, I/O hardware details and more. A 16K system is required for the use of this cassette. **80C Disassembler Price: $49.95**

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BY RICHARD RAMELLA

PHOTOGRAPHING A TV SCREEN

You're fiddling around with random graphics effects when a screen display 50 startlingly charming appears that you wish you could save it. You can—on film. It may be the only easy way to record an image that occurred by a literal million-to-one shot.

I photograph monitor displays for a "pseudo art" gallery on the walls of my computer room, and also to spark my imagination. To have a picture of the way a program looks at some crucial point is quite useful. But that's only my story. There are many reasons to photograph screen displays, and doing so is not an easy task. But it is something that you can do once you understand how.

Now even the novice photographer can take quality pictures of interesting video screen displays.

If you are an accomplished photographer, you may only need to know to put 400 ASA color film in your camera, to set the camera at f/8 at 1/8 of a second, and to shoot from an absolutely still camera position. You'll get pictures.

Of course, there are other methods you might try, and if you're a beginner, you'll need a little extra information.

I recommend using a 35-millimeter camera. That's what most amateur photographers have. Film and processing costs are reasonable. However, you can use any camera with f-stop and exposure length settings. I'll explain these settings a bit later.

Consider using 400 ASA film. The settings mentioned in this article are based on 400 ASA. The higher the ASA number, the less light is needed for a correct exposure. In photo jargon, ASA refers to film speed; a 25 ASA film is rather slow and a 400 ASA film is fast.

I recommend Kodak films. Kodak Ektacolor 400 ASA yields negatives from which prints are made. Kodak Ektachrome ASA 400 yields positive slides which can be projected, and prints can be made from them.

Load your camera and, if possible, mount it on a tripod. Get and set a picture on your color monitor. Consider cleaning the screen with a damp cloth. You may be amazed by the amount of grime that has built up.

You might be helped by Color Exposure Chart, the short Color Basic listing with this article. It shows and labels the nine colors available on the C0C0:

```
100 REM * COLOR EXPOSURE CHART * COLOR BASIC 4K / R.RAMELLA
110 CLS(0)
120 INPUT "F STOP";A$
130 INPUT "EXPOSURE TIME";B$
140 CLS(0)
150 FOR Y=0 TO 5
160 FOR X=0 TO 19
170 SET(X+21,Y,1)
180 SET(X+42,Y,2)
190 SET(X,Y+10,3)
200 SET(X+21,Y+10,4)
210 SET(X+42,Y+10,5)
220 SET(X,Y+20,6)
230 SET(X+21,Y+20,7)
240 SET(X+42,Y+20,8)
250 NEXT X
260 NEXT Y
270 PRINT @ 96,"BLACK ";
280 PRINT @ 108,"GREEN ";
290 PRINT @ 119,"YELLOW ";
300 PRINT @ 258,"BLUE ";
310 PRINT @ 270,"RED ";
320 PRINT @ 280,"BUFF ";
330 PRINT @ 418,"CYAN ";
340 PRINT @ 427,"MAGENTA ";
350 PRINT @ 438,"ORANGE ";
360 PRINT @ 480,"SET: F:"A$;" TIME:"B$" SECOND";
370 GOTO 370
380 END
```

Program Listing. Color Exposure Chart

System Requirements

4KRAM
Color Basic
35mm Camera

black, green, yellow, blue, red, buff, cyan, magenta, and orange.

To get it on the screen, run it and answer the two prompts at the start by tapping enter twice. Later, you might want to answer the prompts by entering the f-stop number and exposure. These are displayed at the bottom of the screen and can help in exposure tests.

But for now, leave the display on the screen and adjust the colors. Set the contrast so the black parts of the screen are barely past the absence of color. Adjust hue and brightness to your satisfaction. Nothing may satisfy you here. Different TV sets give different results. On my monitor, green and cyan are similar, and red always has a bluish tint.

At this time you will see how necessary a tripod is. With it, once the camera is focused and set, it can be left alone except to check the focus before each exposure.

If you absolutely must take a hand-held picture, here's how: Set the camera at f/5.6 at 1/15 of a second. Get comfortable and steady. Focus. Hold the camera with both hands. Lock elbows against your ribs. Take a deep breath and hold it. Squeeze the shutter release gently and firmly. It may work. In lieu of a tripod, consider setting the camera on a table or holding it on the back of a chair as you shoot.

With a tripod, I recommend a setting of f/8 at 1/8 second. If you use 200 ASA film, try a setting of f/5.6 at 1/8 or f/4 at 1/15. In all situations, bracket your exposures (take exposures on either side of the recommended f-stop).

If you're unfamiliar with your camera, the f-stop settings on 35-millimeter cameras are on the lens barrel near the focus grip. They are the list of numbers that may read 1.7 2.8 4 5.6 8 11 16 22. There are variations on different cameras. The f-stop settings determine the amount of light that will strike the film when an exposure is made. An f/1.7 setting lets in much light, whereas an f/22 setting lets in little light.

A knob probably located on the top of the camera body is used to set the shutter speed—the amount of time light will be allowed to strike the film. You may see the figures 1 2 4 8 15 30 60 125 250 500 1000. The 1 stands for one second, and all the rest are fractions of a second, running from 1/2 to 1/1000 of a second.

Do not use a flash for photographing video. The light emitted from the screen is all you need. Also, it is best to shoot the screen in a darkened room, or at least with the screen turned away from windows or other light sources. This avoids reflections, which the convex surface of the television screen seems to pick up from nearly anywhere in the room.

If you want to create better conditions for eliminating glare, find a cardboard box that is high and wide enough to encompass your video screen, and long enough to allow the proper distance between the screen and your camera. Cut a rectangle in one end to fit against the edges of the monitor, and a circle the diameter of your camera lens in the other. You may even wish to paint the inside of the box flat black. In this way, you create a chamber that restricts unwanted light between the camera and its subject.

Never shoot exposures briefer than 1/15 of a second. This rules out 1/30 to 1/1000 of a second. The reason for this is not evident until you see the finished picture. At speeds of 1/30 of a second and faster, a diagonal stripe of discoloration can appear on the film. A color television produces 30 separate pictures each second through a scanning process. In 1/30 of a second, the screen's more than 500 lines are scanned twice, once for even-numbered lines, once for odd-numbered lines. At a 1/30-second exposure, the camera catches only part of the total scan for one picture. The opening in the 35-millimeter camera's shutter curtain moves sideways across the screen, creating the diagonal stripe of a different hue. Stick to 1/15- and 1/8-second exposures.

For the photo with this article, I used Kodak Ektachrome 400 ASA in a 35-millimeter Minolta XG1 on a tripod. The screen belongs to a seven-year-old General Electric TV bought at a garage sale. I used it, rather than the set in the living room, since it is reality for me—color shift, distortions, and all. I developed this slide film myself with the Kodak E-6 process, but it's usually cheaper to let the professional developing services do this part.

I am a professional photographer in the sense that I earn some of my living at it, but I am an amateur photographer in the sense that I still enjoy personal photography. If anyone has questions about the topic covered here, a self-addressed stamped envelope will get you an answer of some sort, perhaps even a helpful one. •

Write Richard Ramella at 1493 ML View Ave., Chico, CA 95926.

See *List of Advertisers on page 130*

BY MARTIN H. GOODMAN

COLOR-MONITOR DRIVER

Lower power requirements and ease of construction improve this circuit board's performance.

At last you have at your disposal an extraordinarily simple circuit that does an excellent job of driving your color-composite monitor. This circuit represents a significant improvement over previously introduced versions for two reasons.

First, it uses only the +5 volt line to power it, unlike several others that require + 12 volts. This makes it considerably safer in the event of a short or goof in your construction, thus reducing the danger to the expensive chips on your board. Second, it is much simpler to build because it requires only four components.

As an added advantage, it does not interfere with your existing RF output, as some of the earlier circuits do. You can also combine it with my monochrome monitor driver circuit (see page 36, *HOTCoCo,* July 1983) and interface it to your CoCo in a plug-in fashion.

Theory

Your Color Computer produces a color-composite video signal (the kind required to drive color monitors) by mixing the outputs of the VDG chip with a video-mixer integrated circuit (IC), MC1372. The output of this chip (pin 12) then feeds into your ASTEC RF modulator box. This box does several things. It acts as a miniature television station to produce a signal that an ordinary TV set can receive. This allows CoCo owners to use their TV sets as monitors.

Unfortunately, the box adds significant noise to the signal. For a crisper image that is free of the Moire patterns of RF interference that often plague the Color Computer, it is necessary to use a color-composite monitor.

Color-composite monitors currently cost between $250 and $350. Manufacturers are also introducing TV sets that have a built-in option allowing you to use them as color monitors. This option actually costs the manufacturer very little. RCA and Panasonic have sets that include this option in the $300 to $400 price range.

My circuit taps into the output of the video-mixer IC and runs it into a dual-emitter follower buffer. The buffer reduces the DC bias on the signal as well. The circuit, which appears in Fig. 1, is simple to construct.

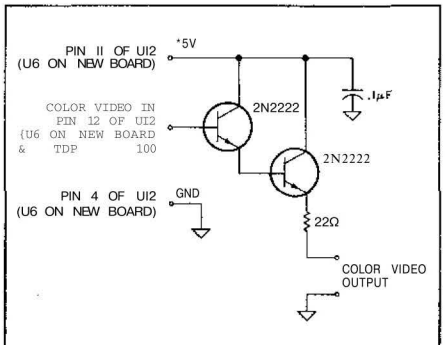

Fig. 1. Circuit for Driving Color-Composite Monitor

Construction Hints

You can lay out this circuit on a scrap of perfboard or add it to the board on which you built the monochrome monitor driver. To supply it properly, you can get the required + 5 volts, ground, and color-composite input from pins 11,5, and 12 of the video-mixer chip. This chip is MCI372, a 14-pin DIP chip located near the 6847 chip. The chip is called U12 on D- and E-board CoCos and U6 on new-board CoCos and TDP 100s. On new-board computers, you can spot this chip because it has a 56K-ohm resistor sitting on top of it soldered to pins 2 and 12. On older boards (D and E), it is located under the RF shield.

You can mount the board on top of the ASTEC RF box and run three wires from it to the MCI372 chip. You can then solder them directly to the chip or attach them via an adapter plug composed of a socket soldered to a header. In the latter case, you can configure your project so that it becomes a plug-in installation. You can run the output through a short piece of coax to an RCA phono socket. You can then snake this out through existing holes in the back of the case.

Notes

As with the monochrome monitor driver, you must supply sound using a separate circuit. Refer to my article on the monochrome monitor driver for hints on how to do this.

I must also warn readers that opening your CoCo's case will void any existing warranty. Also, Radio Shack reserves the right to refuse to repair any board that has been soldered. •

Address correspondence to Marty Goodman, 1529 Addison St., Berkeley, CA 94703.

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BY MARK SILVERBLATT

PERSONAL PROPERTY INVENTORY

Have you checked your personal property insurance lately? Does the dollar amount of your coverage really protect you in the event of fire, theft, or other loss? When was the last time you went through the house, room by room recording items of property by name, rank, serial number, and—especially—replacement cost? A check of this information compared to the limits of your insurance coverage might provide something of a surprise; few people realize just how many valuable possessions they've accumulated over the years.

Do you know exactly what you own? Use this program to create a neat personal property disk inventory.

Computer owners are particularly likely to be the kind of folks who acquire expensive toys. Since many insurance companies offer a reduced rate for "scheduled property," why not employ the computer to keep track of itself and the other insurable items in the household?

Aside from the obvious advantage of fast storage and retrieval of Basic and machine-language programs, adding the disk drive to Radio Shack's Color Computer enables you to build either sequential or direct-access disk data-files.

Sequential files are much like cassette files in that you must read an entire file into memory, manipulate it, and then rerecord it in order to make any changes to the data contained therein. Direct-access files, on the other hand, exploit the real potential of the disk by allowing a single record to be altered without affecting the balance of a file.

Persprop (Program Listing 1) demonstrates the CoCo's disk data-base management capability by creating and managing an inventory of personal property. I have created the following seven files for various categories of property: radio/computer, furniture, audio-visual, kitchen/appliances, clothing, jewelry, and other.

Each file contains direct-access records, with an item of property held in each record. Later in this article I will

Program *Listing I. Persprop*

```
10 'PERSPROP-Personal Property Inventory for 32K Disk COLOR COMP
UTER
20 'COPYRIGHT by Mark Silverblatt, Colormania Co, 1983
30 ' Use PRODRIVE To free graphics memory (PCLEAR0) before loadi
"9
40 CLEAR200:CLEAR(MEM-2000):GOSUB2270
50 '##MAIN MENU##
60 CLS:PRINT"PERSONAL PROPERTY INVENTORY":PRINT:PRINT"MAIN MENU"
:PRINT:PRINT"MODE SELECT":PRINT
70 FOR N=1T04:PRINT N;"- ";MN$(N):NEXT:PRINT:PRINT"SELECT ONE
80 I$=INKEY$:IFI$=""THEN80
90 MS=VAL(I$):ON MS GOTO 110,220,590,1160:GOTO80
100 '##ENTER ITEMS##
110 GOSUB1890'Select Category
120 GOSUB 1960 'Assign File Name
130 GOSUB 1980 'Open & Field
140 CLS:PRINT"ENTER ITEMS":PRINT
150 PRINTCA$(CS);" #"LOF(l)+1:PRINT
160 GOSUB 2090 'Enter Description
170 IF MR=1 THEN MR=0:CLOSE#1:GOTO 60 'Escape
180 FOR N=l TO 4:PRINT:0N N GOSUB 2140,2170,2200,2230:NEXT
190 PUT#1, LOF(l)+l
200 GOTO 140
210 '##EDIT##
220 GOSUB1890'Category Select
230 GOSUB 1960:GOSUB 1980 'File name/Open/Field
240 CLS:PRINT"EDIT ";CA$(CS):PRINT
250 IF LOF(1)=0THENCLOSE#1:PRINT"THIS FILE IS EMPTY":PRINT:G0T0l
010
260 PRINT"<ENTER> FOR RETURN TO MENU":PRINT:INPUT"ENTER RECORD #
";R
270 IF R=0 THEN CLOSE#l:GOT0 60 'Escape
280 IF R>L0F(1) THEN PRINT R;"IS TOO HIGH- LOF IS";LOF(1):GOTO 2
60
290 CLS:PRINT"EDITING ";CA$(CS);" #";R
300 GOSUB 800 'Get and Display Record
310 PRINT" CHANGE___"
320 FOR N=l TO 5:PRINTN;"- ";RC$(N):NEXT
330 PRINT" OR___"
340 PRINT" 6 - DELETE ENTIRE RECORD"
350 PRINT" 7 - RECORD ANY/ALL CHANGES"
360 PRINT" 8 - ESCAPE/CANCEL CHANGES
370 I$=INKEY$:IFI$=""THEN370
380 EC=VAL(I$):ON EC GOTO 400,400,400,400,400,450,550,240:GOT037
0
390 '##CHANGE SPECIFIC FIELD##
400 GOSUB 580'Wipe Screen
410 PRINT@128,"NEW ";:ON EC GOSUB 2090,2140,2170,2200,2230
420 PRINT@32,;:GOSUB810 'Position Cursor; Re-Print Item & Menu
430 GOTO 310
440 '##DELETE RECORD##
450 GOSUB 580'Wipe Screen
```

Listing continued

System Requirements

32K RAM
Color Disk Basic
Disk Drive
Printer (optional)

Listing continued

```
460 PRINT@160,"DELETE RECORD -":PRINT" SURE ?? <Y/OTHER>
470 I$=INKEY$:IFI$=""THEN470
480 IF I$<>"Y"THEN GOSUB 580:PRINT@128,;:GOTO310
490 DI$="DELETED":GOSUB2130
500 AD=0:GOSUB2160
510 AC=0:GOSUB2190
520 RC=0:GOSUB2220
530 WT=0:GOSUB2250
540 '##RECORD CHANGES##
550 PUT#1,R
560 GOTO 240
570 '##WIPE SCREEN LINES 5-16 ##
580 FOR N=0TO2:PRINT@128+(127*N),STRING$(128,32);:NEXT:RETURN
590 '## LIST ##
600 CLS:PRINT"LIST ITEMS":PRINT:LC=0
610 PRINT"1-LIST TO SCREEN ONLY"
620 PRINT"2-LIST TO SCREEN AND PRINTER":PRINT:PRINT"SELECT ONE"
630 I$=INKEY$:IFI$=""THEN630
640 LF=VAL{I$):IFLF<10RLF>2 THEN 630
650 IF LF=1 THEN 740
660 CLS:PRINT"LIST ITEMS":PRINT
670 PRINT"1-SINGLE CATEGORY"
680 PRINT"2-ALL CATEGORIES IN ORDER":PRINT:PRINT"SELECT ONE"
690 I$=INKEY$:IFI$=""THEN690
700 LC=VAL(I$):IFLC<1ORLC>2THEN690
710 P=O:GOSUB1030:GOSUBl860'Printer Prep;Initialize Tallys
720 IF LC=1 THEN 740
730 FOR CS=1TO7:GOTO750
740 GOSUB 1890 'Select category
750 GOSUB 1960:R=0'Asgn File Name; Init Rec#
760 GOSUB 1980:IF LOF(1)=0 THENCLOSE#1:GOTO1000 ELSEIF LF=2THENG
OSUB1100:GOSUB1050
770 CLS:KS=0
780 IF LF=2THENR=R+1:IF R>LOF(l) THENR=0:GOSUB1120: CLOSE#1:GOTO
 990 ELSEIFR>1THEN GOSUB1120
790 IF LF=1THENR=R+1:IFR>LOF(1)THENCLOSE#1:GOTO990
800 GET#1,R:GOSUB2020 'to convert & tally
810 PRINT DI$
820 PRINTTAB(5) LEFT$(CA$(CS),1);R;
830 PRINT USING"#####";AD;
840 PRINT USING"#####";AC;
850 PRINT USING"#####";RC;
860 PRINT USING"#####";WT
870 IF MS=2 THEN RETURN
880 IF LF=2 THEN 920
890 KS=KS+3:IF KS<14THEN780
900 PRINT"<ENTER>=CONT <M><ENTER>=MENU";:INPUTD$
910 IF D$="M" THEN CLOSE#l:GOTO60 ELSE KS=0:GOTO 780
920 PRINT#-2,DI$;" ";LEFT${CA$(CS),1);
930 PRINT#-2,USING"###";R;
940 PRINT#-2,USING"#####";AD;
950 PRINT#-2,USING"#####";AC;
960 PRINT#-2,USING"#####";RC;
970 PRINT#-2,USING"####";WT
980 GOTO 780 'next record
990 IF LC=2 THEN GOSUB 1690 ELSE 1010
1000 NEXT CS:GOSUB1790
1010 PRINT "** DONE ** <ENTER>=MENU";:INPUTD$:GOTO60
1020 '##PRINTER PREP##
1030 CLS:PRINT"PREPARE PRINTER PAPER TO TOP OF FORM AND <ENTER>
DATE STRING":LINE INPUT DA$:KL=3:IFLBN(DA$)>26THENDA$=LEFT$(DA$,
26)
1040 P=P+1:PRINT#-2,"PERSONAL PROPERTY INVENTORY AS OF  ";DA$;"
PAGE";P;"OF    PAGES":GOSUB1120:RETURN
1050 GOSUB1110:PRINT#-2,CA$(CS);:IFR>0THENPRINT#-2," (CONTINUED)
";
1060 PRINT#-2,TAB(55)"CAT    ACQU ACQU REPL LBS":GOSUB1120
1070 PRINT#-2,RC$(1);TAB(54)"CODE  # DATE COST COST  WT":GOSUBll
20:GOSUB1110
1080 RETURN
1090 '##TEST PRINT PAGE##
1100 IF KL>57 THEN FOR N=l TO 63-KL:GOSUBlll0:NEXT:RETURN ELSERE
TURN
1110 PRINT#-2
1120 KL=KL+1:IF KL>62 THEN FOR N=lT03:PRINT#-2,CHR$(10):NEXT:KL=
3:GOSUB1040 ELSERETURN
1130 IF R>0THENGOSUB1050'Print Header
1140 RETURN
1150 '##SORT##
1160 CLS:PRINT"SORT":PRINT
1170 PRINT"1-SINGLE CATEGORY
1180 PRINT"2-ALL CATEGORIES IN ORDER
1190 PRINT:PRINT"SELECT ONE"
1200 I$=INKEY$:IFI$=""THEN1200
1210 LC=VAL(I$):IFLC<1ORLC>2THEN1200
1220 IF LC=1 THEN RUN 1230 ELSE RUN 1240
1230 GOSUB2270:MS=4:GOSUB1890:LC=1:GOTO1310'Single category
1240 GOSUB2270:CS=1:LC=2:GOSUB1310:RUN1250'A11 Cats
1250 GOSUB2270:CS=2:LC=2:GOSUB1310:RUN1260
```

Listing continued

explain how you can easily rename the files to suit your own needs. Each record, in turn, is divided into five fields: description, acquisition date, acquisition cost, replacement cost, and weight.

Options include Enter (build records within the file), Edit (alter or delete any record or any field within a record), Sort (rearrange a file in alphabetical order according to the item's description), and List (print a file or all files to the screen or printer). The List option also includes a Tally feature to subtotal the costs and weights in each category and to calculate grand totals.

"Extended Color Basic and Disk Basic normally allow for reserving from one to eight graphics pages...."

Using Persprop

Program Listing 2, Prodrive, is a load/drive routine that clears out all the graphics RAM pages, and then loads and runs Persprop. Extended Color Basic and Disk Basic normally allow for reserving from one to eight graphics pages (PCLEAR 1 through PCLEAR 8), and the tricks discovered by nondisk users for simulating a PCLEAR 0 will not work with the disk interface installed. This routine will do the trick, and you can adapt it for general use with no modification other than deleting the LOAD "PERSPROP",R statement.

As Persprop autostarts, the main menu greets you, inviting selection of one of the four modes described above. Liberal use of INKEY$ eliminates the need to press enter in most option selections; simply pressing the number key indicating the option you desire will take you to that subroutine. Handle them as follows:

1. Enter Items goes directly to the Category Select subroutine and opens and fields the file you select. You then enter each record, one field at a time. The Description field is intended to include "noun nomenclature" (i.e., item name, manufacturer, model, and serial number) and is fielded for a maximum of 56 characters, in keeping with the program's design for listing each record on an 80-column printer line. Exceeding 56 characters when entering Description

Listing continued

```
1260 GOSUB2270:CS=3:LC=2:GOSUB1310:RUN1270
1270 GOSUB2270:CS=4:LC=2:GOSUB1310:RUN1280
1280 GOSUB2270:CS=5:LC=2:GOSUB1310:RUN1290
1290 GOSUB2270:CS=6:LC=2:GOSUB1310:RUN1300
1300 GOSUB2270:CS=7:LC=2:GOSUB1310:GOTO1670
1310 GOSUB 1960 'Assign File Name
1320 PRINT:PRINT'SORTING "CA$(CS):PRINT
1330 GOSUB 1980 'Open/Field
1340 IF LOF(1)=0 THEN CLOSE#1:GOTO1660
1350 DIM SF(LOF(l)):IF LOF(1)<10 THEN DIM S$(10) ELSE DIM S$(LOF
(1))
1360 SL=LOF(l)
1370 FOR N=1T0 LOF(l)
1380 GET #1,N
1390 S$(N)=DR$'Build sort $tring array
1400 IF LEFT$(DR$,7)<>"DELETED" THEN SF(N)=1 ELSE SF(N)=0:SL=SL-
l'Build flag array
1410 NEXT N:K=0:DIM SL(SL)'Begin sort
1420 K=K+1:N=1
1430 IF SF(N)=0 THEN N=N+l:GOTO 1430'Skip blank items
1440 : FOR M=l TO LOF(l)'Scan array
1450 : IF SF(M)=0 THEN 1470
1460 : IF S$(N)>S$(M) THEN N=M'Swap
1470 : NEXT M
1480 SL(K)=N:SF(N)=0'Set LINK and FLAG arrays
1490 PRINT S$(N)
1500 IF K<SL THEN 1420'Loop if not done
1510 CLOSE#l
1520 OPEN "D",#1,FI$,76
1530 OPEN "D",#2,"TEMP/DAT",76
1540 FIELD #1, 56 AS S$(0), 5 AS S$(l), 5 AS S$(2), 5 AS S$(3),
5 AS S$(4)
1550 FIELD #2, 56 AS S$(5), 5 AS S$(6), 5 AS S$(7), 5 AS S$(8),
5 AS S$(9)
1560 FOR N= 1 TO K
1570 GET #1, SL(N)
1580 FOR M=1T04:S(M)=CVN(S$(M)):NEXTM
1590 LSET S$(5)=S$(0)
1600 F0RM=1T04:LSETS$(M+5)=MKN$(S(M)):NEXTM
1610 PUT #2, N
1620 NEXT N
1630 CLOSE#2:CLOSE#l
1640 KILL FI$
1650 RENAME "TEMP/DAT" TO FI$
1660 IF LC=2 THEN RETURN
1670 INPUT"** SORT DONE ** <ENTER>=MENU";D$:GOTO60
1680 '##SUB TALLY##
16 90 TA=TA+TA(CS)
1700 TR=TR+TR(CS)
1710 TW=TW+TW(CS)
1720 GOSUB 1100'Advance page if needed
1730 PRINT#-2,CA$(CS); " SUB TOTALS":GOSUB1120
1740 PRINT#-2," ACQU COST $";TA(CS):GOSUB1120
1750 PRINT#-2," REPL COST $";TR(CS):GOSUB1120
1760 PRINT#-2," WEIGHT-LBS ";TW(CS):GOSUB1120
1770 RETURN
1780 '##GRAND TALLY##
1790 GOSUB1100
1800 PRINT#-2,"GRAND TOTALS":GOSUB1120
1810 PRINT#-2," TOTAL ACQU COSTS $";TA:GOSUB1120
1820 PRINT#-2," TOTAL REPL COSTS $";TR:GOSUB1120
1830 PRINT#-2," TOTAL WEIGHTS-LBS ";TW:GOSUB1120
1840 RETURN
1850 '##INITIALIZE TALLYS##
1860 TA=0:TR=0:TW=0
1870 FOR N=1TO7:TA(N)=0:TR(N)=0:TW(N)=0:NEXT:RETURN
1880 '##CATEGORY SELECT##
1890 CLS:PRINT MN$(MS):PRINT:PRINT"CATEGORIES:":PRINT
1900 FOR N=1T07:PRINT N;"- ";CA$(N):NEXT
1910 PRINT:PRINT"SELECT ONE"
1920 I$=1NKEY$:IF I$=""THEN 1920
1930 CS=VAL(I$):IF CS<1 OR CS>7 THEN 1920
1940 RETURN
1950 '##ASSIGN FILE NAME##
1960 FI$=LEFT$(CA$(CS),8)+"/DAT":RETURN
1970 END '## OPEN/FIELD ##
1980 OPEN "D",#1,FI$,76
1990 FIELD #1, 56 AS DR$,5 AS AD$,5 AS AC$,5 AS RC$,5 AS WT$
2000 RETURN
2010 '##CVN & TALLY##
2020 DI$=DR$
2030 AD=CVN(AD$)
2040 AC=CVN(AC$):TA(CS)=TA(CS)+AC
2050 RC=CVN(RC$):TR(CS)=TR(CS)+RC
2060 WT=CVN(WT$):TW(CS)=TW(CS)+WT
2070 RETURN
2080 '##LSET/MKN##
2090 PRINT"PRESS <ENTER> TO ESCAPE TO MENU OR ELSE ENTER"
```

Listing continued

forces a try-again prompt.

Likewise, the input for Acquisition Date expects to see a four-digit number (YYMM), but will accept zero in any or all of these fields. Acquisition and replacement-cost fields round off any input to even dollars, $9999 maximum, and limits weight to 999 lbs. Again, the program imposes these limits only to allow 80-column printer formatting. Exceeding the limits will simply bring up the try-again prompt.

Escape from the Enter Items mode by pressing enter when asked for the next description.

2. Edit Items takes you again through Category Select and then requires you to enter the record number on which you desire to operate. For this reason it is very helpful to have already made an interim dump to the printer, because a printout will indicate record numbers.

Edit displays the entire record at top screen, gives options to specify the field to be altered, and permits escape from the edit session. Once you've altered a field, the record is again displayed, including any changes made, but the disk file is not changed until you so command. You can therefore edit one or more fields and still cancel changes before altering the disk file. Take a close look at the Edit submenu and you'll see what I mean.

The Delete Record option employs some file protection by asking "Sure?" and then requiring you to press the Y key before executing. Pressing any other key cancels the deletion and returns to the submenu. Once you delete an item, the word "deleted" replaces that item's disk record until the file is sorted, at which time it is discarded altogether.

3. List Items permits electing to do so to screen or printer.

List to Screen is a single category command (i.e., goes through Category Select and then formats the screen with the first five records from the category chosen). A bottom line prompt then provides the option of continuing with the next five records (enter) or returning to main menu (M enter).

List to Printer pauses to permit you to advance the paper to the top-of-form and to enter a data string (26 characters maximum—anything more will be chopped off) before you select either a single category or all categories in order.

If you select all categories, the routine activates the tally function, and it prints the grand totals at the end of the listing, with subtotals after each category. In either case, the program counts lines

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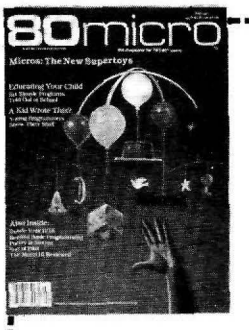

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Listing continued

```
2100 PRINT RC?(1):LINE INPUT DI$
2110 IF DI$="" THEN MR=1:RETURN
2120 IF LEN(DI$)>56 THENPRINT"LENGTH EXCEEDED 56-TRY AGAIN":GOTO
 2100
2130 LSET DR$=DI$:RETURN
2140 PRINT RC$(2):INPUT AD:AD=INT(AD)
2150 IF AD>9999THENPRINT"WRONG FORMAT- TRY AGAIN":GOT02140
2160 LSET AD$=MKN$(AD):RETURN
2170 PRINT RC$(3):INPUT AC:AC=INT(AC)
2180 IFAC>9999THENPRINT"EXCEEDED LIMIT $9999- TRY AGAIN":G0T0217
0
2190 LSET AC$=MKN$(AC):RETURN
2200 PRINT RC$(4):INPUT RC:RC=INT(RC)
2210 IF RC>9999THENPRINT"EXCEEDED LIMIT $9999- TRY AGAIN":GOT022
00
2220 LSET RC$=MKN$(RC):RETURN
2230 PRINT RC$(5):INPUT WT:WT=INT(WT)
2240 IFWT>999THENPRINT"EXCEEDED LIMIT 999LBS- TRY AGAIN":GOT0223
0
2250 LSET WT$=MKN$(WT):RETURN
2260 ' ## READ DATA LINES ##
2270 FOR N=1 TO 4:READ MN$(N):NEXT
2280 FOR N=1 TO 7:READ CA$(N)sNEXT
2290 FOR N=1 TO 5:READ RC$(N):NEXT
2300 RETURN
2310 DATA "ENTER ITEMS","EDIT ITEMS","LIST","SORT"
2320 DATA "RADIO-COMPUTER","FURNITURE","AUDIO-VISUAL","KITCHEN-A
PPLIANCES","CLOTHING","JEWELRY","OTHER"
2330 DATA "ITEM/MFGR/MODEL/SERIAL#","ACQUISITION DATE <YYMM>","A
CQUISITION COST <$>","REPLACEMENT COST <$>","APPROXIMATE WEIGHT
<LBS>"
```

	Input or Print	Fielded Disk Record	Sort Rewrite For Linked List Before	After
Description	**DI$**	DR$	**S$(0)**	**S$(5)**
Acqu Dale	**AD**	AD$	**S$(1)**	**S$(6)**
Acqu Cost	**AC**	AC$	**S$(2)**	**S$(7)**
Repl Cost	RC	RC$	**S$(3)**	**S$(8)**
Weight	**WT**	**WT$**	**S$(4)**	**S$(9)**

Tallys	**Specific Category Sub Total**	**Grand Totals**
Acqu Costs	**TA(CS)**	**TA**
Repl Costs	TR(CS)	TR
Weights	TW(CS)	TW

CA$( )	Category Names
CS	Category Selected
DA$	DATE (for printout)
D$	Dummy Input
EC	EDIT (submenu) command selected
FI$	(Disk) File Name
I$	INKEY$ key pressed
K	Link List position number (sort)
KS	Line Counter (screen)
KL	Line Counter (printer)
LC	List and Sort Option 1 = Single Category 2 = All Categories
LF	List Format 1 = Screen Only 2 = Printer and Screen
MN$( )	Mode Name
MR	Menu Return Flag
MS	Mode Selected (1-4)
M,N	"Throw away" loop counters
P	Printer page number
R	Record number
RC$(R)	Fielded Disk Record
S$( )	Strings for sort and sort rewrite
SF(K)	Sort flags 1 = Record present 2 = Record gone
SL(K)	Sort Linked List
SL	Sort list size (number of records in file less those deleted)

Table I. Persprop Variable List

and advances to the next page after it has printed 60 lines, providing three-line margins at the top and bottom of each 66-line page.

Printer formatting prints a title, including a data string, if used, and numbers each page. A column heading for the various fields precedes each category, and a category code—the first letter of the category name—and the item's record number follow the description field. I included this design feature to facilitate editing and also to provide for my own special need: being in the Army, I tend to move very often, and will now be able to get the movers to make an accurate packing list by simply tagging items with category code and line number, and giving them a copy of the printout.

4. Sort Items also permits selection of a single category versus all categories. Reading the description field of each record into a one-dimension string array accomplishes the sort. The routine then scans the array while it builds an ersatz-linked list, determining the order in which it rewrites the records into a new disk file, named TEMP/DAT. It then kills the original file, and renames the new file.

Faster sorts are certainly possible, but I chose this method to minimize disk drive and media wear by requiring only one read and one write operation to accomplish the sort.

Note: Some CoCo disk users have reported system crashes when they use CLOSE with two or more open files when string arrays are in use. I also experienced this disturbing problem but found that closing the buffers in the opposite order from which they were opened eliminated **the problem, at least** in this application. This technique is much like using nested **FOR... NEXT** loops (i.e., OPEN #1, then OPEN #2—manipulate—CLOSE #2, then CLOSE #1).

Dimensioning the arrays in the all-categories mode resulted in another problem, as going to the next category yielded a DD error—you can't redimension an array! I could have used separate arrays for sorting each category, at the cost of whole bunches of memory. I decided instead to reinitialize all variables, including array dimensions, with each category's use of the Sort routine. This is why line 1220 and lines 1240-1290 each contain RUN statements; in this manner I was able to reuse the sort array for each category.

In the event that you decide to renumber the program, beware of the bug in Color Basic that neglects to adjust "run

↙See List of Advertisers on page 130

line number" statements. The CoCo will adjust the GOTOs and GOSUBs automatically, but you'll have to change the RUN statements manually.

Finally, you can easily change the category names I have used by simply rewriting the DATA statements in line 2320, so long as you continue to use seven categories. Changing to more or less than seven categories requires adjustment of loop counters at lines 730,1870,1900, 1930, and 2280, as well as adjusting the "run line number" statements.

For masochists who might desire to make further program modifications, Table 1 provides a variables list. In any case, after building your data files, don't forget the ultimate insurance-make a back-up disk. •

```
1 'PRODRIVE-Frees all graphics pages, loads and runs PERSPROP
10 CLEAR200:L=3585:DEFUSR0=L
20 READP:POKEL,P
30 L=L+1:IPL<3593THEN20
40 X=USR0(3593):LOAD"PERSPROP",R
50 DATA 189,179,237,31,2,126,150,167
```

Program Listing 2. Prodrive

Address correspondence to Mark Silverblatt, HHC, 93rd Signal Brigade, Box 181, APO New York 09279.

PERSONAL PROPERTY INVENTORY AS OF 9 APRIL 1983 9:58 PM PAGE 1 OF PAGES

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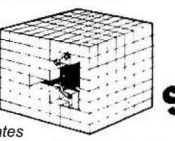

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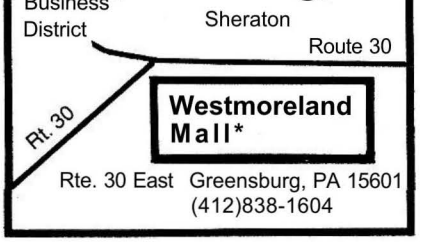

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BY DAVID MEREDITH

DISPLAYING MOVING GRAPHICS

Are those flat, static computer graphics boring you? Would you like to display moving pictures of three-dimensional objects, pictures that move around the screen, grow bigger and smaller, and rotate in space? My program, Display, does all this.

Display is a hybrid Basic/machine-language program that allows a 32K CoCo to show moving high-resolution images of three-dimensional objects. The objects displayed are *skeletons* (points joined by line segments), and the possible motions include sliding left, right, up, and down (called *panning);* growing larger and smaller (called *scaling);* and rotating six different ways.

To use Display, first enter each point you want to display. Then specify which pairs of points are to be connected and type DISPLAY. Your picture will appear on the screen within one second.

Then, by pressing various command keys, you can move your picture around the screen, make it grow larger or smaller, or make it appear to rotate in space. You can stop the display at any time to change points or line segments or to create an entirely new picture, and then return to the display. Finally, if you like your picture, you can save it on tape.

System Requirements

32KRAM
Extended Color Basic
Editor/Assembler

You can create 3-dimensional objects and manipulate them in space using this amazing program.

The Microworld of Display

Throughout this article, I will use "object" to refer to the three-dimensional skeleton to be displayed and "picture" to mean the resulting graphics display.

Display creates a microworld, as explained by Seymour Pappert in *Mindstorms* (New York: Basic Books, 1980). That is, when you use Display, you are operating in a limited but complete and coherent logical environment. This is a three-dimensional world populated by points and line segments. The points have names: A, B, C, ... Z, so there can be 26 of them at most.

When defining a point, you specify its name and its x-,y-,z-coordinates. You define line segments by naming their endpoints. When the screen displays your picture, the origin of the coordinate system is at the center of the TV screen, the x-axis goes left to right, the y-axis goes bottom to top, and the z-axis points right at you. Each screen pixel corresponds to one unit on a coordinate axis.

When you define points, you must specify their coordinates as integers between - 80 and 80, but when the program runs, the coordinates can take on real values between - 4,096 and 4,096. Large coordinate values can be generated when you allow a picture to slide far in one direction or to grow very large. Because coordinates are kept as real values (accurate to 1/256), you can shrink pictures to a single dot on the screen and then expand them again without losing detail.

If your object grows large, the TV screen will show only part of it. Only points with x-coordinate between — 128 and 127 and y-coordinate between - 96 and 95 will be visible. If any part of a line segment falls in this range, that part of the line segment will be shown, even though the ends of the line may not be visible. Thus, you can create a complex object, allow it to grow larger than the screen, and then display different magnified parts of it while retaining the entire object in your computer's memory.

How to Use Display

First load the Basic component of the program, then type and enter PCLEAR8:RUN. (The reason for PCLEAR8 is explained in Note 1 at the end of this article.) The program first executes CLOADM"DISPLAY" to load its machine-language component (which must be ready for loading when you type RUN) and then displays the message, "Enter HELP anytime for guidance." At this point, or at any other time when the text screen is visible, you can create, modify, erase, verify, save, load, and display objects.

To define (or redefine) a point, type

the name of the point, then =, and then the coordinates separated by commas, as in the following:

```
A= 0,0,0,
F= -50,50,-50
```

The coordinates must be integers between - 80 and 80.

To specify a line segment, just enter the endpoints like this: AF. To erase a line segment, enter the endpoints followed by #: AF#. You can define or erase more than one line segment on one line. For example, ACCBDE#HF would define line segments AC, CB, and HF and would erase DE. Up to 60 line segments can be included in one object.

To print the coordinates of all the points you have defined, enter ?. You can display a subrange of defined points with commands such as the following:

```
?C-G
?H-
?-G
```

To list all of the line segments you have defined, type ??.

To save the current object on tape, prepare your tape recorder for writing a new file and type SAVE"name". Your object will be saved under whatever file name you designate. As with all tape files, the name can include up to eight alphabetic characters, or you can omit the file name.

To read an object from tape, enter LOAD"name".

The program saves objects and loads them as binary files with the CLOADM and CSAVEM commands (see Note 2). Actually, all that is saved on tape are the buffers holding the points and line segments—355 bytes in all. That is all it takes to define an object.

Now for the rest of Display's commands: To erase an object entirely, just type NEW. To get a screenful of helpful information about using Display, type HELP. Finally, to see a picture of your object, type DISPLAY.

When you type DISPLAY the Basic program does four operations. It reads the list of line segments and marks all unused points as undefined. This prevents the machine-language routines from wasting time moving points that are not displayed. It then POKEs 0 into memory cell $11A (282) to deactivate the uppercase keyboard lock, executes the machine-language component of Display, and it POKEs 255 into memory cell $11A to restore the uppercase keyboard lock.

While executing the machine-language program, you can move the picture of your object 13 ways, as described in Table 1.

Machine-Language Routines

The clearest way of describing the machine-language component of Display is with a pseudocode outline. I will use as pseudocode subroutine names the same mnemonics that are used in the Assembly listing.

The program begins and ends with some housekeeping:

```
Disable regular interrupts
Establish a new S-stack
Execute MAIN
Restore the S-stack (for Basic)
Return.
```

The routine MAIN is the traffic cop. It does the following:

```
Sets the VDG register and the control
register for high-resolution graphics
Executes DISPLA (Display a picture
of the object)
Repeats
```


✓See *List of Advertisers on page 130*

```
Waits for the command key
If the command key is in [↑, ↓, →,
←, b, s, X, Y, Z, z, y, z], then it
repeats
   Modifies object according to
   command key
   Executes DISPLA until key is no
   longer depressed
Endif
Until key = @
Returns
```

Basic Data Structures

To understand how Display pans, scales, rotates, and displays objects, you must first see how the program stores points and line segments. There are separate buffers for points and lines. The 234-byte buffer POINTS starting at $7000, allots 9 bytes to each of the 26 points, A-Z. If a point is undefined, $80 is stored in its first byte. (Since all coordinates must lie between -2^{12} and 2^{12} you will see that $80 can never be the first byte of a defined point.)

Each point has three coordinates stored in order x, y, z, and each coordinate is stored as a 3-byte signed integer that is 256 times the coordinate value. Alternatively, think of each 3-byte coordinate as a signed hexadecimal value accurate to two hexadecimal digits (8 bits) to the right of the hexadecimal point.

Line segments are stored as 2-byte records in the 121-byte buffer LINES starting at $70EA. The program packs the records in the low end of the buffer followed by a single termination byte containing $FF. The 2 bytes defining a line segment contain the address of the endpoints of the line relative to POINTS. That is, point A corresponds to 0, B to 9, C to $12 = 18, and so forth. Thus, the 2 bytes defining the line segment AC contain 0,$12; the 2 bytes defining the line segment DK contain $1B,$5 A (decimal 27,90).

The line-segment buffer is a table of pointers. If ADDR is the address of a line-segment record, and if (ADDR) means the contents of ADDR, then the address of the first endpoint of the line segment is POINTS + (ADDR), and the address of the second endpoint is POINTS + (ADDR + 1).

I've divided the rest of this article into two parts. First, I will explain the routines that pan, scale, and rotate your object. These change the coordinates of the points without affecting the line segments at all. I move the object by moving the points and then reconstructing the line segments between the newly positioned points.

Second, I will explain how the program creates the picture of your object. When you press a command key, the program alternately modifies the object a little and then displays a new picture of the repositioned object. In this way the object seems to slide around your TV screen, grow larger or smaller, or rotate continuously in space.

Moving the Object

Whether you are panning, scaling, or rotating, you move the object in small increments between successive displays.

Panning is the easiest motion to achieve. Each time the program calls one of the routines, PANL, PANR, PANU, or PAND, it adds or subtracts two from the x- or y-coordinate of each defined point. For example, to slide the object to the right, call PANR. This subroutine adds two to the signed number in the first 2 bytes of the x-coordinate of each point. (Remember that these 2 bytes represent the integer part of the coordinate.)

Scaling is almost as easy. Each time the program executes the subroutine BIGGER, each coordinate of each defined point grows by 1/32. SMALLR shrinks coordinates by 1/32. In each case, the scaling is achieved by placing each coordinate on the S-stack, shifting it 5 bits to the right (dividing by 32), and adding or subtracting the result from the original coordinate value.

Now I come to the rotations. There are six of them, as you can rotate two ways around each of three axes. Each rotation subroutine (ROTX, ROTY, ROTZ, ROTMX, ROTMY, and ROTMZ) rotates all the points 7.18 degrees one way around one of the axes. I selected this amount of rotation because sin(7.18°) is almost equal to 1/8 and cos(7.18°) is almost equal to 127/128.

To rotate a point around an axis, you must modify two of the coordinates of the point. Each of the six rotation subroutines works the same way. Each goes through the list of points and, for each defined point, moves the addresses of the two coordinates to be modified to the X-register and Y-register. Then it calls a subroutine ROTATE to effect the rotation.

The six different ways in which the subroutines can point the X-register and Y-register at two out of three coordinates correspond to the six possible rotations.

Let's look in detail at rotating a single point counter-clockwise around the x-axis. Call the original coordinates of the point x_{old}, y_{old}, and z_{old}. The coordinates of the point after rotation will be as follows:

$$x_{new} = x_{old}$$

$$y_{new} = \frac{127}{128} y_{old} - \frac{1}{8} z_{old}$$

$$z_{new} = \frac{1}{8} y_{old} + \frac{127}{128} z_{old}$$

Aficionados of linear algebra will recognize these equations:

$$x_{new} = x_{old}$$
$$y_{new} = y_{old}\cos(\theta) - z_{old}\sin(\theta)$$
$$z_{new} = z_{old}\sin(\theta) + z_{old}\cos(\theta)$$

θ is the angle of rotation. I chose the

Command key	Action
↑, ↓, ←, →	move your object around the screen (panning)
B, S	make your object bigger or smaller (scaling)
X, Y, Z	rotate your object counter-clockwise around the X-, Y-, or Z-axis
(Shift) X, Y, Z	rotate your object clockwise around one of the axes
@	return to the Basic program

These commands continue working as long as you depress the command key.

Table I. Commands for Object Movement

```
Clear the unseen graphics screen.
For each line segment PQ in the object
   XI  =  INT(x-coordinate of P) (INT takes the integer part)
   Y1  =  INT(y-coordinate of P)
   X2  =  INT(x-coordinate of Q)
   Y2  =  INT(y-coordinate of Q)
Execute Line (draw a line on the unseen screen from (X1,Y1) to (X2.Y2))
ENDFOR.
Display this graphics screen.
```

Table 2. A Pseudocode Version of DISPLA

angle $\theta = 7.18°$ so that multiplication by $\cos(\theta) = 127/128$ and $\sin(\theta) = 1/8$ would require only a few arithmetic shifts, followed by a single addition or subtraction. (The values given for sine and cosine are accurate to one part in 25,000.)

The program uses an algorithm slightly different from the one above. No distinction is made between old and new coordinates. Rather, the program executes the following equivalent sequence:

```
y =(127/128)y -(1/8)z
z =(1/8)y + (129/128)z
```

If you compare this last algorithm with the one preceding it, you will see that they do not have exactly the same result. However, for the accuracy required by the program, they are sufficiently close.

The routines for panning, scaling, and rotating all contain checks within themselves to see that points do not grow too large. Coordinates must remain between - 4,096 and 4,096. If one of the movement routines pushes a point out of bounds, the program restores the offending point and all points preceding it in the points buffer to their original state. That is, the current, partially completed incremental change is undone.

In addition, objects are not permitted to grow too small. After the subroutine SMALLR reduces an object, the program checks each line segment. If any segment has endpoints in which the coordinates all have equal integer parts (the 2 high-order bytes of each coordinate), then the program expands the object to its previous size. Note that if the coordinates of two points all have equal integer parts, then the program will plot two points at the same place on the screen no matter how you rotate the object in space.

Drawing the Picture

While you press a command key, the program alternately moves the object very slightly and then displays the picture of the object in its new position.

To draw the picture of the object, the program goes to the subroutine DISPLA, which clears the screen and then draws each line segment in turn. Actually, you never see DISPLA clearing the screen or drawing the line segments. Clearing and drawing are done on an "invisible" graphics screen before the program displays the picture.

The CoCo can display a high-resolution picture based on information contained in $1800 bytes beginning at any multiple of $200. I use what the Basic manual calls the first four graphics pages ($600-$1DFF) to hold one graphics screen, and graphics pages 5-8 ($1E00-$35FF) for the second graphics screen. One of these screens is being displayed on your TV whenever Display is running.

When the program calls DISPLA, it clears (sets to 0) the part of memory devoted to the other graphics screen and draws the picture of the object there. Then it displays the new graphics screen and uses the other one for the next picture of the object.

The variable TL ($721F-$7220) keeps track of which graphics screen is being displayed. *Getting Started with Color Basic,* pp. 259-260, explains switching graphics screens.

```
      IF X1 LEFT AND Y1  Y THEN (The Left endpoint is already on the visible screen)
        GOTO LN3
      XTEMP=X2
      YTEMP = Y2
LN4 X = (X1 + XTEMP) DIV 2 (DIV 2 means divide by 2 and take the integer part)
      Y=(Y1 + YTEMP) DIV 2
      IF (X  LEFT AND Y  TOP) OR (X  RIGHT AND Y  BOTTOM) THEN
      RETURN (No part of the line is visible)
      IF X<LEFT OR Y<BOTTOM THEN
        X1=X
        Y1=Y
        GOTO LN4
      ELSE IF X>LEFT AND Y>BOTTOM THEN
        XTEMP = X
        YTEMP = Y
        GOTO LN4
      ELSE ((X,Y) is on the left or bottom boundary of the visible screen)
        X1 = X (These are the corrected values for X1 and Y1)
        Y1 = Y
LN3 .....
```

Table 3. Pseudocode Version of Clip Routine

Table 2 gives a pseudocode version of DISPLA. You might note two points about this routine. First of all, I ignore the z-coordinate of each point. That is because the value of the z-coordinate does not affect the location of a point in the picture. Second, I use only the integer parts of the x- and y-coordinates. Truncating is faster than rounding and no less precise. Points separated by more than one unit are displayed separately on the screen.

The last routine I want to discuss is the line-drawing routine, LINE. Four parameters, X1, Y1, X2, and Y2 are passed to LINE, and it draws a line on the screen from (X1,Y1) to (X2,Y2). Remember that (0,0) is the center of the screen, the x-coordinate goes left to right, and the y-coordinate goes bottom to top.

These conventions are different from Radio Shack's, which place (0,0) at the top left corner and measure the Y-coordinate top to bottom. Radio Shack's coordinates are perfect for describing the location of characters on a printed page; mine are those used universally by scientists, engineers, and mathematicians for two-dimensional graphics.

LINE begins by comparing X1 and X2, and swapping (X1,Y1) with (X2,Y2) if necessary, to assure that X1 X2. Then LINE divides into two branches. I will discuss the case Y1 Y2; the other case, handled by SELine (south east line), is similar.

To recapitulate, I want to draw a line from (X1,Y1) to (X2,Y2), and I have arranged matters so that X1 X2 and Y1 Y2. The coordinates X1, Y1, X2, and Y2 are between -4,096 and 4,096, but you can only see a point (X,Y) if -128 X 127 and -96 Y 95.

The first thing to do is to check to see if any part of the line will fall into the visible part of the screen. I define some constants corresponding to the borders of the visible screen:

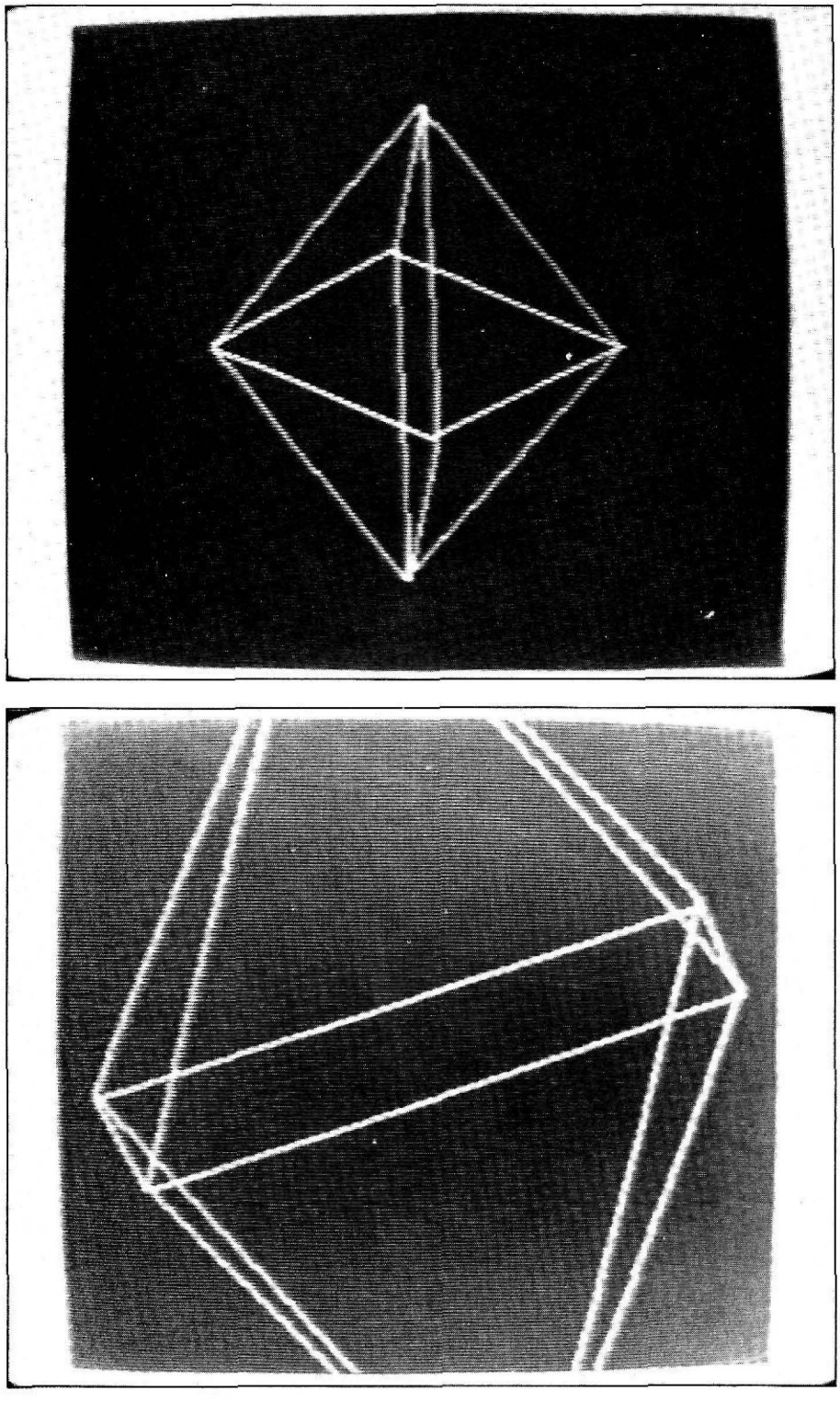
```
LEFT=-$80 = -128
RIGHT=$7F = 127
TOP = $5F = 95
BOTTOM=-$60 = -96
```

Then I execute the following routine to skip invisible lines:

```
IF X1  RIGHT OR Y1  TOP OR X2  LEFT
OR Y2  BOTTOM THEN RETURN FROM
SUBROUTINE LINE (No part of the line falls
into the visible screen)
```

This test eliminates only some of the invisible lines. Others will be eliminated below.

Next, I clip the line. That is, I cut off that part of the line that doesn't show



Photos la and lb. Normal and Enlarged Views of a Diamond Shape

on the screen by making the values of (X1,Yl) and (X2,Y2) equal to the endpoints of the visible portion of the line to be drawn. An algorithm analogous to a binary search does the clipping.

I will describe in pseudocode how (X1,Yl) are reset, if necessary, from their original values to the left endpoint of the visible portion of the line. A similar process resets (X2,Y2) equal to the right endpoint of the visible portion of the line. Of course, if an endpoint of the line is already visible on the screen, then the clipping process leaves it unchanged.

Note finally that while clipping away the invisible part of a line, I may discover that the entire line lies outside the visible screen. In that case I quietly execute a RTS and return from the subroutine LINE.

Table 3 shows the pseudocode version of the routine that clips the left end of the line from (X1,Yl) to (X2,Y2). Remember, X1 X2 and Y1 Y2.

When I have clipped the endpoints of my line where necessary, I know that I have endpoints (X1, Y1) and (X2, Y2) on the visible screen, with (X2,Y2) northeast of (X1,Y1). More precisely:

-$80 X1 X2 $7F
-$60 Y1 Y2 $5F

The routine that sets the pixels on the screen for the line from (X1.Y1) to (X2,Y2) mimics the Basic instruction LINE(X1,Y1)-(X2,Y2),PSET. Actually, there are two routines: one for the case Y2-Y1<X2-X1, and the other for Y2-Y1 X2-X1. The first case corresponds to the routine in Line beginning at ENELN (east north east line). The second is similar.

If you wanted to draw a line on the screen, you might try something like this:

```
SLOPE = (Y2 - Y1)/(X2-X1)
Y = Y1
FORX = X1 TO X2 DO
  YINT = INT(Y) (The integer part of Y).
  PSET(X,YINT) (X is always an integer—PSET
    turns on the pixel at (X,YINT)).
  Y = Y + SLOPE
ENDFOR
```

You could write this routine in Basic using the PSET function. You would draw a straight line, but the processing would be painfully slow. Even a machine-language routine modeled on this algorithm is slow, because using a function like PSET requires that you recompute the byte and bit corresponding to (X,YINT) for each different value of X between X1 and X2.

There is a better way. As X is incremented, the byte and bits corresponding to the points (X,YINT) follow each other in a regular manner. The basic idea is as follows:

```
SLOPE = (Y2-Y1)/(X2 - X1)
Start at pixel corresponding to (X1,Y1)
DO X2 - X1 + 1 TIMES
  light up the pixel
  move over one pixel and up slope pixels
ENDDO
```

Unfortunately, slope is a fraction. Since you can't move up a fraction of a pixel, you must do something like this:

```
SLOPE = (Y2- Y1)/(X2 - X1)
B = 0
Start at pixel corresponding to (X1,Y1)
DO X2-X1 + 1 TIMES
  light up the pixel
  move over one pixel
  B = B + SLOPE
  IF B  1 THEN B = B - 1; move up one pixel
ENDDO
```

FINALLY!

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This is the algorithm realized by the routine ENELN. To explain how I coded it, I must first explain which byte and bit correspond to the pixel at a point (X,Y).

Let TL be the address of the byte corresponding to the top left corner of the high-resolution screen. Either TL = $600 or TL = $1E00, depending on which graphics screen you are drawing.

Bit 7 of byte TL controls the pixel at the top left corner of the screen, and the next seven pixels of the top row are controlled by bits 6-0 of byte TL. Bits 7-0 of byte TL + 1 control the next eight pixels. Bits 7-0 of byte TL + $20 = TL + 32 control the first eight pixels of the second row.

Since there are 192 rows of pixels on the high-resolution graphics screen, the pixel in the lower right corner of the screen is controlled by bit 0 of byte TL+ $17FF = TL + 6143.

Computing the bit and byte corresponding to a point (X,Y) uses integer division (DIV) and the remainder function (MOD). Remember that N DIV M is the largest integer not greater than N/M. For example, 8 DIV 2 = 4; 7 DIV 3 = 2; and -7 DIV 3 = -3. N MOD M = M*(N/M - N DIV M) so 8 MOD 2 = 0; 7 MOD 3 = 1; and -7 MOD 3 = 2.

Since I have placed (0,0) at the center of the screen, and since I let the Y-coordinate increase as it goes up the screen, I compute the byte and bit corresponding to the point (X,Y) as follows:

BYTE(X, Y) = TL + ($59 - Y)*$20 + ($80 + X)DIV 8
BIT(X,Y) = 7-X MOD 8

Table 4 shows a new version of the line-drawing routine. The algorithm in this table faithfully mirrors the Assembly routine beginning at ENELN. The main complication comes in computing BIT (X,Y) and setting the bit to 1.

The U-register contains none of the numbers 0-7, but rather one of the addresses, BITS...LASTBT. BITS contains the binary number 10000000; BITS+1 contains 01000000, and so forth, until BITS + 7 = LASTBT contains 00000001.

The U-register contains the address of one of these words, which are called *masks,* indicating which bit is to be set to 1. The address of the byte to be modified is in the X-register, and the instructions bit UREG of byte XREG = 1 is expanded into the following sequence:

```
LDA ,X get the byte to be modified
ORA ,U set the required bit to 1
STA ,X return the modified byte to screen
   memory.
```

Program Listing 1. Basic Portion of Display

```
100 REM PROGRAM DISPLAY
110 REM COPYRIGHT DAVID MEREDITH L983
120 REM BASIC PROGRAM PERMITS INPUT OF A 3-D PICTURE AS POINTS A
ND LINE SEGMENTS.  MACHINE LANGUAGE COMPONENT DISPLAYS THE PICTU
RE
130 REM AND ALLOWS PANNING, SCALING, AND ROTATING
140 CLS:PRINT873,"D I S P L A Y":PRINT@135,"BY DAVID MEREDITH":P
RINT@201,"COPYRIGHT 1983"
145 PRINT@416,"READING MACHINE LANGUAGE PART..."
150 CLOADM"DISPLAYM":PCLEAR8:CLEAR 100,&H7000
160 PO=&H7000:LI=PO+9*26:MA=LI+121:REM ADDRESSES OF POINTS BUFFE
R, LINES BUFFER, AND MAIN DISPLAY ROUTINE
165 DIM CH(25)
170 GOSUB 1000: REM NEW PICTURE
175 CS$="HELPNEWDISPLAY":LD$="LOAD":SV$="SAVE":AA=ASC("A"):QU$=C
HR$(34)
180 CLS:PRINT"ENTER help ANYTIME FOR GUIDANCE"
190 LINEINPUT A$:REM GET NEW POINT, LINE, OR COMMAND
200 I=INSTR(A$," "):IFI<>0THENA$=LEFT$(A$,I-1)+RIGHT$(A$,LEN(A$)
-I):GOTO200:REM ELIMINATE BLANKS
210  IFLEN(A$)>2THENI=INSTR(CS$,A$):IFI=0THEN215ELSEIFI=1THENGOSU
B1600:GOTO190ELSEIFI=5THENGOSUB1000:GOTO190ELSEIFI=8THENGOSUB180
0:GOTO190
215  IF  INSTR(A$,LD$)=1THENGOSUB1200:GOTO190ELSEIFINSTR(A$,SV$)=1
THENGOSUB1400:GOTO190
220  IFINSTR(A$,"=")=2THENGOSUB2000:GOTO190:REM DEFINE A POINT
230  IFINSTR(A$,"??")=1 THEN GOSUB 2200:GOTO190:REM PRINT LINE SE
GMENTS
240  IFINSTR(A$,"?")=1 THENGOSUB2400:GOTO190:REM PRINT POINTS
250 REM AT THIS POINT A$ EITHER DEFINES LINES OR IS INCORRECT
260 L=LEN(A$):IFL<2THENGOSUB2600:GOTO190:REM IF LEN(A$)<2 THEN L
INE INCORRECT
270 IFL<2THEN190ELSEA1=ASC(LEFT$(A$,1))-AA:A2=ASC(MID$(A$,2,1))-
AA:IF A<0 OR A1>25 OR A2<0 OR A2>25 THEN GOSUB2600:GOTO190ELSE
L=L-2:A$=RIGHT$(A$,L)
274 IFA1=A2 THENPRINT:PRINT"ENDPOINTS MUST BE DISTINCT":PRINT:GO
TO190
275 IFINSTR(A$,"#")=1THENL=L-1:A$=RIGHT$(A$,L):GOTO400:REM  DELET
E A POINT
280  I=LI:A1=9*A1:A2=9*A2
```

Listing continued

The entire routine LINE seems to produce lines identical to those drawn by the Basic command, **LINE.**

Conclusion

Here are some sample objects you can try with Display. The first is a diamond. Enter points and line segments as follows:

```
A =0,0,50
B =0,0,-50
C =0,50,0
D =0,-50,0
E =50,0,0
F =-50,0,0
AC AD AE AF BC BD BE BF CE CF DE DF
```

Note: Press enter after typing each line segment for this and all other sample objects.

Here are the specifications for a cube (when it first appears on the screen, all you see is a square, because the back half is hiding behind the front half):

```
A =0,0,0
B =50,0,0
C =50,50,0
D =0,50,0
E =0,0,50
F =50,0,50
G =50,50,50
H =0,50,50
AB BC CD DA EF FG GH HE
AE BF CG DH
```

Finally, you can draw groups of objects on the screen. Here, for example, are the four letters, W, O, R, D. You can make them spin and move just like the animated logos in a TV commercial:

```
A =-64,0,0
B =-64,31,0
C =-55,15,0
D =-45,0,0
E =-45,31,0
F =-32,0,0
G =-32,31,0
H =-13,31,0
I =-13,0,0
J =0,0,0
K =0,15,0
L =0,31,0
M=19,31,0
N =19,15,0
O = 19,0,0
P =32,0,0
Q =32,31,0
R =48,31,0
S =51,28,0
T =51,3,0
U =48,0,0
AB AC CD DE FG GH HI IF JK KL LM MN
NK KO PQ QR RS ST TU UP
```

Display has two limitations. The first is a software limitation that could be remedied by any reader. You cannot

program moving graphics displays with this program; you can only control them in real time. However, you could program a graphics display by calling separately the subroutines that pan, scale, rotate, and display objects. Just remember to disable the regular interrupt each time you call one of the subroutines.

The second limitation is due to the hardware. The display cannot be made to move faster or to show more complex animation. The 6809 is a wonderful chip, but it can only work so fast.

Moving graphics systems more powerful than Display take lots of computing power—more than can be expected of an 8-bit processor unsupported by special graphics hardware. I do not believe this program could be recoded to run more than twice as fast as it does now. Most of the running time is spent in the line-drawing routine, which seems fairly efficient to me.

Professional graphics systems use special-purpose hardware and often some form of parallel processing to speed up their displays. However, Display contains some of the basic software elements of a moving graphics system, and the hardware requirement is certainly reasonable—about 10 percent of the cost of a high-quality color-graphics terminal. So, enjoy experimenting with moving graphics, and write to me if you find some interesting ways to use this program, or if you just create some unusual objects.

Final Notes

1) Executing PCLEAR8 before running Display seems to overcome an obscure bug in the Basic instruction EXEC.

Display is loaded from tape into memory beginning with the fifth graphics page. Executing PCLEAR8 in line 150 should move the program beyond the eighth graphics page, so that the machine-language routines that alter the memory corresponding to the graphics pages should not affect the program. But it does not work that way. Try the following program and watch it crash:

```
10 CLEAR 100, &H3900
20 PCLEAR 8
30 FOR I = &H3900 TO &H390F
40 READ X
50 POKE I,X
60 NEXT I
70 EXEC &H3900
80 PRINT "SUCCESSFUL RETURN
```

Continues on p. 127

Listing continued

```
290 P=PEEK(I):Q=PEEK(I+1):IFP<>255THENIF(P=A1 ANDQ=A2)OR(P=A2 AN
DQ=A1)THENPRINT:PRINT"LINE ";CHR$(AA+A1/9);CHR$(AA+A2/9);" ALREA
DY DEFINED":PRINT:GOTO190ELSEI=I+2:GOTO290:REM FIND NEXT OPEN SP
ACE IN LINES BUFFERCHECKING FOR DUPLICATION
300 IF I=MA-1 THENPRINT:PRINT"NO ROOM FOR ANOTHER LINE":PRINT:GO
TO190
310 IFPEEK(PO+A1)=128THENPRINT:PRINT"POINT ";CHR$(A1/9+AA);" NOT
 DEFINED":PRINT:GOTO270
320 IFPEEK(PO+A2)=128THENPRINT:PRINT"POINT ";CHR$(A2/9+AA);" NOT
 DEFINED":PRINT:GOTO270
330 POKEI,A1:POKEI+1,A2:POKEI+2,255:IFL>0THEN270ELSE190:REM PUT
LINE SEGMENT IN LINE BUFFER AND GET NEXT SEGMENT IF ANY
400 REM DELETE A LINE SEGMENT A1,A2
410 I=LI:A1=9*A1:A2=9*A2
420 IFPEEK(I)=255 THENPRINT:PRINTLINE SEGMENT ";CHR$(A1/9+AA);C
HR$(A2/9+AA);" NOT DEFINED":PRINT:GOTO270
430 P=PEEK(I):Q=PEEK(I+1):IF(P<>A1 ORQ<>A2)AND(P<>A2 ORQ<>A1)THE
NI=I+2:GOTO420
440 P=PEEK(I+2):POKEI,P:IFP=255THEN270ELSEI=I+1:GOTO440:REM DELE
TE THE POINT BY MOVING  DATA DOWN THE BUFFER
1000 REM MAKE A BLANK PICTURE
1010 FORI=PO TO PO+9*25 STEP 9:POKEI,128:NEXT:REM MARK ALL POINT
S AS UNDEFINED
1020 POKELI,255:REM CLEAR LINE BUFFER
1030 RETURN
1200 REM LOAD A PICTURE FROM TAPE
1210 I=INSTR(A$,QU$):IFI<>0THENJ=INSTR(I+1,A$,QU$):IFJ<>0THENNA$
=MID$(A$,I,J-I+1)ELSENA$=RIGHT$(A$,LEN(A$)-I)ELSENA$=""
1220 IFLEN(NA$)>8THENNA$=LEFT$(NA$,8)
1230 CLOADM NA$:GOTO1800:REM DISPLAY PICTURE AFTER LOADING
1400 REM SAVE CURRENT PICTURE ON TAPE
1410 I=INSTR{A$,QU$):IFI<>0THENJ=INSTR(I+1,A$,QU$):IFJ<>0THENNA$
=MID$(A$,I,J-I+1)ELSENA$=RIGHT$(A$,LEN(A$)-I)ELSENA$=""
1420 IFLEN(NA$)>8THENNA$=LEFT$(NA$,8)
1430 CSAVEM NA$,PO,MA-1,PO:RETURN
1600 REM HELP ROUTINE
1610 CLS:PRINT"DISPLAY PICTURE:  display"
1620 PRINT"ERASE PICTURE:  new"
1630 PRINT"SAVE PIX ON TAPE:  save";QU$;"NAME";QU$
1640 PRINT"READ PIX FROM TAPE:  load";QU$;"NAME";QU$
1650 PRINT"ENTER POINT P:  P = X,Y,Z"
1660 PRINT"ENTER LINE SEGMENT AB:  AB"
1670 PRINT"DELETE LINE SEGMENT CD:  CD#"
1680 PRINT"PRINT POINTS A TO H:  ?A-H"
1690 PRINT"PRINT LINE SEGMENTS:  ??"
1700 PRINT:RETURN
1800 REM DISPLAY THE PICTURE
1810 REM FIRST DECLARE ALL UNUSED POINTS AS UNDEFINED
1820 FORI=0TO25:CH(I)=0:NEXT
1830 I=LI
1840 P=PEEK(I):IFP<>255THENCH(P/9)=1:I=I+1:GOTO1840:REM MARK ALL
 POINT NAMES USED
1850 FORI=0TO25:IFCH(I)=0THENPOKEPO+9*I,128:NEXT:REM MARK UNUSED
 POINTS AS UNDEFINED
1860 POKE 282,0:EXEC MA:POKE282,255:PRINT:RETURN
2000 REM INPUT A POINT
2010 A=ASC(LEFT$(A$,1))-AA:IFA<0ORA>25THENGOSUB 2600:RETURN
2020 AD=PO+9*A
2030 A$=RIGHT$(A$,LEN(A$)-2)
2040 IFA$=""THENGOSUB2600:RETURN
2050 VA=VAL(A$):IFABS(VA)>80THENPRINT:PRINT"COORDINATES MUST BE
BETWEEN -80 AND 80":PRINT:RETURNELSEB=LEN(A$)-LEN(STR$(VA)):IFVA
<0THENB=B-1
2055 IFB<3THENGOSUB2600:GOTO190ELSEA$=RIGHT$(A$,B):IFVA>=0THENV1
=0:V2=VA ELSEV1=255:V2=256+VA
2060 POKE AD,V1:POKEAD+1,V2:POKEAD+2,0:AD=AD+3
2070 IFA$=""THENGOSUB2600:RETURN
2080 VA=VAL(A$):IFABS(VA)>80THENPRINT:PRINT"COORDINATES MUST BE
BETWEEN -80 AND 80":PRINT:RETURNELSEB=LEN(A$)-LEN(STR$(VA)):IFVA
<0THENB=B-1
2085 IFB<1THENGOSUB2600:GOTO190ELSEA$=RIGHT$(A$,B):IFVA>=0THENV1
=0:V2=VA ELSE V1=255:V2=256+VA
2090 POKE AD,V1:POKEAD+1,V2:POKEAD+2,0:AD=AD+3
2140 VA=VAL(A$):IFABS(VA)>80 THEN PRINT:PRINT"COORDINATES MUST B
E BETWEEN -80 AND 80":PRINT:RETURN
2145 IFVA>=0THENV1=0:V2=VA ELSEV1=255:V2=256+VA
2150 POKE AD,VI:POKEAD+1,V2:POKEAD+2,0:RETURN
2200 REM PRINT LINES
2210 I=LI
2220 P=PEEK(I):IF P=255 THEN PRINT:RETURN
2230 PRINTCHR$(P/9+AA);CHR$(PEEK(I+1)/9+AA);" ";:I=I+2:GOTO2220
2400 REM PRINT POINTS
2410 A1=0:A2=25:I=INSTR(A$,"-"):IFI=3THENA1=ASC(MID$(A$,2,1))-AA
:IFA1<0ORA1>25THENA1=0:GOTO2030
2420 IFI<LEN(A$)ANDI<=3THENA2=ASC(MID$(A$,I+1,1) )-AA:IFA2<0ORA2>
25THENA2=25
2430 FORI=A1 TO A2:AD=PO+9*I:IFPEEK(AD)=128THENNEXT:RETURN
2440 PRINTCHR$(I+AA);" = ";:FORJ=0TO6STEP3
```

Listing continued

Listing continued

```
2450  VA=PEEK(AD+J)*256+PEEK(AD+J+1)+PEEK(AD+J+2)/256:IFVA>32767T
HENVA=VA-65536
2460  V$=STR$(VA):PRINTV$;:IPJ<>6THENPRINT",";
2465  NEXT:PRINT:NEXT:RETURN
2600  PRINT:PRINT"UNRECOGNIZED  COMMAND":PRINT:RETURN
```

Program Listing 2. Assembly Portion of Display

```
                    00100 *
                    00110 *  PROGRAM  <<DISPLAY>>
                    00120 *  PAN,  SCALE,  AND ROTATE CONTENTS OF *POINTS* THEN DISP
LAY  THE  CONTENTS OF *LINES*
                    00130 *
7000                00140          ORG      $7000
                    00150 *
                    00160 *  BASIC DATA STRUCTURES--THE POINTS AND LINES TO BE DRA
WN. POINTS MAINTAINS THE COODINATES THE COORDINATES OF THE POINTS
                    00170 *
7000                00180 POINTS   RMB      9*26     STORE THREE COORDS OF THREE BYT
ES EACH LABELED A..Z FOR THE USER !
                    00190 *  UNUSED POINTS HAVE $80 IN THE FIRST BYTE OF EACH COOR
DINATE
70EA                00200 LINES    RMB      121      UP TO 30 PAIRS OF POINTS,  LAST
PAIR FOLLOWED BY -1,  POINT L REPRESENTED BY 9*(ASC(L)-ASC(A))
                    00210 *  INTRODUCTORY HOUSEKEEPING TO DISABLE BASIC INTERRUPTS
 AND CREATE NEW STACK THEN RESTORE THEN RESTORE ENVIRONMENT FOR RETURN TO BASIC
                    00220 *
7163 1A    10       00230          ORCC     #$10     DISABLE REGULAR INTERRUPT
7165 33    E4       00240          LEAU     ,S
7167 10CE 8000      00250          LDS      #$8000   USE HIGH MEMORY FOR HARDWARE ST
ACK
716B 34    40       00260          PSHS     U
716D BD    7177     00270          JSR      MAIN
7170 35    40       00280          PULS     U
7172 32    C4       00290          LEAS     ,U       RESTORE HARDWARE STACK
7174 1C    EF       00300          ANDCC    #$EF     ENABLE REGULAR INTERRUPT
7176 39             00310          RTS
                    00320 *
                    00330 *  MAIN DISPLAY LOOP--LOOKS FOR A KEY COMMANDING ROTATIO
N,  PANNING,  OR SORTING AND ORDERS  SSAME.  INCLUDES  AUTO REPEAT
                    00340 *
7177 B7    FFC0     00350 MAIN     STA      $FFC0    SET VDG = 110
717A B7    FFC3     00360          STA      $FFC3
717D B7    FFC5     00370          STA      $FFC5
7180 B6    FF22     00380          LDA      $FF22    SET HI BITS CONTROL REGISTER =
$F0
7183 84    07       00390          ANDA     #7
7185 8A    F0       00400          ORA      #$F0
7187 B7    FF22     00410          STA      $FF22
718A BD    7221     00420          JSR      DISPLA   DISPLAY THE PICTURE
718D AD    9F A000  00430 KEY      JSR      [$A000]
7191 27    FA       00440          BEQ      KEY
7193 BD    7731     00445          JSR      KEYVAL
7196 81    08       00450          CMPA     #$8      LEFT ARROW
7198 26    05       00460          BNE      MAIN1
719A 8E    72AF     00470          LDX      #PANL
719D 20    68       00480          BRA      REPEAT
719F 81    09       00490 MAIN1    CMPA     #$9      RIGHT ARROW
71A1 26    05       00500          BNE      MAIN2
71A3 8E    72E5     00510          LDX      #PANR
71A6 20    5F       88520          BRA      REPEAT
71A8 81    5E       00530 MAIN2    CMPA     #$5E     UP ARROW
71AA 26    05       00540          BNE      MAIN3
71AC 8E    7351     00550          LDX      #PANU
71AF 20    56       00560          BRA      REPEAT
71B1 81    0A       00570  MAIN3   CMPA     #$0A     DOWN ARROW
71B3 26    05       00580          BNE      MAIN4
71B5 8E    731B     00590          LDX      #PAND
71B8 20    4D       00600          BRA      REPEAT
71BA 81    78       00610 MAIN4    CMPA     #$78     UNSHIFTED X
71BC 26    05       00620          BNE      MAIN5
71BE 8E    7387     00630          LDX      #ROTX
71C1 20    44       00640          BRA      REPEAT
71C3 81    58       00650 MAIN5    CMPA     #$58     SHIFTED X
71C5 26    05       00660          BNE      MAIN6
71C7 8E    73D0     00670          LDX      #ROTMX
71CA 20    3B       00680          BRA      REPEAT
71CC 81    79       00690 MAIN6    CMPA     #$79     UNSHIFTED Y
71CE 26    05       00700          BNE      MAIN7
71D0 8E    7419     00710          LDX      #ROTY
71D3 20    32       00720          BRA      REPEAT
71D5 81    53       00730 MAIN7    CMPA     #$59     SHIFTED Y
71D7 26    05       00740          BNE      MAIN8
71D3 8E    7460     00750          LDX      #ROTMY
71DC 20    29       00760          BRA      REPEAT
71DE 81    7A       00770 MAIN8    CMPA     #$7A     UNSHIFTED Z
71E0 26    05       00780          BNE      MAIN9
71E2 8E    74A7     00790          LDX      #ROTZ
71E5 20    20       00800          BRA      REPEAT
71E7 81    5A       00810 MAIN9    CMPA     #$5A     SHIFTED Z
71E9 26    05       00820          BNE      MAIN10
71EB 8E    74EE     00830          LDX      #ROTMZ
71EE 20    17       00840          BRA      REPEAT
71F0 81    62       00850 MAIN10   CMPA     #$62     UNSHIFTED B
71F2 26    05       00860          BNE      MAIN11
71F4 8E    7618     00870          LDX      #BIGGER
71F7 20    0E       00880          BRA      REPEAT
71F9 81    73       00890 MAIN11   CMPA     #$73     UNSHIFTED S
71FB 26    05       00900          BNE      MAIN12
71FD 8E    76AB     00910          LDX      #SMALLR
7200 20    05       00920          BRA      REPEAT
7202 81    40       00930 MAIN12   CMPA     #$40     @
7204 26    87       00940          BNE      KEY      NO COMMAND RECOGNIZED
7206 39             00950          RTS
7207 34    14       00960 REPEAT   PSHS     X,B      SAVE ADDRESS OF SUB CALLED BY L
AST KEY AND SUM OF KEY BUFFERS
7209 AD    F8 01    00970 REP1     JSR      [1,S]    1,S POINTS TO ADDRESS OF SUBROU
TINE CALLED BY LAST KEY PRESSED
720C BD    7221     00980          JSR      DISPLA   DISPLAY UPDATED POINTS
720F AD    9F A000  00990          JSR      [$A000]
7213 BD    7731     01000          JSR      KEYVAL
7216 E1    E4       01010          CMPB     ,S
7218 27    EF       01090          BEQ      REP1     KEY STILL DEPRESSED
721A 32    63       01100          LEAS     3,S      RESTORE STACK
721C 16    FF6E     01110          LBRA     KEY      LOOK FOR ANOTHER COMMAND
                    01120 *
                    01130 *  CREATE A PICTURE USING CURRENT POINTS AND LINES ON TH
E  UNSEEN  GRAPHICS SCREEN THEN DISPLAY THAT SCREEN
                    01140 *
721F      0600      01150 TL       FDB      $600     CONTAINS THE ADDRESS OF THE FIR
ST BYTE OF THE PRESENTLY UNSEEN GRAPHICS SCREEN--INITIALIZED SO
                    01160 *
                    01170 *  PLOT THE CURRENT LINES ON THE UNSEEN GRAPHICS SCREEN
THEN DISPLAY THE SCREEN
                    01180 *
7221 4F             01190 DISPLA   CLRA      BLANK SCREEN
7222 C6    0C       01200          LDB      #$C
7224 108E 0000      01210          LDY      #0
7228 BE    721F     01220          LDX      TL
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Listing continued

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722B 10AF 81    01230 DISP1   STY     ,X++
722E 4A         01240         DECA
722F 26   FA    01250         BNE     DISP1
7231 5A         01260         DECB
7232 26   F7    01270         BNE     DISP1
                01280 *
                01290 * PLOT EACH LINE
                01300 *
7234 CE   70EA  01310         LDU     #LINES
7237 E6   C0    01320 DISP3   LDB     ,U+
7239 C1   FF    01330         CMPB    #$FF
723B 27   2F    01340         BEQ     DISP2   LAST POINT?
723D 4F         01350         CLRA
723E            01360 P1300
723E C3   7000  01370         RDDD    #POINTS
7241 1F   02    01380         TFR     D,Y     ADDRESS OF FIRST POINT
7243 AE   A4    01390         LDX     ,Y
7245 BF   7752  01400         STX     X1
7248 31   23    01410         LEAY    3,Y
724A AE   A4    01420         LDX     ,Y
724C BF   7754  01430         STX     Y1
724F E6   C0    01440         LDB     ,U+
7251 4F         01450         CLRA
7252 C3   7000  01460         RDDD    #POINTS
7255 IF   02    01470         TFR     D,Y     ADDRESS OF SECOND POINT
7257 AE   A4    01480         LDX     ,Y
7259 BF   7756  01490         STX     X2
725C 31   23    01500         LEAY    3,Y
725E AE   A4    01510         LDX     ,Y
7260 BF   7758  01520         STX     Y2
7263 34   40    01530         PSHS    U
7265 BD   775B  01540         JSR     LINE
7268 35   40    01550         PULS    U
726A 20   CB    01560         BRA     DISP3
                01570 *
                01580 * SWITCH SCREENS TO SHOW NEW PICTURE
                01590 *
726C BE   721F  01600 DISP2   LDX     TL
726F SC   0600  01610         CHPX    #$600
7272 27   IF    01620         BEQ     DISP4
7274 B7   FFC7  01630         STA     $FFC7   VIDEO OFFSET=$1E00/$200=$F
7277 B7   FFC9  01640         STA     $FFC9
727A B7   FFCB  01650         STA     $FFC3
727D B7   FFCD  01660         STA     $FFCD
7280 B7   FFCE  01670         STA     $FFCE
7283 B7   FFD0  01680         STA     $FFD0
7286 B7   FFD2  01690         STA     $FFD2
7289 B7   FFD4  01700         STA     $FFD4
728C 3E   0600  01710         LDX     #$600
728F BF   721F  01720         STX     TL      SET TL = FIRST BYTE OF UNUSED S
CREEN
7292 39         01730         RTS
7293 B7   FFC7  01740 DISP4   STA     $FFC7   SET VIDEO OFFSET = $600/$200=$3
7296 B7   FFC9  01750         STA     $FFC9
7299 B7   FFCA  01760         STA     $FFCA
729C B7   FFCC  01770         STA     $FFCC
729F B7   FFCE  01780         STA     $FFCE
72A2 B7   FFD0  01790         STA     $FFD0
72A5 B7   FFD2  01800         STA     $FFD2
72A8 8E   1E00  01810         LDX     #$1E00
72AB BF   721F  01820         STX     TL      FIRST BYTE OF UNSEEN VIDEO SCRE
EN
72AE 39         01830         RTS
                01840 *
                01850 * ROUTINES TO MOVE POINTS
                01860 *
                01870 *
                01880 * RAN LEFT
                01890 *
          70E1  01900 LASTPT  SET     P0INTS+$9*$19
72AF 8E   7000  01910 PANL    LDX     #POINTS
72B2 A6   84    01920 PANL2   LDA     ,X
72B4 81   80    01930         CMPA    #$80
72B6 27   0B    01940         BEQ     PANL1
72B8 EC   84    01950         LDD     ,¥,     GET X COORDINATE AND SUBTRACT 2
72BA 83   0002  01960         SUBD    #2
72BD ED   84    01970         STD     ,X
72BF 81   80    01980         CMPA    #-$80
72C1 2F   08    01990         BLE     PANL4   POINT OUT OF BOUNDS
72C3 30   09    02050 PANL1   LEAX    9,X
72C5 8C   70E1  02060         CMPX    #LASTPT
72C8 23   E8    02070         BLS     PANL2
72CA 39         0 2 0 8 0     RTS
72CB A6   84    02090 PANL4   LDA     ,X      SINCE ONE POINT OUT OF BOUNDS,
RESTORE ALL POINTS TO ORIGINAL VALUES
72CD 81   80    02100         CNPA    #$80
72CF 27   0C    02110         BEQ     PANL5
72D1 A6   01    02120         LDA     1,X
72D3 8B   02    02130         RDDA    #2
72D5 A7   01    02140         STA     1,X
72D7 A6   84    02150         LDA     ,X
72D9 89   00    02160         ADCA    #0
72DB A7   84    02170         STA     ,X
72DD 30   17    02180 PANL5   LEAX    -9,X
72DF 8C   7000  02190         CMPX    #POINTS
72E2 24   E7    02200         BHS     PANL4
72E4 39         02210         RTS
                02220 *
                02230 * FAN RIGHT
                02240 *
72E5 8E   7000  02250 PRNR    LDX     #POINTS
72E8 A6   84    02260 PRNR2   LDA     ,X
72EA 81   80    02270         CMPA    #$80
72EC 27   0B    02280         BEQ     PANR1   IF POINT UNDEFINED
72EE EC   84    02290         LDD     ,X      ADD 2 TO X COORDINATE
72F0 C3   0002  02300         ADDD    #2
72F3 ED   84    02310         STD     ,X
72F5 81   10    02320         CMPA    #$10
72F7 2C   08    02330         BGE     PANR4   POINT OUT OF BOUNDS
72F9 30   09    02390 PANR1   LEAK    9,X
72FB 8C   70E1  02400         CMPX    #LASTPT
72FE 23   E8    02410         BLS     PANR2
7300 39         02420         RTS
7301 A6   84    02430 PANR4   LDA     ,X      SINCE ONE POINT OUT OF BOUNDS,
RESTORE ALL POINTS  TO ORIGINAL VALUES
7303 81   80    02440         CMPA    #$80
7305 27   0C    02450         BEQ     PANR5
7307 A6   01    02460         LDA     1,X
7309 80   02    02470         SUBA    #2
730B A7   01    02480         STA     1,X
730D A6   84    02490         LDA     ,X
730F 82   00    02500         SBCA    #0
7311 A7   84    02510         STA     ,x
7313 30   17    02520 PANR5   LEAX    -9,X
7315 8C   7000  02530         CMPX    #POINTS
7318 24   E7    02540         BHS     PRNR4
731A 39         02550         RTS
                02560 *
                02570 * PAN DOWN
                02580 *
731B 8E   7080  02590 PAND    LDX     #POINTS
731E A6   34    02600 PRND2   LDA     ,X
7320 81   80    02610         CMPA    #$80
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Listing continued

Listing continued

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7322 27   0B       02620          BEQ     PAND1   IF POINT UNDEFINED
7324 EC   63       02630          LDD     3,X     SUBTRACT 2 FROM Y COORDINATE
7326 83   0002     02640          SUBD    #2
7329 ED   03       02650          STD     3,X
732B 81   F0       02660          CMPA    #-$10
732D 2F   08       02670          BLE     PAND4   IF POINT OUT OF BOUNDS
732F 30   09       02730 PAND1    LEAX    9,X
7331 8C   70E1     02740          CMPX    #LASTPT
7334 23   E8       02750          BLS     PAND2
7336 39            02760          RTS
7337 A6   84       02770 PAND4    LDA     ,X      SINCE ONE POINT OUT OF BOUNDS,
RESTORE ALL POINTS  TO ORIGINAL VALUES
7339 81   80       02780          CMPA    #$80
733B 27   0C       02790          BEQ     PAND5
733D A6   04       02800          LDA     4,X
733F 8B   02       02810          ADDA    #2
7341 A7   04       02820          STA     4,X
7343 A6   03       02830          LDA     3,X
7345 89   00       02840          ADCA    #0
7347 A7   03       02850          STA     3,X
7349 30   17       02860 PAND5    LEAX    -9,X
734B 8C   7000     02870          CMPX    #POINTS
734E 24   E7       02880          BHS     PAND4
7350 39            02890          RTS
                   02900 *
                   02910 * PAN UP
                   02920 *
7351 8E   7000     02930 PANU     LDX     #POINTS
7354 A6   84       02940 PANU2    LDA     ,X
7356 81   80       02950          CMPA    #$80
7358 27   0B       02960          BEQ     PANU1   IF POINT UNDEFINED
735A EC   03       02970          LDD     3,X     ADD 2 TO Y COORDINATE
735C C3   0002     02980          ADDD    #2
735F ED   03       02990          STD     3,X
7361 81   10       03000          CMPA    #$10
7363 2C   08       03010          BGE     PANU4   POINT OUT OF BOUNDS
7365 30   09       03070 PANU1    LEAX    9,X
7367 8C   70E1     03080          CMPX    #LASTPT
736A 23   EG       03090          BLS     PANU2
736C 39            03100          RTS
736D A6   84       03110 PANU4    LDA     ,x      SINCE ONE POINT OUT OF BOUNDS,
RESTORE ALL POINTS  TO ORIGINAL VALUES
736F 81   80       03120          CMPA    #$80
7371 27   0C       03130          BEQ     PANU5
7373 A6   04       03140          LDA     4,X
7375 80   02       03150          SUBA    #2
7377 A7   04       03160          STA     4,X
7379 A6   03       03170          LDA     3,X
737B 82   00       03180          SBCA    #6
737D A7   03       03190          STA     3,X
737F 30   17       03200 PANU5    LEAX    -9,X
7381 8C   7000     03210          CMPX    #POINTS
7384 24   E7       03220          BHS     PANU4
7386 39            03230          RTS
                   03240 *
                   03250 * ROTATE POSITIVELY ABOUT X AXIS
                   03260 *
7387 BE   7000     03270 ROTX     LDX     #POINTS
738A A6   84       03280 ROTX1    LDA     ,X
738C 81   80       03290          CMPA    #$80    CHECK FOR UNDEFINED POINT
738E 27   1F       03300          BEQ     ROTX2
7390 34   10       03310          PSHS    X
7392 30   03       03320          LEAX    3,X     ADDRESS OF Y-COORDINATE OF CURR
ENT POINT
7394 31   03       03330          LEAY    3,X     ADDRESS OF Z-COORDINATE OF CURR
ENT POINT
7396 BD   7535     03340          JSR     ROTATE
7393 35   10       03350          PULS    X
739B A6   93       03360          LDA     3,X
739D 81   10       03370          CMPA    #-$10
739F 2C   16       03380          BGE     R0TX3
73A1 8I   F0       03390          CMPA    #-$10
73A3 2F   12       03400          BLE     R0TX3   POINT TOO BIG
73A5 A6   06       03410          LDA     6,x
73A7 81   10       03420          CMPA    #$10
73A9 2C   0C       03430          BGE     R0TX3
73AB 81   F0       03440          CMPA    #-$10
73AD 2F   08       03450          BLE     R0TX3
73AF 30   03       03460 ROTX2    LERX    9,X     GET NEXT POINT
73B1 8C   70E1     03470          CMPX    #LASTPT
73B4 2F   D4       03480          BLE     ROTX1
73B6  39           03490          RTS
73B7 34   10       03500 R0TX3    PSHS    X       UNDO ROTATIONS AS ONE POINT TO
0 LARGE
73B9 A6   84       03510          LDA     ,X
73BB 31   80       03520          CMPA    #$80
73BD 27   07       03530          BEQ     RX
73BF 31   03       03540          LEAY    3,X
73C1 30   06       03550          LEAX    6,X
73C3 BD   7535     03560          JSR     ROTATE
73C6 35   10       03570 RX       PULS    X
73C8 30   17       03580          LEAX    -9,X
73CA 3C   7000     03590          CMPX    #POINTS
73CD 24   ES       03600          BHS     ROTX3
73CF 39            03610          RTS
                   03620 *
                   03630 * ROTATE NEGATIVELY ABOUT X AXIS
                   03640 *
73D0 SE   7000     03650 ROTMX    LDX     #POINTS
73D3 f16  84       03660 ROTMX1   LDA     ,y,
73D5 81   80       03670          CMPA    #$80    CHECK FOR UNDEFINED POINT
73D7 27   IF       03680          BEQ     ROTMX2
73D9 34   10       03690          PSHS    X
73DB 31   33       03700          LEAY    3,X     RDDRESS OF Y-COORDINATE OF CURR
ENT POINT
73DD 30   06       03710          LERX    6,X     ADDRESS OF Z-COORDINATE OF CURR
ENT POINT
73DF BD   7535     03720          JSR     ROTATE
73E2 35   10       03730          PULS    X
73E4 A6   03       03740          LDA     3,X
73E6 81   10       03750          CMPA    #$10
73E8 2C   16       03760          BGE     ROTMX3
73EA 81   F0       03770          CMPA    #-$10
73EC 2F   12       03780          BLE     ROTMX3  POINT TOO BIG
73EE A6   06       03790          LDA     6,x
73F0 81   10       03800          CMPA    #$10
73F2 2C   0C       03810          BGE     ROTMX3
73F4 81   F0       03820          CMPA    #-$10
73F6 2F   08       03830          BLE     ROTMX3
73FS 30   09       03840 ROTMX2   LEAX    9,X     GET NEXT POINT
73FR 8C   70E1     03850          CMPX    #LASTPT
73FD 2F   D4       03860          BLE     ROTMX1
73FF 39            03870          RTS
7400 34   10       03880 ROTMX3   PSHS    X       UNDO ROTATIONS RS  ONE POINT TO
0 LARGE
7402 A6   84       03890          LDR     ,X
7404 81   80       03900          CMPA    #$80
7406 27   07       03910          BEQ     RMX
7408 30   03       03920          LERX    3,X
740A 31   03       03930          LEAY    3,X
740C BD   7535     03940          JSR     ROTATE
740F 35   10       03950 RMX      PULS    X
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Listing continued

Listing continued

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7411 30   17      03960          LEAX    -9,X
7413 8C   7000    03970          CMPX    #POINTS
7416 24   E8      03980          BHS     ROTMX3
7418 39           03990          RTS
                  04000 *
                  04010 * ROTATE POSITIVELY ABOUT Y AXIS
                  04020 *
7419 8E   7000    04030 ROTY     LDX     #POINTS
741C A6   84      04040 ROTY1    LDA     ,X
741E 81   80      04050          CMPA    #$80    CHECK FOR UNDEFINED POINT
7420 27   IF      04060          BEQ     R0TY2
7422 34   10      04070          PSHS    X
7424 31   84      04080          LEAY    ,X      ADDRESS OF X-COORDINATE OF CURR
ENT POINT
7426 30   06      04090          LEAX    6,X     ADDRESS OF Z-COORDINATE OF CURR
ENT POINT
7428 BD   7535    04100          JSR     ROTATE
742B 35   10      04110          PULS    X
742D A6   84      04120          LDA     ,X
742F 81   10      04130          CMPA    #$10
7431 2C   16      04140          BGE     R0TY3
7433 81   F0      04150          CMPA    #-$10
7435 2F   12      04160          BLE     R0TY3   POINT TOO BIG
7437 A6   06      04170          LDA     6,X
7439 81   10      04180          CMPA    #$10
743B 2C   0C      04190          BGE     R0TY3
743D 81   F0      04200          CMPA    #-$10
743F 2F   08      04210          BLE     R0TY3
7441 30   09      04220 R0TY2    LEAX    9,X     GET NEXT POINT
7443 8C   70E1    04230          CMPX    #LASTPT
7446 2F   D4      04240          BLE     ROTY1
7448 39           04250          RTS
7449 34   10      04260 R0TY3    PSHS    X       UNDO ROTATIONS AS  CHE POINT TO
0 LARGE
744B A6   84      04270          LDA     ,X
744D 81   80      04280          CMPA    #$80
744F 27   05      04290          BEQ     RY
7451 31   06      04300          LEAY    6,X
7453 BD   7535    04310          JSR     ROTATE
7456 35   10      04320 RY       PULS    X
7458 30   17      04330          LEAX    -9,X
745A 8C   7000    04340          COMX    #POINTS
745D 24   EA      04350          BHS     ROTY3
745F 39           04360          RTS
                  04370 *
                  04380 * ROTATE NEGATIVELY ABOUT Y AXIS
                  04390 *
7460 8E   7000    04400 ROTMY    LDX     #POINTS
7463 A6   84      04410 ROTMY1   LDR     ,X
7465 81   80      04420          CMPR    #$80    CHECK FOR UNDEFINED POINT
7467 27   ID      04430          BEQ     R0TMY2
7469 34   10      04440          PSHS    X
746B 31   06      04450          LERY    6,X     ADDRESS OF Z-COORDINATE OF CURR
ENT POINT—X CONTAINS X-COORD
746D BD   7535    04460          JSR     ROTATE
7470 35   10      04470          PULS    X
7472 A6   84      04480          LDR     ,X
7474 81   10      04490          CNPR    #$10
7476 2C   16      04500          BGE     ROTMY3
7478 81   F0      04510          CMPR    #-$10
747A 2F   12      04520          BLE     ROTMY3  POINT TOO BIG
747C A6   06      04530          LDA     6,X
747E 81   10      04540          CMPA    #$10
7480 2C   0C      04550          BGE     ROTMY3
7482 81   F0      04560          CMPR    #-$10
7484 2F   08      04570          BLE     ROTMY3
7486 30   09      04580 R0TMY2   LERX    9,X     GET NEXT POINT
7488 8C   70E1    04590          CMPX    #LASTPT
748B 2F   D6      04600          BLE     ROTMY1
748D 39           04610          RTS
743E 34   10      04620 R0TMY3   PSHS    X       UNDO ROTATIONS AS  ONE POINT TO
O LARGE
7490 A6   84      04630          LDR     ,X
7492 81   80      04640          CMPA    #$80
7494 27   07      04650          BEQ     RMY
7496 31   84      04660          LEAY    ,X
7498 30   06      04670          LEAX    6,X
749A BD   7535    04680          JSR     ROTATE
749D 35   10      04690 RMY      PULS    X
749F 30   17      04700          LEAX    -9,X
74A1 8C   7000    04710          CMPX    #POINTS
74A4 24   E8      04720          BHS     ROTMY3
74A6 39           04730          RTS
                  04740 *
                  04750 * ROTATE POSITIVELY ABOUT Z AXIS
                  04760 *
74A7 8E   7000    04770 ROTZ     LDX     #POINTS
74AA A6   84      04780 ROTZ1    LDA     ,X
74AC 81   80      04790          CMPA    #$80    CHECK FOR UNDEFINED POINT
74AE 27   1D      04800          BEQ     R0TZ2
74B0 34   10      04810          PSHS    X
74B2 31   03      04820          LEAY    3,X     ADDRESS OF Y-COORDINATE OF CURR
ENT POINT—X HAS X-COORDINATE
74B4 BD   7535    04830          JSR     ROTATE
74B7 35   10      04840          PULS    X
74B9 A6   84      04850          LDA     ,X
74BB 81   10      04860          CMPA    #$10
74BD 2C   16      04870          BGE     ROTZ3
74BF 31   F0      04880          CMPA    #-$10
74C1 2F   12      04890          BLE     ROTZ3   POINT TOO BIG
74C3 A6   03      04900          LDA     3,X
74C5 81   10      04910          CMPA    #$10
74C7 2C   0C      04920          BGE     ROTZ3
74C9 81   F0      04930          CMPA    #-$10
74CB 2F   08      04940          BLE     ROTZ3
74CD 30   09      04950 R0TZ2    LEAX    9,X     GET NEXT POINT
74CF BC   70E1    04960          CMPX    #LASTPT
74D2 2F   D6      04970          BLE     ROTZ1
74D4 39           04980          RTS
74D5 34   10      04990 R0TZ3    PSHS    X       UNDO ROTATIONS AS  ONE POINT TO
0 LARGE
74D7 A6   84      05000          LDA     ,X
74D9 81   80      05010          CMPA    #$80
74DB 27   07      05020          BEQ     RZ
74DD 31   84      05030          LEAY    ,X
74DF 30   03      05040          LEAX    3,X
74E1 BD   7535    05050          JSR     ROTATE
74E4 35   10      05060 PZ       PULS    X
74E6 30   17      05070          LEAX    -9,X
74E8 8C   7000    05080          CMPX    #POINTS
74EB 24   E8      05090          BHS     ROTZ3
74ED 39           05100          RTS
                  05110 *
                  05120 * ROTATE NEGATIVELY ABOUT Z AXIS
                  05130 *
74EE 8E   7000    05140 ROTMZ    LDX     #POINTS
74F1 A6   84      05150 ROTMZ1   LDA     ,X
74F3 81   80      05160          CMPA    #$80    CHECK FOR UNDEFINED POINT
74F5 27   1F      05170          BEQ     ROTMZ2
74F7 34   10      05180          PSHS    X
74F9 31   84      05190          LEAY    ,X      ADDRESS OF X-COORDINATE OF CURR
ENT POINT
74FB 30   03      05200          LEAX    3,X     ADDRESS OF Y-COORDINATE OF CURR
ENT POINT
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Listing continued

Listing continued

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74FD BD   7535     05210          JSR     ROTATE
7500 35   10       05220          PULS    X
7502  A6  84       05230          LDA     ,X
7504 81   10       05240          CMPA    #$10
7506 2C   16       05250          BGE     ROTMZ3
7508 81   F0       05260          CMPA    #-$10
750A 2F   12       05270          BLE     ROTMZ3  POINT TOO BIG
750C A6   03       05280          LDA     3,X
750E 81   10       05290          CMPA    #$10
7510 2C   0C       05300          BGE     ROTMZ3
7512 81   F0       05310          CMPA    #-$10
7514 2F   08       05320          BLE     ROTMZ3
7516 30   09       05330 ROTMZ2   LEAX    9,X     GET NEXT POINT
7518 8C   70E1     05340          CMPX    #LASTPT
751B 2F   D4       05350          BLE     ROTMZ1
751D 39            05360          RTS
751E 34   10       05370 ROTMZ3   PSHS    X       UNDO ROTATIONS AS  ONE POINT TO
0 LARGE
7520 A6   84       05380          LDA     ,X
7522 81   80       05390          CMPA    #$80
7524 27   07       05400          BEQ     RMZ
7526 31   03       05410          LEAY    3,X
7528 BD   7535     05420          JSR     ROTATE
752B 35   10       05430          PULS    X
752D 30   17       05440 RMZ      LEAX    -9,X
752F 8C   7000     05450          CMPX    #POINTS
7532 24   EA       05460          BHS     ROTMZ3
7534 39            05470          RTS
                   05480 *
                   05490 * ROTATE AROUND SOME AXIS AS FOLLOWS:  X = COORD POINTE
D AT BY X-REG, Y=COORD POITED  AT BY Y-REG
                   05500 * X,Y=(127/128)X-(1/8)Y,(1/8)X+127/128)Y
                   05510 *
7535 33   7A       05520 ROTATE   LEAU    -6,S
7537 EC   84       05530          LDD     ,X
7539 ED   C4       05540          STD     ,U
753B ED   43       05550          STD     3,U
753D A6   02       05560          LDA     2,X
753F A7   42       05570          STA     2,U
7541 A7   45       05580          STA     5,U
7543 67   43       05590          ASR     3,U
7545 66   44       05600          ROR     4,U
7547 66   45       05610          ROR     5,U
7549 67   43       05620          ASR     3,U
754B 66   44       05630          ROR     4,U
754D 66   45       05640          ROR     5,U
754F 67   43       05650          ASR     3,U
7551 66   44       05660          ROR     4,U
7553 66   45       05670          ROR     5,U
7555 6?   43       05680          ASR     3,U
7557 66   44       05690          ROR     4,U
7559 66   45       05700          ROR     5,U
755B 67   43       05710          ASR     3,U
755D 66   44       05720          ROR     4,U
755F 66   45       05730          ROR     5,U
7561 67   43       05740          ASR     3,U
7563 66   44       05750          ROR     4,U
7565 66   45       05760          ROR     5,U
7567 67   43       05770          ASR     3,U
7569 66   44       05780          ROR     4,U
756B 66   45       05790          ROR     5,U
756D A6   42       05800          LDA     2,U
756F A0   45       05810          SUBA    5,U
7571 A7   42       05820          STA     2,U
7573 A6   41       05830          LDR     1,U
7575 A2   44       05840          SBCA    4,U
7577 A7   41       05850          STA     1,U
7579 A6   C4       05860          LDA     ,U
757B A2   43       05870          SBCA    3,U
757D A7   C4       05880          STA     ,U
757F EC   A4       85890          LDD     ,Y
7581 ED   43       05900          STD     3,U
7583 A6   22       05910          LDA     2,Y
7585 A7   45       05920          STA     5,U
7587 67   43       05930          ASR     3,U
7583 66   44       05940          ROR     4,U
758B 66   45       05950          ROR     5,U
758D 67   43       05960          ASR     3,U
758F 66   44       05970          ROR     4,U
7591 66   45       05980          ROR     5,U
7593 67   43       05990          ASR     3,U
7595 66   44       06000          ROR     4,U
7597 66   45       06010          ROR     5,U
7599 A6   42       06020          LDA     2,U
759E A0   45       06030          SUBA    5,U
759D A7   42       06040          STA     2,U
759F A6   41       06050          LDA     1,U
75A1 A2   44       06060          SBCA    4,U
75A3 A7   41       06070          STA     1,U
75A5 A6   C4       06080          LDA     ,U
75A7 A2   43       06090          SBCA    3,U
75A9 A7   C4       06100          STA     ,U
75AB EC   C4       06110          LDD     ,U
75AD ED   84       06120          STD     ,X
75AF A6   42       06130          LDA     2,U
75B1 A7   02       06140          STA     2,X
75B3 EC   A4       06150          LDD     ,Y
75B5 ED   43       06160          STD     3,U
75B7 A6   22       06170          LDA     2,Y
75B9 A7   45       06180          STA     5,U
75BB 67   C4       06190          ASR     ,U
75BD 66   41       06200          ROR     1,U
75BF 66   42       06210          ROR     2,U
75C1 67   C4       06220          ASR     ,U
75C3 66   41       06230          ROR     1,U
75C5 66   42       06240          ROR     2,U
75C7 67   C4       06250          ASR     ,U
75C9 66   41       06260          ROR     1,U
75CB 66   42       06270          ROR     2,U
75CD EC   41       06280          LDD     1,U
75CF E3   44       06290          ADDD    4,U
75D1 ED   41       06300          STD     1,U
75D3 A6   C4       06310          LDA     ,U
75D5 A9   43       06320          ADCA    3,U
75D7 A7   C4       06330          STA     ,U
75D9 67   43       06340          RSR     3,U
75DB 66   44       06350          ROR     4,U
75DD 66   45       06360          ROR     5/U
75DF 67   43       06370          ASR     3,U
75E1 66   44       06380          ROR     4,U
75E3 66   45       06390          ROR     5,U
75E3 67   43       06400          ASR     3,U
75E7 66   44       06410          ROR     4,U
75E9 66   45       06420          ROR     3,U
75EB 67   43       06430          ASR     3,U
75ED 66   44       06440          ROR     4,U
75EF 66   45       06450          ROR     5,U
75F1 67   43       06460          ASR     3,U
75F3 66   44       06470          ROR     4,U
75F5 66   45       06480          ROR     5,U
75F7 67   43       06490          ASR     3,U
75F9 66   44       06500          ROR     4,U
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Listing continued

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75FB 66   45       06510          ROR     5,U
75FD 67   43       06520          RSR     3,U
75FF 66   44       06530          ROR     4,U
7601 66   45       06540          ROR     5,U
7603 EC   41       06550          LDD     1,U
7605 E3   44       06560          RDDD    4,U
7607 ED   41       06570          STD     1,U
7609 A6   C4       06580          LDA     ,U
760B A9   43       06590          ADCA    3,U
760D A7   C4       06600          STA     ,U
760F EC   C4       06610          LDD     ,U
7611 ED   A4       06620          STD     ,Y
7613 A6   42       06630          LDA     2,U
7615 A7   22       06640          STA     2,Y
7617 39            06650          RTS
                   06660 *
                   06670 * MAKE THE FIGURE 1/32 BIGGER
                   06680 *
7618 8E   7000     06690 BIGGER   LDX     #POINTS
761B A6   84       06700 BIG1     LDA     ,X      CHECK IF POINT DEFINED
761D 81   80       06710          CMPA    #$80
761F 27   24       06720          BEQ     BIG2
7621 BD   766C     06730          JSR     GETBIG  INCREASE ALL THREE COORDINATES
7624 30   03       06740          LEAX    3,X
7626 BD   766C     06750          JSR     GETBIG
7629 30   03       06760          LEAX    3,X
762B BD   766C     06770          JSR     GETBIG
762E 30   1A       06780          LEAX    -6,X
7630 31   84       06790          LEAY    ,X      CHEC IF ANY OF 3 COORDS TOO BIG
7632 BD   76A1     06800          JSR     TOOBIG
7635 2C   16       06810          BGE     BIG3
7637 31   23       06820          LEAY    3,Y
7639 BD   76A1     06830          JSR     TOOBIG
763C 2C   0F       06840          BGE     BIG3
763E 31   23       06850          LEAY    3,Y
7640 8D   76A1     06860          JSR     TOOBIG
7643 2C   08       06870          BGE     BIG3
7645 30   09       06880 BIG2     LEAX    9,X     GET NEXT POINT
7647 8C   70E1     06890          CMPX    #LASTPT
764A 2F   CF       06900          BLE     BIG1
764C 39            06910          RTS
764D A6   84       06920 BIG3     LDA     ,X      RESTORE POINTS IF ONE MADE OUT
OF BOUNDS
764F 81   80       06930          CMPA    #$80
7651 26   04       06940          BNE     BIG8
7653 30   17       06950          LEAX    -9,X
7655 20   0F       06960          BRA     BIG9
7657 BD   76FC     06970 BIG8     JSR     GETSML
765A 30   03       06980          LEAX    3,X
765C BD   76FC     06990          JSR     GETSML
765F 30   03       07000          LEAX    3,X
7661 BD   76FC     07010          JSR     GETSML
7664 30   11       07020          LEAX    -$F,X
7666 8C   7000     07030 BIG9     CMPX    #POINTS
7669 24   E2       07040          BHS     BIG3
766B 39            07050          RTS
766C 33   7D       07060 GETBIG   LEAU    -3,S    MAKE ONE COORDINATE 1/32 BIGGER
766E EC   84       07070          LDD     ,X
7670 ED   C4       07080          STD     ,U
7672 A6   02       07090          LDA     2,X
7674 A7   42       07100          STA     2,U
7676 67   C4       07110          ASR     ,U
7678 66   41       07120          ROR     1,U
767A 66   42       07130          ROR     2,U
767C 67   C4       07140          ASR     ,U
767E 66   41       07150          ROR     1,U
7689 66   42       07160          ROR     2,U
7682 6?   C4       07170          ASR     ,U
7684 66   41       07180          ROR     1,U
7686 66   42       07190          ROR     2,U
7688 67   C4       07200          ASR     ,U
768A 66   41       07210          ROR     1,U
768C 66   42       07220          ROR     2,U
768E 67   C4       07230          ASR     ,U
7690 66   41       07240          ROR     1,U
7692 65   42       07250          ROR     2,U
7694 EC   01       07260          LDD     1,X
7696 E3   41       07270          ADDD    1,U
7698 ED   01       07280          STD     1,X
769A A6   84       07290          LDA     ,x
769C A9   C4       07300          ADCA    ,U
769E A7   84       07310          STA     ,X
76A0 39            07320          RTS
76A1 A6   A4       07330 TOOBIG   LDA     ,Y      CHECK IF A COORDINATE TOO BIG--
IF FIRST BYTE >= $80 OR <= -$80
76A3 81   10       07340          CMPA    #$10
76A5 2C   03       07350          BGE     TB1
76A7 40            07360          NEGA
76A8 81   10       07370          CMPA    #$10
76AA 39            07380 TB1      RTS             BGE WILL GO IF NUMBER LOADED IN
TO A WAS >=$10 OR <=-$10
                   07390 *
                   07400 * MAKE THE FIGURE 1/32 SMALLER
                   07410 *
76AB 8E   7000     07420 SMALLR   LDX     #POINTS
76AE A6   84       07430 SML1     LDA     ,X      CHECK IF POINT DEFINED
76B0 81   80       07440          CMPA    #$80
76B2 27   11       07450          BEQ     SML2
76B4 BD   76FC     07460          JSR     GETSML
76B7 30   03       07470          LEAX    3,X
76B9 BD   76FC     07480          JSR     GETSML
76BC 30   03       07490          LEAX    3,X
76BE BD   76FC     07500          JSR     GETSML
76C1 30   03       07510          LEAX    3,X
76C3 20   02       07320          BRA     SMLR1
76C5 30   09       07530 SML2     LEAX    9,X     GET NEXT POINT
76C7 8C   70E1     07540 SMLR1    CMPX    #LASTPT
76CA 2F   E2       07550          BLE     SML1
                   07560 * CHECK FOR LINE SEGMENT LENGTH < 1 -- IF ONE FOUND, RE
STORE POINTS TO ORIGINAL VALUES
76CC CE   70EA     07570          LDU     #LINES
76CF 4F            07580 SMLR6    CLRA
76D0 E6   C0       07590          LDB     ,U+
76D2 C1   FF       07600          CMPB    #$FF
76D4 27   25       07610          BEQ     SMLR5   LAST LINE SEGMENT TESTED
76D6 C3   7000     07620          ADDD    #POINTS
76D9  1F  01       07630          TFR     D,X     ADDRESS OF FIRST POINT
76DB 4F            07640          CLRA
76DC E6   C0       07650          LDB     ,U+
76DE C3   7000     07660          ODDD    #POINTS
76E1  1F  02       07670          TFR     D,Y     ADDRESS OF SECOND POINT
76E3 EC   84       07680          LDD     ,x
76E5 10A3A4        07690          CMPD    ,Y      TEST FIRST COORD
76E8 26   E5       07700          BNE     SMLR6   INTEGER PARTS NOT EQUAL
76EA EC   03       07710          LDD     3,X
76EC 10A323        07720          CMPD    3,Y
76EF 26   DE       07730          BNE     SMLR6   INTEGER PARTS OF SECOND COORD N
OT EQUAL
76F1 EC   06       07740          LDD     6,X
76F3 10A3 26       07750          CMPD    6,Y
76F6 26   D7       07760          BNE     SMLR6   INTEGER PARTS OF THIRD COORD NO
T EQU AL
                   07770 * ALL COMPONENTS OF LINE SEGMENT HAVE EQUAL INTEGER PAR
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Listing continued

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TS, SO UNDO SMALLER AND RTS FROM BIGGER
76F8 16   FF1D      07780          LBRH    BIGGER
76FB 39             07790 SMLR5    RTS                ALL LINE  SEGMENTS CHECKED AND
LONG ENOUGH
76FC 33   7D        07800 GETSML   LEAU    -3,S
76FE EC   84        07810          LDD     ,X
7700 ED   C4        07820          STD     ,U
7702 A6   02        07830          LDA     2,X
7704 A7   42        07840          STA     2,U
7706 67   C4        07850          ASR     ,U
7708 66   41        07860          ROR     1,U
770A 66   42        07870          ROR     2,U
770C 67   C4        07880          ASR     ,U
770E 66   41        07890          ROR     1,U
7710 66   42        07900          ROR     2,U
7712 67   C4        07910          ASR     ,U
7714 66   41        07920          ROR     1,U
7716 66   42        07930          ROR     2,U
7713 67   04        07940          ASR     ,U
771A 66   41        07950          ROR     1,U
771C 66   42        07960          ROR     2,U
771E 67   04        07970          ASR     ,U
7720 66   41        07980          ROR     1,U
7722 66   42        07990          ROR     2,U
7724 EC   01        08000          LDD     1,X
7726 R3   41        08010          SUBD    1,U
7728 ED   01        08020          STD     1,X
772A A6   34        08030          LDA     ,X
772C A2   04        08040          SBCA    ,U
772E A7   84        08050          STA     ,X
7730 39             08060          RTS
                    09000 *
                    09010 * SUM KEY BUFFERS TO  B-REGISTER.  USED TO DETERMINE IF
KEY STILL DEPRESSED
                    09020 *
7731 F6   0132      09030 KEYVRL   LDB     $152
7734 FB   0153      09040          ADDB    $153
7737 FB   0154      09050          ADDB    $154
773A FB   0155      09060          ADDB    $155
773D FB   0156      09070          ADDB    $156
7740 FB   0157      09080          ADDB    $157
7743 FB   0158      09090          ADDB     $158
7746 FB   0159      09100          ADDB    $159
7749 39             09110          RTS
                    10000 *
                    10010 * DRAW A LINE. X1, X2 TO Y1,Y2 - COORDINATES ARE SIGNED
 16 BIT  INTEGER,  VISIBLE  SCREEN  IS  -128  TO  127,  -95  TO  95  ON  USUAL
                    10020 * X,Y GRAPH
                    10030 *
774A        80      10040 BITS     FCB     $80       FOR SETTING POINTS ON GRAPHICS
SCREEN
774B        40      10050          FCB     $40
774C        20      10060          FCB     $20
774D        10      10070          FCB     $10
774E        08      10080          FCB     $8
774F        04      10090          FCB     $4
7750        02      10100          FCB     $2
7751        01      10110 LRSTBT   FCB     $1
            005F    10120 TOP      EQU     $5F       LIMITS OF VIRTUAL SCREEN
            FFA0    10130 BOTTOM   EQU     -$60
            FF80    10140 LEFT     EQU     -$80
            007F    10150 RIGHT    EQU     $7F
7752                10170 XI       RMB     1         2-BYTE COORDINATES FOR TWO POIN
TS
7753                10180 X1P      RMB     1
7754                10190 Yl       RMB     1
7755                10200 Y1P      RMB     1
7756                10210 X2       RMB     1
7757                10220 X2P      RMB     1
7758                10230 Y2       RMB     1
7759                10240 Y2P      RMB     1
775A                10250 SLOPE    RMB     1
                    10260 *
                    10270 * BEGIN LINE DRAWING ALGORITHM
                    10280 *
                    10290 * MAKE SURE X1<X2 OR REVERSE COORDINRTES
                    10300 *
775B FC   7756      10310 LINE     LDD     X2
775E 10B3 7752      10320          CMPD    X1
7762 2C   17        10330          BGE     LN1
7764 BE   7752      10340          LDX     X1
7767 FD   7752      10350          STD     X1
776A BF   7756      10360          STX     X2
776D BE   7754      10370          LDX     Y1
7770 10BE 7758      10380          LDY     Y2
7774 BF   7758      10390          STX     Y2
7777 10BF 7754      10400          STY     Y1
                    10410 *
                    10420 * CHECK FOR SIGN OF SLOPE
                    10430 * *
777B FC   7753      10440 LN1      LDD     Y2
777E 10B3 7754      10450          CMPD    Y1
7782 102D 018E      10460          LBLT    SELINE
                    10470 *
                    10480 *BEGIN DRAWING LINE WITH POSITIVE SLOPE
                    10490 *
                    10500 * CHECK FOR NO VISIBLE LINE
                    10510 *
7786 FC   7732      10520          LDD     X1
7789 1083 007F      10530          CMPD    BRIGHT
778D 102C 0313      10540          LBGE    LNDONE
7791 FC   7734      10550          LDD     Y1
7794 1083 005F      10560          CMPD    #TOP
7798 102C 0308      10570          LBGE    LNDONE
779C FC   7756      10580          LDD     X2
779F 1083 FF30      10590          CMPD    #LEFT
77A3 102F 02FD      10600          LBLE    LNDONE
77A7 FC   7758      10610          LDD     Y2
77AA 1083 FFR0      10620          CMPD    #BOTTOM
77AE 102F 02F2      10630          LBLE    LNDONE
                    10640 *
                    10650 * CHECK IF MUST CLIP LEFT END OF LINE
                    10660 *
77B2 FC   7752      10670          LDD     X1
77B5 1083 FF80      10680          CMPD    #LEFT
77B9 2D   09        10690          BLT     LN2
77BB FC   7754      10700          LDD     Y1
77BE 1083 FFR0      10710          CMPD    #BOTTOM
77C2 2C   6F        10720          BGE     LN3
                    10730 *
                    10740 * CLIP LEFT END OF LINE
                    10750 *
77C4 BE   7756      10760 LNZ      LDX     X2
77C7 10BE 7738      10770          LDY     Y2
77CB 34   30        10780          PSHS    X,Y
77CD FC   7752      10790 LN4      LDD     X1        X=(X1+X2)/2
77D0 F3   7756      10800          ADDD    X2
77D3 47             10810          ASRA
77D4 56             10820          RORB
77D5 1F   01        10830          TFP     D,X
77D7 FC   7754      10840          LDD     Y1        Y=(Y1+Y2)/2
77DA F3   7758      10850          ADDD    Y2
77DD 47             10860          ASRA
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Listing continued

Listing continued

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77DE 56          10870          RORB
77DF 1F   02     10880          TFR     D,Y
77E1 8C   FF80   10890          CMPX    #LEFT
77E4 2E   08     10900          BGT     LN5
77E6 108C 005F   10910          CMPV    #TOP
77EA 102C 02B4   10920          LBGE    LNDON1  NO VISIBLE LINE
77EE 3C   007F   10930 LN5      CMPX    #RIGHT
77F1 2D   08     10940          BLT     LN6
77F3 108C FFA0   10950          CMPY    #BOTTOM
77F7 102F 02A7   10960          LBLE    LNDON1  NO VISIBLE LINE
77FB 8C   FF80   10970 LN6      CMPX    #LEFT
77FE 2D   06     10980          BLT     LN7
7800 108C FFA0   10990          CMPY    #BOTTOM
7804 2C   09     11000          BGE     LN8
7806 BF   7752   11010 LN7      STX     X1      REPLACE LEFT POINT BY MIDPOINT
AND REPEAT
7809 10BF 7754   11020          STY     Y1
780D 20   BE     11030          BRA     LN4
780F 8C   FF80   11040 LN8      CMPX    #LEFT
7812 2F   0F     11050          BLE     LN9
7814 108C FFA0   11060          CMPY    #BOTTOM
7818 2F   09     11070          BLE     LN9
781A BF   7756   11080          STX     X2      REPLACE RIGHT POINT BY MIDPOINT
781D 10BF 7758   11090          STY     Y2
7821 20   AA     11100          BRA     LN4
7823 BF   7752   11110 LN9      STX     X1      X1,Y1 NOW ON LEFT OR BOTTOM BOU
NDARY
7826 10BF 7754   11120          STY     Y1
782A 35   30     11130          PULS    X,Y     RECOVER ORIGINAL RIGHT POINT
782C BF   7756   11140          STX     X2
782F 10BF 7758   11150          STY     Y2
                 11160 * CHECK IF MUST CLIP RIGHT END OF LINE
                 11170 *
7833 FC   7756   11180 LN3      LDD     X2
7836 1083 007F   11190          CMPD    #RIGHT
783A 2E   09     11200          BGT     LN10
783C FC   7758   11210          LDD     Y2
783F 1083 005F   11220          CMPD    #TOP
7843 2F   55     11230          BLE     LN18
                 11240 *
                 11250 * CLIP RIGHT END OF LINE
                 11260 *
7845 BE   7752   11270 LN10     LDX     X1
7848 10BE 7754   11280          LDY     Y1
784C 34   30     11290          PSHS    X,Y
784E FC   7752   11300 LN11     LDD     X1      X=(X1+X2)/2
7851 F3   7756   11310          ADDD    X2
7854 47          11320          ASRA
7855 56          11330          RORB
7856 1F   01     11340          TFR     D,X
7858 FC   7754   11350          LDD     Y1      Y=(Y1+Y2)/2
785B F3   7758   11360          ADDD    Y2
785E 47          11370          ASRA
785F 56          11380          RORB
7860 1F   02     11390          TFR     D,Y
7862 3C   007F   11400          CMPX    #RIGHT
7865 2E   06     11410          BGT     LN12
7867 108C 005F   11420          CMPY    #TOP
786B 2F   09     11430          BLE     LN13
786D BF   7756   11440 LN12     STX     X2      MOVE RIGHT POINT TO MIDPOINT AN
D REPEAT
7870 10BF 7758   11450          STY     Y2
7874 20   D8     11460          BRA     LN11
7876 8C   007F   11470 LN13     CMPX    #RIGHT
7879 2C   0F     11480          BGE     LN14
787B 108C 005F   11490          CMPY    #TOP
787F 2C   09     11500          BGE     LN14
7881 BF   7752   11510          STX     X1      MOVE LEFT POINT TO MIDPOINT AND
 REPEAT
7884 10BF 7754   11520          STY     Y1
7888 20   C4     11530          BRA     LN11
788A BF   7756   11540 LN14     STX     X2      MOVE X2,Y2 TO TOP OR RIGHT BOUN
DARY,  RECOVER X1,Y1
788D 10BF 7758   11550          STY     Y2
7891 35   30     11560          PULS    X,Y
7893 BF   7752   11570          STX     X1
7896 10BF 7754   11580          STY     Y1
                 11590 *
                 11600 * DECIDE IF SLOPE > 1
                 11610 *
789A B6   7757   11620 LN18     LDA     X2P     X1P, ETC HOLD CORRECT ONE-BYTE
SIGNED VALUES FOR THE COORDINATES,  WHICH ARE NOW ON THE VIRTUAL SCREEN
789D B0   7753   11630          SUBA    X1P
78A0 34   02     11640          PSHS    A
78A2 F6   7759   11650          LDB     Y2P
78A3 F0   7755   11660          SUBB    Y1P
78A8 E1   E0     11670          CMPB    ,S+
78AA 25   33     11680          BL0     ENELN
                 11690 *
                 11700 * DRAW A LINE WITH POSITIVE SLOPE
                 11710 *
78AC 34   04     11720          PSHS    B       SAVE NUMBER OF POINTS ON LINE -
 1
78AE BD   7AA5   11730          JSR     GETSLP  SLOPE = DX/DY,  AN 8-BIT FRACTIO
N
78B1 BD   7AC0   11740          JSP     FRSTBT  SET X,U TO POINT TO BYTE AND BI
T ON GRAPHICS SCREEN CORRESP.  TO X1,Y1
78B4 35   04     11750          PULS    B
78B6 4F          11760          CLRA
78B7 1F   02     11770          TFR     D,Y
78B9 31   21     11780          LEAY    1,Y     Y=#POINTS ON LINE
78BB 5F          11790          CLRB
78BC A6   34     11800 LN13     LDA     ,X      SET THE POINTS ON THE GRAPHICS
SCREEN FOR THE LINE
78BE AA   C4     11810          ORA     ,U      GET THE BYTE AND OR IN THE BIT
78C0 A7   84     11820          STA     ,X
78C2 31   3F     11830          LEAY    -1,Y    REDUCE POINT COUNT
78C4 1027 01DC   11840          LBEU    LNDONE
78C8 30   88 E0  11850          LEAX    -$20,X  INCREASE Y-COORDINATE BY 1
78CB FB   775A   11860          ADDB    SLOPE   INCREASE X-COORDINATE BY SLOPE
(A FRACTION)
78CE 24   EC     11870          BCC     LN15    B=X MOD 1
78D0 33   41     11880          LEAU    1,U     INCREASE X-COORDINATE BY 1
78D2 1183 7751   11890          CMPU    #LASTBT TRY TO MOVE RIGHT ONE BIT
78D6 23   E4     11900          BLS     LN15
78D8 CE   774A   11910          LDU     #BITS   ELSE USE NEXT BYTE AND LEFT BIT
78DB 30   01     11920          LEAX    1,X
78DD 20   DD     11930          BRA     LN15
                 11940 *
                 11950 * DRAW LINE WITH POSITIVE SLOPE <1
                 11960 *
78DF 34   02     11970 ENELN    PSHS    A       SAVE # POINTS ON  LINE - 1
78E1 1E   89     11980          EXG     A,B
78E3 BD   7AA5   11990          JSR     GETSLP  SLOPE = DY/DX
78E6 BD   7AC0   12000          JSR     FRSTBT  X,U ARE BYTE AND BIT CORRESP.  T
O X1,Y1
78E9 35   04     12010          PULS    B
78EB 4F          12020          CLRA
78EC 1F   02     12030          TFR     D,Y
78EE 31   21     12040          LEAY    1,Y     Y=#POINTS ON LINE
78F0 5F          12050          CLRB
78F1 A6   84     12060 LN16     LDA     ,X      DRAW THE LINE
```

Listing continued

```
78F3 AA   C4       12070          ORA     ,U      GET  THE  BYTE,  OR IN  THE BIT
78F5 A7   84       12080          STA     ,X
78F7 31   3F       12090          LEAY    -1,Y    REDUCE THE POINT COUNT
78F9 1027 01A7     12100          LBEQ    LNDONE
78FD 33   41       12110          LERU    1,U     MOVE ONE BIT TO RIGHT
78FF 1183 7751     12120          CUPU    #LASTBT IF POSSIBLE
7903 23   05       12130          BLS     LN17
7905 30   01       12140          LEAK    1,X     ELSE MOVE TO NEXT BYTE AND FIRS
T BIT
7907 CE   774A     12150          LDU     #BITS
790A FB   775A     12160 LN17     ADDB    SLOPE
790D 24   E2       12170          BCC     LN16    NO OVERFLO TO NEXT INTEGER WHEN
 ADDING SLOPE TO Y
790F 30   88 E0    12180          LEAK    -$20,X  ELSE RDD 1 TO Y-COORDINATE
7912 20   DD       12190          BRA     LN16
                   12200 *
                   12210 * BEGIN DRAWING LINE WITH NEGATIVE SLOPE
                   12220 *
                   12230 * CHECK FOR NO VISIBLE LINE
                   12240 *
7914 FC   7752     12250 SELINE   LDD     X1
7917 1083 007F     12260          CMPD    #RIGHT
791B 102C 0185     12270          LBGE    LNDONE
791F FC   7754     12280          LDD     Y1
7922 1083 FFA0     12290          CMPD    #BOTTOM
7926 102F 017A     12300          LBLE    LNDONE
792A FC   7756     12310          LDD     X2
792D 1083 FF80     12320          CMPD    #LEFT
7931 102F 016F     12330          LBLE    LNDONE
7935 FC   7758     12340          LDD     Y2
7938 1083 005F     12350          CMPD    #TOP
793C 102C 0164     12360          LBGE    LNDONE
                   12370 *
                   12380 * CHECK  IF MUST CLIP LEFT END OF LINE
                   12390 *
7940 FC   7752     12400          LDD     X1
7943 1083 FF80     12410          CMPD    #LEFT
7947 2D   09       12420          BLT     LN2A
7949 FC   7754     12430          LDD     Y1
794C 1083 005F     12440          CMPD    #TOP
7950 2F   6F       12450          BLE     LN3A
                   12460 *
                   12470 * CLIP'LEFT END OF LINE FT END OF LI
                   12480 *
7952 BE   7756     12490 LN2A     LDX     X2
7955 10BE 7758     12500          LDY     Y2
7959 34   30       12510          PSHS    X,Y
795B FC   7752     12520 LN4A     LDD     X1      X=(X1+X2)/2
795E F3   7756     12530          RDDD    X2
7961 47            12540          RSRA
7962 56            12550          RORB
7963 1F   01       12560          TFR     D,X
7965 FC   7754     12570          LDD     Y1      Y=(Y1+Y2)/2
7968 F3   7758     12580          ADDD    Y2
796B 47            12590          ASRA
796C 56            12600          RORB
796D 1F   02       12610          TFR     D,Y
796F 8C   FF80     12620          CMPX    #LEFT
7972 2E   08       12630          BGT     LN5A
7974 108C FFA0     12640          CMPY    #BOTTOM
7978 102F 0126     12650          LBLE    LNDON1  NO VISIBLE LINE
797C 8C   007F     12660 LN5A     CMPX    #RIGHT
797F 2D   08       12670          BLT     LN6A
7981 108C 005F     12680          CMPY    #TOP
7985 102C 0119     12690          LBGE    LNDON1  NO VISIBLE LINE
7989 8C   FF80     12700 LN6A     CMPX    #LEFT
798C 2D   06       12710          BLT     LN7A
798E 108C 005F     12720          CMPY    #TOP
7992 2F   09       12730          BLE     LN8A
7994 BF   7752     12740 LN7A     STX     X1      REPLACE LEFT POINT BY MIDPOINT
AND REPEAT
7997 10BF 7754     12750          STY     Y1
799B 28   BE       12760          BRA     LN4A
799D SC   FF80     12770 LN8A     CMPX    #LEFT
79A0 2F   0F       12780          BLE     LN9A
79A2 10SC 005F     12790          CMPY    #TOP
79A6 2C   09       12800          BGE     LN9A
79A8 8F   7756     12810          STX     X2      REPLACE RIGHT POINT BY MIDPOINT
79AB 10BF 7758     12820          STY     Y2
79AF 20   AA       12830          BRA     LN4A
79B1 BF   7752     12840 LN9R     STX     X1      X1,Y1 NOW ON LEFT OR BOTTOM BOU
NDARY
79B4 10BF 7754     12850          STY     Y1
79B8 35   30       12860          PULS    X,Y     RECOVER ORIGINAL RIGHT POINT
79BA BF   7756     12870          STX     X2
79BD 10BF 7758     12880          STY     Y2
                   12890 * CHECK IF MUST CLIP RIGHT END 0F LINE
                   12900 *
79C1 FC   7756     12910 LN3A     LDD     X2
79C4 1083 007F     12920          CMPD    #RIGHT
79C8 2E   09       12930          BGT     LN10A
79CA FC   7758     12940          LDD     Y2
79CD 1083 FFR0     12950          CMPD    #BOTTOM
79D1 2C   55       12960          BGE     LN18A
                   12970 *
                   12980 * CLIP RIGHT END OF LINE
                   12990 *
79D3 BE   7752     13000 LN10A    LDX     X1
79D6 10BE 7754     13010          LDY     Y1
79DA 34   30       13020          PSHS    X,Y
79DC FC   7752     13030 LN11A    LDD     X1      X=(X1+X2)/2
79DF F3   7756     13040          ADDD    X2
79E2 47            13050          ASRA
79E3 56            13060          RORB
79E4 1F   01       13070          TFR     D,X
79E6 FC   7754     13080          LDD     Y1      Y=(Y1+Y2)/2
79E9 F3   7758     13090          ADDD    Y2
79EC 47            13100          ASRA
79ED 56            13110          RORB
79EE 1F   02       13120          TFR     D,Y
79F0 8C   007F     13130          CMPX    #RIGHT
79F3 2E   06       13140          BGT     LN12A
79F5 108C FFA0     13150          CMPY    #BOTTOM
79F9 EC   09       13160          BGE     LN13A
79FB BF   7756     13170 LN12A    STX     X2      MOVE RIGHT POINT TO MIDPOINT AN
D REPEAT
79FE 10BF 7758     13180          STY     Y2
7A02 20   D8       13190          BRR     LN11A
7A04 8C   007F     13200 LN13A    CMPX    #RIGHT
7A07 2C   0F       13210          BGE     LN14A
7A09 108C FFA0     13220          CMPY    #BOTTOM
7A0D 2F   09       13230          BLE     LN14A
7A0F BF   7752     13240          STX     X1      MOVE LEFT POINT TO MIDPOINT AND
 REPERT
7A12 10BF 7754     13250          STY     Y1
7A16 20   C4       13260          BRR     LN11A
7A18 BF   7756     13270 LN14A    STX     X2      MOVE X2,Y2 TO TOP OR RIGHT BOUN
DARY, RECOVER X1,Y1
7A1B 10BF 7758     13280          STY     Y2
7A1F 35   30       13290          PULS    X,Y
7A21 BF   7752     13300          STX     X1
7A24 10BF 7754     13310          STY     Y1
```

Listing continued

listing continued

```
                    13320 *
                    13330 * DECIDE IF SLOPE > 1
                    13340 *
7A28 86   7757      13350 LN18A   LDA     X2P      X1P, ETC HOLD CORRECT ONE-BYTE
SIGNED VALUES FOR THE COORDINATES, WHICH ARE NOW ON THE VIRTUAL SCREEN
7A2B B0   7753      13360         SUBA    X1P
7A2E 34   02        13370         PSHS    A
7A30 F6   7755      13380         LDB     Y1P
7A33 F0   7759      13390         SUBB    Y2P
7A36 E1   E0        13400         CMPB    ,S+
7A38 25   33        13410         BLO     ESELN
                    13420 *
                    13430 * DRAW A LINE WITH NEGATIVE SLOPE <= -1
                    13440 *
7A3A 34   04        13450         PSHS    B        SAVE NUMBER OF POINTS ON LINE -
 1
7A3C BD   7AA5      13460         JSR     GETSLP   SLOPE = -DX/DY, AN 8-BIT FRACTI
ON
7A3F BD   7AC0      13470         JSR     FRSTBT   SET X,U  TO POINT TO BYTE AND BI
T ON GRAPHICS SCREEN CORRESP.  TO X1,Y1
7A42 35   04        13480         PULS    B
7A44 4F             13490         CLRA
7A45 1F   02        13500         TFR     D,Y
7A47 31   21        13510         LEAY    1,Y      Y=#POINTS ON LINE
7A49 5F             13520         CLRB
7A4A A6   84        13530 LN15A   LDA     ,X       SET THE POINTS ON THE GRAPHICS
SCREEN FOR THE LINE
7A4C AA   C4        13540         ORA     ,U       GET THE BYTE AND OR IN THE BIT
7A4E A7   84        13550         STA     ,X
7A50 31   3F        13560         LEAY    -1,Y     REDUCE POINT COUNT
7A52 1027 004E      13570         LBEQ    LNDONE
7A56 30   88 20     13580         LEAX    $20,X    DECREASE Y-COORDINATE BY 1
7A59 FB   775A      13590         ADDB    SLOPE    INCREASE X-COORDINATE BY SLOPE
(A FRACTION)
7A5C 24   EC        13600         BCC     LN15A    B=X MOD 1
7A5E 33   41        13610         LEAU    1,U      INCREASE X-COORDINATE BY 1
7A60 1183 7751      13620         CMPU    #LASTBT  TRY TO MOVE RIGHT ONE BIT
7A64 23   E4        13630         BLS     LN15A
7A66 CE   774A      13640         LDU     #BITS    ELSE USE NEXT BYTE AND LEFT BIT
7A69 30   01        13650         LEAX    1,X
7A6B 20   DD        13660         BRA     LN15A
                    13670 *
                    13630 * DRAW LINE WITH NEGATIVE SLOPE > -1
                    13690 *
7A6D 34   02        13700 ESELN   PSHS    A        SAVE # POINTS ON  LINE - 1
7A6F 1E   89        13710         EXG     A,B
7A71 BD   7AA5      13720         JSR     GETSLP   SLOPE = -DY/DX
7A74 BD   7AC0      13730         JSR     FRSTBT   X,U APE BYTE AND BIT CORRESP.  T
O X1, Y1
7A77 35   04        13740         PULS    B
7A79 4F             13750         CLRA
7A7A 1F   02        13760         TFR     D,Y
7A7C 31   21        13770         LEAY    1,Y      Y=#POINTS ON LINE
7A7E 5F             13780         CLRB
7A7F A6   84        13790 LN16A   LDA     ,X       DRAW THE LINE
7A81 AA   C4        13800         ORA     ,U       GET  THE  BYTE,  OR IN  THE BIT
7A83 A7   84        13810         STA     ,X
7A85 31   3F        13820         LEAY    -1,Y     REDUCE THE POINT COUNT
7A87 1027 0019      13830         LBEQ    LNDONE
7A8B 33   41        13840         LEAU    1,U      MOVE ONE BIT TO RIGHT
7A8D 1183 7751      13850         CMPU    #LRSTBT  IF POSSIBLE
7A91 23   05        13860         BLS     LN17A
7A93 30   01        13870         LEAX    1,X      ELSE NOVE TO NEXT BYTE AND FIRS
T BIT
7A95 CE   774A      13880         LDU     #BITS
7A93 FB   775A      13890 LN17A   ADDB    SLOPE
7A9B 24   E2        13900         BCC     LN16A    NO OVERFLO TO NEXT INTEGER WHEN
 ADDING  SLOPE TO Y'
7A9D 30   88 20     13910         LEAX    $20,X    ELSE SUBTRACT 1 FROM Y-COORDINA
TE
7AA0 20   DD        13920         BRA     LN16A
7AA2 35   30        13925 LNDON1  PULS    X,Y
7AA4 33             13930 LNDONE  RTS
                    13940 *
                    13950 * ASSUME f1<B CONTAIN UNSIGNED INTEGERS,  PUT A/B  INTO SL
OPE
                    13960 *
7AA5 34   04        13970 GETSLP  PSHS    B
7AA7 5F             13980         CLRB
7AA8 8E   0008      13990         LDX     #8
7AAB 58             14000 GETS    ASLB
7AAC 48             14010         ASLA
7AAD 25   04        14020         BCS     GET1
7AAF A1   E4        14030         CMPA    ,S
7AB1 25   03        14040         BLO     GET4
7AB3 A0   E4        14050 GET1    SUBf1   ,S
7AB5 5C             14060         INCB
7AB6 30   1F        14070 GET4    LEAX    -1,X
7AB8 26   F1        14080         BNE     GET5
7ABA 32   61        14090         LEAS    1,S
7ABC E7   775A      14100         STB     SLOPE
7ABF 39             14110         RTS
                    14120 *
                    14130 * FIND BYTE X AND BIT (U) ON  GRAPHICS SCREEN CORRESPON
DING TO X1,Y1
                    14140 * X=$600+Y1*32+X1DIV8 AND U=#BITS+X1M0D8
                    14150 * WE USE $600+Y1*(256/8)+X1DIV8 FOR X,  AND AS WE DIVIDE
 X1 BY THREE SUCCESSIVE 2'S,  WE  PICK UP THE BITS FOR MODIFYNG  U.
                    14160 *
7AC0 BE   721F      14170 FASTBT  LDX     TL
7AC3 86   5F        14180         LDA     #95
7AC5 B0   7755      14190         SUBA    Y1P
7AC8 F6   7753      14200         LDB     X1P
7ACB CB   80        14210         ADDB    #$80
7ACD CE   774A      14220         LDU     #BITS
7AD0 1C   FE        14230         ANDCC   #$FE
7AD2 46             14240         RORA
7AD3 56             14250         RORB
7AD4 24   02        14260         BCC     FRST1
7AD6 33   41        14270         LEAU    1,U
7AD8 47             14280 FRST1   RSRA
7AD9 56             14290         RORB
7ADA 24   02        14300         BCC     FRST2
7ADC 33   42        14310         LEAU    2,U
7ADE 47             14320 FRST2   ASRA
7ADF 56             14330         RORB
7AE0 24   02        14340         BCC     FRST3
7AE2 33   44        14350         LEAU    4,U
7AE4 30   8B        14360 FRST3   LEAX    D,X
7AE6 39             14370         RTS
          0000      14380         END
00000 TOTAL. ERRORS

BIG1     761B
BIG2     7645
BIG3     764D
BIG8     7657
BIG9     7666
BIGGER   7618
BITS     774A
BOTTOM   FFA0
DISP1    722B
DISP2    726C
DISP3    7237
DISP4    7293
```

Listing continued

Listing continued

DISPLA	7221	LN6A	7989	RMZ	752D
ENELN	78DF	LN7	7806	ROTATE	7535
ESELN	7A6D	LN7A	7994	ROTMX	73D0
FRST1	7AD8	LN8	780F	ROTMX1	73D3
FR3T2	7ADE	LN8A	799D	ROTMX2	73F8
FRST3	7AE4	LN9	7823	ROTMX3	7400
FRSTBT	7AC0	LH9A	79B1	ROTMY	7460
GET1	7AB3	LNDON1	7AA2	ROTMY1	7463
GET4	7AB6	LNDONE	7AA4	ROTMY2	7486
GET5	7AAB	MAIN	7177	R0TMY3	748E
GETBIG	766C	MAIN1	719F	ROTMZ	74EE
GETSLP	7AA5	MAIN10	71F0	ROTMZ1	74F1
GETSML	76FC	MAIN11	71F9	ROTMZ2	7516
KEY	718D	MAIN12	7202	ROTMZ3	751E
KEYVAL	7731	MAIN2	71A8	ROTX	7387
LASTBT	7751	MAIN3	71B1	ROTX1	738A
LASTPT	70E1	MAIN4	71BA	ROTX2	73AF
LEFT	FF80	MAIN5	71C3	ROTX3	73B7
LINE	7758	MAIN6	71CC	ROTY	7419
LINES	70EA	MAIN7	71D5	ROTY1	741C
LN1	777B	MAIN8	71DE	ROTY2	7441
LN10	7845	MAIN9	71E7	ROTY3	7449
LN10A	79D3	P1300	723E	ROTZ	74A7
LN11	784E	PAND	731B	ROTZ1	74AA
LN11A	79DC	PAND1	732F	ROTZ2	74CD
LN12	786D	PAND2	731E	ROTZ3	74D5
LN12A	79FB	PAND4	7337	RX	73C6
LN13	7876	PAND5	7349	RY	7456
LH13A	7A04	PANL	72RF	RZ	74E4
LN14	788A	PANL1	72C3	SELINE	7914
LN14A	7A18	PANL2	72B2	SLOPE	775R
LN15	78BC	PANL4	72CB	SMALLR	76RB
LN15A	7A4A	PANL5	72DD	SML1	76RE
LN16	78F1	PANR	72E5	3ML2	76C5
LN16A	7A7F	PANR1	72F9	SMLR1	76C7
LN17	790A	PANR2	72E8	SMLR5	76FB
LN17A	7A98	PANR4	7301	SMLR6	76CF
LN18	789A	PANR5	7313	TB1	76AA
LN18A	7A28	PANU	7351	TL	721F
LN2	77C4	PANU1	7365	TOOBIG	76A1
LH2A	7952	PANU2	7354	TOP	005F
LN3	7933	PANU4	736D	X1	7752
LN3A	79C1	PANU5	737F	X1P	7753
LN4	77CD	POINTS	7000	X2	7756
LN4R	795B	REP1	7209	X2P	7757
LN5	77EE	REPEAT	7207	Y1	7754
LN5A	797C	RIGHT	007F	Y1P	7755
LN6	77FB	RMX	740F	Y2	7758
		RMY	749D	Y2P	7759

```
SLOPE = (Y2-Y1)/(X2 =X1)
BREG = 0
XREG = BYTE(X1,Y1)
UREG = BIT(X1,Y1)
DO X2-X1 + 1 TIMES
  Bit UREG of byte XREG = 1 (turn on pixel)
  UREG = UREG - 1 (move one pixel to the right)
  IF UREG= - 1 THEN (moving to the next byte if necessary)
    UREG=7
    XREG = XREG+1
  BREG = BREG + SLOPE
  IF  BREG  1 THEN (have we moved far enough to the right to justify)
    BREG = BREG - 1 (going up one pixel?)
    XREG = XREG-$20
ENDDO
```

Table 4. A New Version of the Line-Drawing Routine

```
        ORG $3900
        LDY#0
        LDX #$1E00
LABEL   STY ,X+ +    STORE ZEROES INTO
        CMPX #$3600  MEMORY $1E00#$3600
        BNE LABEL
        RTS
```

Table 5. Assembly-Language Routine to Clear Graphics Pages

Continued from p. IIS

```
    FROM EXEC"
 90 STOP
100 DATA 16, 142, 0, 0, 142, 30, 0, 16,
    175, 129, 140, 54, 0, 38, 248, 57
```

The machine-language portion of this program is a compilation of the Assembly-language routine that clears graphics pages 5-8 (bytes $1E00-$35FF) (see Table 5).

Type PCLEAR 8: RUN. The program will run and you should see on the screen "Successful return from Basic." Now type PCLEAR 4:RUN. Watch the program crash; it never reaches line 80. Run it again. The program works. Type PCLEAR 4: RUN. Crash.

What is going on here?

When you execute PCLEAR N, your program is moved so that its text begins after the Nth graphics page. Memory locations 25-26 contain the starting address of your program. Try executing PCLEARs and PEEKing this location. It changes as the PCLEAR changes your program's location.

If your program is located after graphics page 4 when you run it, then, even though you move it with PCLEAR 8 in the program, clearing graphics pages 5-8 causes the program to crash. If you run your program after moving it to the end of graphics page 8, the program executes flawlessly.

2) I will describe the Basic commands CSAVEM and CLOADM, since Radio Shack omitted them from the CoCo manuals. To save a block of memory between address ADDR1 and ADDR2 in a tape file called "name," use this command: CSAVEM"name",ADDR1, ADDR2,ADDR3. ADDR3, the "execution address," is any value between 0 and $7FFF. It is syntactically necessary but has no apparent effect.

To recover the information from tape and place it back into memory (in the same location), use CLOADM "name". No address parameters are necessary, and the execution address will be stored in memory locations $9D-$9E (decimal 158-159). The files saved with CSAVEM are called *binary files.* They are useful because they load and save very quickly, and any information can be saved, even if it is not recognizable by Basic as ASCII or numeric data. •

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Reader's Forum

Turbo-Charge Your Color Computer

Your Color Computer is capable of running at 1.46 times its regular speed. Try this command:

```
POKE 65495,0
```

Notice that the cursor is flashing extremely rapidly.

Now run this program:

```
10FORD=1TO 100000
20 NEXT D
```

Instead of taking the usual 219 seconds, it runs in 150 seconds.

To regress back to standard speed:

```
POKE 65494,0
```

In the Color Computer, there is a chip called the synchronous address multiplexor (SAM). This IC handles all the system timing, dynamic RAM refresh, and video RAM addressing. Inside the chip, there is a flip-flop that controls the divider chain for the processor clock. This clock in turn determines how fast the CPU executes instructions. The flip-flop is set by accessing location 65495, and reset by accessing location 65494.

When using this capability, there are a few items of which you must take note. Any routine that depends on software timing loops will not work properly. For this reason, the cassette and serial port will not operate correctly. The disk drive may not work right either. In the case of the disk and cassette interfaces, files written at high speed may be read in at high speed, but this mode of operation is not recommended.

The SOUND and PLAY commands will create pitches that are too high even though the duration will remain the same. To illustrate this, try:

```
10 POKE 65494,0
20 SOUND 200,2
30 POKE 65495,0
40 SOUND 200,2
50 GOTO 10
```

It sounds like a European police siren.

To avoid these problems, slow down the machine before each operation and then speed up again after the operation is complete.

This speed-up option will make some projects possible that weren't possible before, such as game programs with lots of moving graphics. Other programs, such as a sorting routine, can have their run-time reduced significantly.

David B. Rankin
Warrensburg, MO 64093

Disk Extended Color Basic Tokens

Disk Extended Color Basic adds 25 Basic keywords. Here is a list of those new keywords with their token values:

Keyword	Token
DIR	206
DRIVE	207
FIELD	208
FILES	209
KILL	210
LOAD	211
LSET	212
MERGE	213
RENAME	214
RSET	215
SAVE	216
WRITE	217
VERIFY	218
UNLOAD	219
DSKINI	220
BACKUP	221
COPY	222
DSKI$	223
DSKO$	224
CVN	255 + 162
FREE	255 + 163
LOC	255 + 164
LOF	255 + 165
MKN$	255 + 166
AS	255 + 167

Fred de Soet
Amsterdam, Holland

Line Break for Colorterm

The following listing is a patch we wrote to enable Colorterm, by Martin Consulting, to send a true line break.

```
2E8B                 00100          ORG    $2E8B
2E8B  34  07         00110          PSHS   A,B,CC
2E8D  7F  FF20       00120          CLR    $FF20
2E90  31  3F         00130  DELAY   LEAY   -1,Y
2E92  12             00140          NOP
2E93  26  FB         00150          BNE    DELAY
2E95  86  02         00160          LDA    #2
2E97  B7  FF20       00170          STA    $FF20
2E9A  35  07         00180          PULS   A,B,CC
2E9C  7E  2418       00190          JMP    $2418
          0000       00200          END
```

In order to jump to this routine, you will have to do the following POKEs:

Location	Value to Poke
23D5	19
23EF	7E
23F0	2E
23F1	8B

The patch was necessary for us because our host would respond only to a true line break. •

Dan Durachko & Phil Irey
University Park, PA 16802

see List of Advertisers on page 130

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List of Advertisers on page 130

PRODUCT NEWS

Edited by Mark E. Reynolds

Get Down!

Can't make it to Studio 54 this weekend? Don't worry—now you can get down in your own living room with Kaleidophone, a hardware/software package that interfaces your hi-fi to your CoCo and graphically displays your music. Just plug one cable into the headphone jack on the hi-fi and the other into the joystick port on your computer.

Besides the hardware (which includes all necessary plugs and cables) you receive a free issue of *Kaleidophonics,* a cassette magazine of programs for the Kaleidophone. The current issue consists of more than a dozen display programs in Basic, plus nine machine-language routines for high-speed effects.

There's also an instant program feature by which you type in letters on the keyboard to create a whole new display program in seconds. Of course, you can also program it yourself in Basic or machine language. The package includes 10 pages of detailed instructions.

Kaleidophone costs $49.95 and requires 16K. It will work with Color Basic. For more information, contact New Salem Research, West Main St., New Salem, MA 01355.

Reader Service ✓ 552

Colorspeak

Colorspeak is a self-contained, phoneme-based voice synthesizer in a cartridge-style pack.

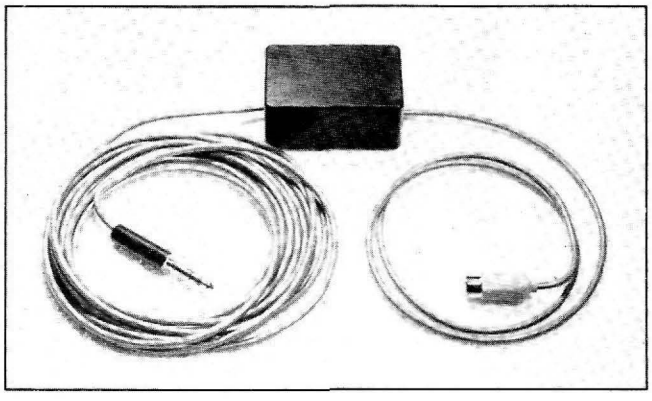
The hardware has its program in ROM and its own 2K RAM, so it requires no memory. Colorspeak uses the Votrax SC01 phoneme-synthesizer chip and will work on any CoCo.

The software features a text-to-speech mode, and inflection mode, a phoneme mode that allows you to program the SC01 chip directly in phonemes, and a spelling mode that spells text and pronounces most punctuation.

All of Colorspeak's features are accessible from Basic, and all Basic string manipulations are applicable.

Colorspeak sells for $169, and $4 buys a detailed user's manual. For more information, contact Bumblebee Software, P.O. Box 25427, Chicago, IL 60625.

Reader Servic ✓ 550



Kaleidophone from New Salem Research

Copy Files or Programs

Colorcopy is a menu-driven copy utility that copies data files or programs from disk to tape, tape to disk, or disk to disk. It also kills files or programs.

Colorcopy can copy Basic or machine-language programs. It allows group selection of file names or extensions, and menu selection of individual files. It can write multiple copies of files to tape, back up a disk to tape, restore a tape to disk, or copy files in alphabetical sequence.

Colorcopy is written in Basic with machine-language subroutines. It requires 32K and a DOS and sells for $15, ppd., on cassette or $20, ppd., on disk. For more information, contact CoCopro, P.O. Box 37022, St. Louis, MO 63141.

Reader Servic ✓ 556

Glaxxons

Glaxxons is a high-resolution, arcade-type game in which you attempt to destroy squadrons of swooping, diving enemy spacecraft. You've got to get as many of them as possible before they get you. The game becomes more difficult as it goes on, and it offers a choice of seven different skill levels.

This machine-language program is available on 16K cassette for $24.95 and 32K disk for S29.95 from Mark Data Products, 24001 Alicia Parkway, Suite 207, Mission Viejo, CA 92691, 714-768-1551.

Reader Servic ✓ 551

Look Into Your CoCo

Want to look inside your 66 and see what's there? Super-9 lets you do just that. It also provides facilities for printing the information it unlocks.

Super-9 will display memory contents in several forms, including ASCII, hex, and symbolic (disassembled machine language). It allows you to modify memory, to find all occurrences of a given byte or word (within a specific range of addresses), to transfer blocks of memory of the same size, to call subroutines, and to display the 6809 registers.

The print routine can accommodate baud rates

from 600-9,600, and it can send the display to the printer. Super-9 even has a built-in command that transfers the contents of ROM to the upper 32K of RAM on a 64K machine.

Super-9 sells for $49.50 on cassette and is available from Computer Business Machines and Services, P.O. Box 1172, 520 East Main, Ada, OK 74820, 405-436-4141.

Reader Service ✔ 558

Four Products for OS-9 Operating Systems

The JBM Group announces four new products for 6809 microcomputers using the OS-9 operating system.

• AdLib lets you store common data definitions and source-code routines in a single library file. It also preprocesses just before compilation. This makes data storage easier to control by providing a shared definition of file descriptions, record layouts, sections of code, and text. Consequently, you can automatically apply changes, made in one place, to all of your programs.

AdLib costs $50.

• SORTC is a compounding disk sort package that processes large volumes of data. It has special features that include a performance predictor function that responds to user-controlled parameters, and a code generator. SORTC allows specification of memory allocated to data and also creation of user-modifiable source code. It permits ascending and descending sequences on multiple keys and supports six standard data types.

The self-contained compounding function sums specified numeric fields and consolidates data records during the sorting process. This simplifies report generation and master file updates. It also reduces disk access and usage. SORTC costs $150.

• ISAM (Indexed Sequential File Access Method) provides powerful capabilities for the sophisticated user as well as an easy-to-use data management system for the novice.

It features sequential and random access in any combination for both keyed and unkeyed records, thus conserving directory space while allowing fast access to and control over information groups.

ISAM is crash-resistant, which simplifies operational considerations as it performs in-place reorganization. ISAM costs $350.

• XRF (Cross Reference Facility) simulates the capabilities of a full data-base system without the related overhead in CPU time and disk usage. It is a layered package for use with JBM's ISAM.

Using Boolean logic, XRF routines maintain a separate ISAM file containing the information to link logically associated records together. Overhead for on-line information processing is low.

You can consider the primary data ISAM file to be a multiple-key file when used with XRF. At the same time, you can make complex selections by inclusion or exception of various criteria.

XRF costs $200, or $100 when purchased with ISAM.

All of these products come on a disk and include a comprehensive user's manual. For more information about them, contact The JBM Group Inc., 332 West Church Road, King of Prussia, PA 19406, 215-337-3138.

Reader Service ✔ 557

The Talking Speller

If you're tired of reciting lists of spelling words to young spellers, here's a program that may prove helpful: The Talking Speller uses the CoCo's ability to control a cassette recorder and play back the list of words through the monitor speaker.

Teachers or parents can enter a list of spelling words and vocally record them on tape. The Talking Speller will play back the word, wait for a response from the keyboard, and keep score of the student's performance. It displays the correct spelling after three wrong attempts.

In a noisy classroom setting, you can use earphones instead of the speaker to provide individualized testing or drill and instruction.

The program is menu-driven and doesn't require Extended Color Basic. Screen prompts guide you as you record the spelling list.

The Talking Speller comes on tape for $19.95 from Superior Graphic Software Products, P.O. Box 451, Canton, NC 28716.

Reader Service ✔ 553

Copy a Program Or Pilot a Spacecraft

There are two new programs from Oregon Color Computer Systems.

• Catacomb is a multi-screen, multicolor, high-resolution, machine-language, arcade-type game.

To win, you must avoid enemy patrols and get fuel for an escape from the Catacomb. Then you must travel the hyperspace corridor to a mothership, while dodging space mines and enemy ships.

Catacomb will run on a standard 16K CoCo and is available on cassette for $19.95 and on disk for $23.95.

• Peek Copy is a machine-language/Basic cassette copy program. It is menu-driven and displays start, end, and execute addresses as well as each memory address.

Peek Copy requires 16K and will reproduce most autostart programs. It is available on cassette for $11.95.

For more information on both of these programs, contact Oregon Color Computer Systems, P.O. Box 11468, Eugene, OR 97440, 503-687-9286.

Reader Service ✔ 554

Double-Speed Cassette Operations

Your computer can perform double-speed cassette operations with Fastape, a machine-language utility program that allows full use of the CoCo's high-speed mode.

You can change the speed mode with a control key and cause automatic adjustment of the cassette and printer parameters. The program also features control-key entry of various common Basic commands. It leaves all but ½K of Basic's available memory free.

Fastape sells for $21.95 and is available from SpectroSystems, 11111 N. Kendall Drive, Suite A108, Miami, FL 33176, 305-274-3899.

Reader Service ✔ 555

Graphically Speaking

BAR CHARTS AND HISTOGRAMS

by Delmar E. Searls

Bar charts and histograms are frequently used in statistics and business applications to provide a visual representation of data that conveys, at a glance, the general trends involved.

In general, a good graph will have a vertical scale that starts at zero (Fig. 1). Graphs with vertical scales starting at some other value (Fig. 2) can be easily misinterpreted since the rate of change is greatly magnified.

Bar charts are composed of distinct rectangles (the bars) having definite gaps between adjacent bars (Figs. 1 and 2). They are used to represent data that can be put into distinct categories, such as the number of people that prefer Brand A, Brand B, and Brand C.

Histograms, on the other hand, are composed of rectangles that share a common side with each adjacent rectangle as if the bars in a bar chart were squeezed together until they touched. A histogram is used when the data is from a theoretically continuous scale. This includes data such as heights, weights, life expectancy, and grade-point averages.

These continuous scales are divided into a series of nonoverlapping intervals of equal width. The number of data elements that lie in a particular interval is called the frequency. A list of all the intervals and the corresponding frequencies is called a frequency distribution.

A histogram is a graphical representation of a frequency distribution where the heights of the rectangles represent the frequencies. (In a strictly technical sense, it is the area of the rectangle that represents the frequency, but as long as each interval has the same width, the height will also represent the frequency.)

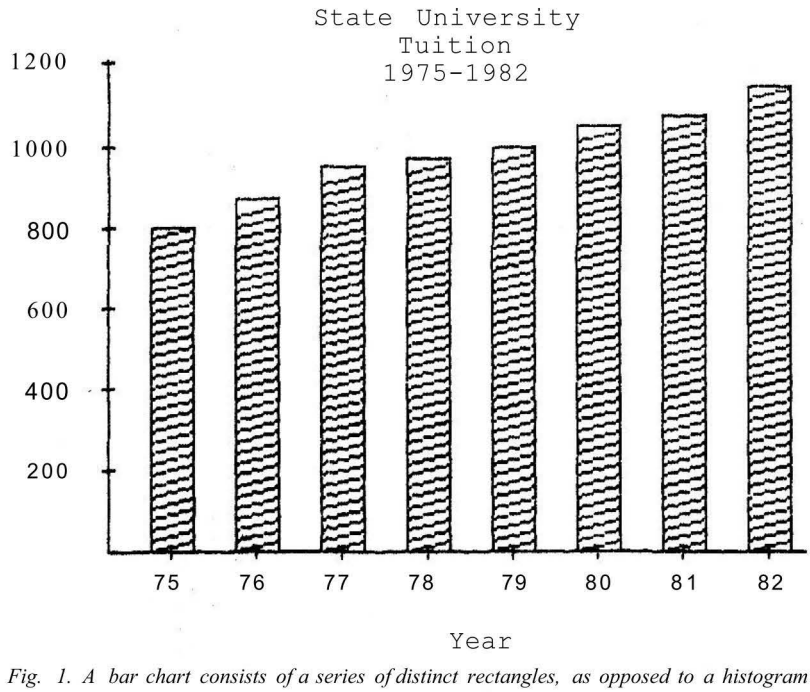


Fig. 1. A bar chart consists of a series of distinct rectangles, as opposed to a histogram where the rectangles are touching. A good bar chart has a vertical scale that starts at zero.

Bar Charts

Program Listing 1 draws bar charts from data supplied by the user and stored in data statements at the end of the program. The number of bars is stored at line 9000 and the individual heights at line 9010. Lines 0-38 are essentially the same as the subroutines presented in my first column *{HOT CoCo,* June 1983), although there are some minor changes in lines 0-1. These subroutines set up the graphics screen Oines 0-2) and let you use the screen as though it were a plotter (lines 10-16).

The subroutine in lines 30-38 draws rectangles based on data supplied by

System Requirements

16K RAM
Extended Color Basic
LP VII, Color Graphic Printer (optional)

the main program, which starts at line 1000. Lines 1000-1040 read the data stored at the end of the program. The variable MA is used to determine the maximum height occurring in the data set. This value is used to set the vertical scale. In line 1050 the origin of the coordinate system is moved to the lower left corner of the screen.

> *"...a good graph will have a vertical scale that starts at zero."*

The vertical distance available is 182 dots (or pixels). This means that the tallest bar can be no more than 182 pixels high. In line 1060 the y-scale (height per pixel) is set using the height of the tallest bar. I chose to base my graphs on a maximum height of 180 pixels because I planned on placing tick marks every 30 pixels. Thus, there are six tick marks, each representing 30 times the vertical scale per pixel (30*YS).

Lines 1090-1170 give you an opportunity to change the y-scale. The maximum height and the current scale per tick mark are printed on the screen. You are then given the option of altering this scale. For example, suppose each tick mark represents an increase in height of 191.666667. It would be much nicer to adjust this to 200 so that the tick marks could be labeled 200,

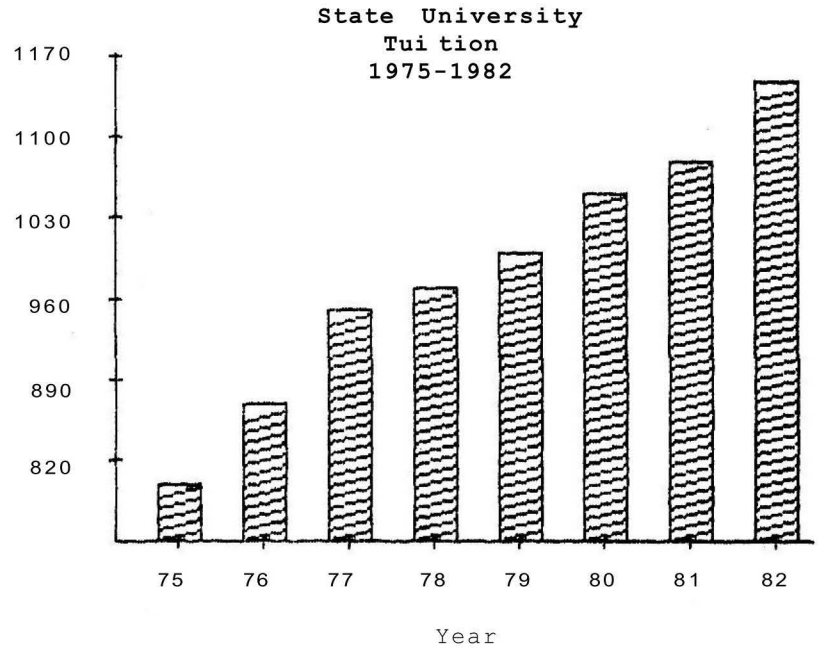


Fig. 2. If the vertical scale of a bar chart starts at some number other than zero, the graph can be misinterpreted. At a glance, it appears that the tuition rate at State University is soaring. Such graphs exaggerate the rate of change.

```
1030 READ H(I) : IF ABS(H(I))>MA THEN MA = ABS(H(I))

1050 X= -120:Y=0:M=-3:GOSUB 10
1060 YS=MA/90 : REM—SCALE PER PIXEL ON Y-AXIS

3000 X=0:Y=-91:M=-1:GOSUB 10
3010 X=0:Y=91:M=1:GOSUB 10
3020 FOR Y= -90 TO 90 STEP 30
3025 IF Y=0 THEN 3050

5020 PMODE4,1:SCREEN1,1:PMODE3,1:IF A$<>"Y" THEN 9999

Delete lines 5030-5036.

5045 IF H(I)<0 THEN C=3 ELSE C=2
5050 X=(2*1 - 1/2)*XS+8:IF H(I)<0 THEN Y=100 ELSE Y=90

Modify data statements as necessary.
```

Table 1. You can modify Program Listing 1 to include negative and positive heights. Making the changes as indicated will produce graphs such as the one in Photo 2.

See List of Advertisers on page 130

Program Listing 1. Bar charts are drawn on the PMODE3 graphics screen using data stored at the end of the program. The bars can be colored red, white, blue, or can be left black. You can easily modify the program to draw bar charts on the PMODE4 screen.

```
0 PI=3.141592:GOSUB1:GOTO1000:
1 PM0DE4,1:PCLS
2 X0=128:Y0=96:X=0:Y=0:M=-1:GOSUB10:RETURN
7 '
8 '  THE PLOT(X,Y,M) SUBROUTINE
9 '
012
10 XX=INT(X+.5) :YY=INT(Y+.5)':IFABS(M)=2THENSX=SX+XX:SY=SY-YY:GOT
11 SX=X0+XX:SY=Y0-YY
12 IFSX<0THENSX=0ELSEIFSX>255THENSX=255
13 IFSY<0THENSY=0ELSEIFSY>191THENSY=191
14 P$=STR$(SX)+","+STR$(SY):IFM>0THENDRAW"M"+P$ELSEDRAW"BM"+P$
15 IFM=-3THENX0=SX:Y0=SY
16 RETURN
27 '
28 ' THE BOXES SUBROUTINE
29 '
30 X1=X-W/2:Y1=Y-H/2
31 X2=X1+W:Y2=Y1+H
32 X=X1:Y=Y1:M=-1:GOSUB10
33 DX=X2-X1:DY=Y2-Y1
34 X=DX:Y=0:M=2:GOSUB10
35 X=0:Y=DY:GOSUB10
36 X=-DX:Y=0:GOSUB10
37 X=0:Y=-DY:GOSUB10
38 RETURN
990 :
991 '***************************
992               '*            *
993 '*  THIS PROGRAM DRAWS      *
994 '*  BAR CHARTS BASED ON     *
995 '*  DATA STORED AT THE      *
996 '*  END OF THE PROGRAM.     *
997               '*            *
998 '***************************
999 :
1000 READ N :  REM - READ NUMBER OF BARS
1010 DIM H(N):MA=0
1017 :
1018 REM - READ HEIGHTS OF BARS AND FIND MAXIMUM HEIGHT  (MA)
1019 :
1020 FOR I=1 TO N
1030 READ H(I)  : IF H(I)>MA THEN MA=H(I)
1040 NEXT I
1041 :
1050 X=-120:Y=-85:M=-3:GOSUB 10  : REM - RELOCATE ORIGIN TO LOWER
 LEFT
1060 YS=MA/180  : REM - SCALE PER PIXEL ON Y-AXIS
107 0 XS=INT(120/N)  : REM - BAR WIDTH AND DISTANCE BETWEEN BARS
1080 IF INT(XS/2)=XS/2 THEN XS=XS-1  : REM - MAKE XS AN ODD NUMBE
R
1087 :
1088 REM - ADJUST Y-SCALE  (OPTIONAL)
1089 :
1090 CLS:PRINT"MAXIMUM HEIGHT IS";MA
1100 PRINT:PRINT-THERE ARE 6 TICK MARKS ON THE   Y-AXIS.   EACH
TICK MARK"
1120 PRINT"REPRESENTS";30*YS
1130 PRINT:PRINT"DO YOU WANT TO CHANGE THIS <N>"
1140 INPUT A$:IF A$<>"Y" THEN 2000
1150 PRINT:PRINT"ENTER THE DESIRED VALUE  (IT MUSTBE MORE THAN";3
0*YS;")"
1160 INPUT V:  IF V<30*YS THEN 1150
1170 YS=V/30
1997 :
1998 REM  **** DRAW X-AXIS ****
1999 :
2000 SCREEN1,1:PMODE3,1:X=2*N*XS+5:Y=0:M=1:GOSUB  10
2007 :
2008 REM - DRAW TICK MARKS
2009 :
2010 XT=1.5*XS  : REM - LOCATION OF MIDDLE OF FIRST BAR
2020 FOR I=0 TO N-1
2030 :  X=XT+2*I*XS:Y=2:M=-1:GOSUB 10  : REM - BLANK MOVE
2040 :  Y=-2:M=1:GOSUB  10  : REM - DRAW TICK MARK
2050 NEXT I
2997 :
2998 REM  **** DRAW Y-AXIS ****
2999 :
3000 X=0:Y=0:M=-1:GOSUB 10  : REM - BLANK MOVE TO ORIGIN
3010 X=0:Y=181:M=1:GOSUB 10  : REM - DRAW VERTICAL LINE
3017 :
3018 REM - DRAW TICK MARKS
```

Listing continued

400, 600, and so on. As a result, the bars are slightly shorter than they would have been, but the graph looks better and is easier to read.

Line 1170 converts this new scale per tick mark into the corresponding scale per pixel. Notice in line 1130 the default option is to leave the scale unchanged. I indicate default options by enclosing them in brackets <N>. The default option is selected any time you press only the enter key in response to an INPUT command in the program.

Let's back up to line 1070. Here the width of each bar (and the width of the gaps between bars) is calculated. The total width available is 240 pixels. For each bar there is a corresponding gap so that the width of each bar is given by 240/(2*N), which can be simplified to 120/N. This seems to work best for getting the tick mark at the middle

"A histogram is a graphical representation of a frequency distribution."

of each bar. This is complicated somewhat by PMODE3, in which the same pixel represents two different x-coordinates.

Lines 2000-2050 draw the x-axis (horizontal scale), and lines 3000-3050 draw the y-axis. In each case a line is drawn with the appropriate number of tick marks added. Each tick mark is just a short line segment extending two pixels on either side of the axis. The bars are drawn in lines 4000-4020. The lower left corner of each bar is calculated (X1,Y1) along with the width (W = XS for all bars) and the height (H = H(I), where H(I) was read from the data).

With this information the Boxes subroutine is entered at line 31. Entry at line 30 requires the center of the box, the width, and the height, while entry at line 32 requires a pair of diagonally opposed corners.

This program uses the 128-by-192 screen (PMODE3) with red, white, and blue on a black background. As many of you probably know, this screen is selected by executing a

of the hill!

It's a jungle out there, but the latest news on the Color Computer grapevine is that, above the swirling mists of confusion, more and more people are discovering the Rainbow.®

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Just for your TRS-80® COLOR TDP System 100 Dragon-32 MC-10

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Listing continued

```
3019 :
3020 FOR Y=30 TO 180 STEP 30
3030 :  X=-2:M=-1:GOSUB 10 : REM - BLANK MOVE
3040 :  X=2:M=1:GOSUB 10 : REM - DRAW TICK MARK
3050 NEXT Y
3997 :
3998 REM  **** DRAW BARS ****
3999 :
4000 FOR I=1 TO N
4010 X1=(2*I-1)*XS:W=XS:Y1=0:H=INT(H(I)/YS+.5):GOSUB 31
4020 NEXT I
4997 :
4998 REM  **** COLOR THE BARS (OPTIONAL) ****
4999 :
5000 CLS
5010 PRINT"DO YOU WISH TO COLOR THE BARS":INPUT "<N>";A$
5020 IF A$<>"Y" THEN PMODE4,1:SCREEN1,1:PMODE3,1:GOTO 9999
5030 PRINT"2 = BLUE":PRINT"3 = RED":PRINT"4 = WHITE"
5035 INPUT "COLOR <2>";C:IF C=0 THEN C=2
5036 PMODE 4,1:COLOR C:SCREEN1,1:PMODE3,1
5040 FOR I=1 TO N
5050 :  X=(2*I-1/2)*XS+8:Y=177
5060 :  PAINT(X,Y),C,0
5070 NEXT I
8997 :
8998 REM  **** DATA STORAGE ****
8999 :
9000 DATA 8
9010 DATA 800,870,950,970,1000,1050,1080,1150
9998 :
9999 GOTO 9999
```

PMODE4 command (line 1) followed by a SCREEN 1,1 and a PMODE3 command (line 2000) in that order.

You might also be aware that this screen has the peculiarity of switching colors. Usually a COLOR 3 command produces red (on my system), but sometimes the machine produces blue instead. In spite of this minor problem, I like this screen display because the colors show up nicely on the black background.

This program would be most useful when you plan to use the television as your primary display (Photo 1) as opposed to sending the graph to a printer (Fig. 3).

The bar coloring is optional and is handled in lines 5000-5070. If you decide to color the bars, the color options are listed on the screen in line 5030. The default color is blue (most of the time), as indicated by <2> in line 5035. Line 5050 locates a pixel near the bottom of each bar, and the PAINT command in line 5060 colors the bar.

I have made no attempt to label the bar chart on the screen because of the relatively low resolution. I prefer to use as much of the space as possible for the bar chart itself. A printout of the graph can be labeled using a typewriter, as in Figs. 1 and 2.

Converting the program to draw charts on the PMODE4 screen is very easy. Simply delete the PMODE3 command in lines 2000, 5020, and 5036. In line 1080 change INT(XS/2) = XS/2 to read INT(XS/2)<>XS/2. Change line 5060 to read PAINT (X,Y),1,1 and delete lines 5030 and 5035.

You can still color the bars, although you are limited to only white. A printout of the PMODE4 option (without coloring) is given in Fig. 4.

Plain bars are okay, but you might want to add some shading. If so, delete lines 4998-5070 and add the lines in Program Listing 2. This little routine draws a series of slanted lines to provide some shading (see Figs. 1 and 2).

In line 5010 a blank move is made to the lower left corner of the rectangle. The height of the rectangle (in pixels) is calculated in line 5020. The loop in lines 5030-5060 draws the slanted lines. In line 5030 the y-coordinate of the current pen location (it starts at lower left) is increased by four and

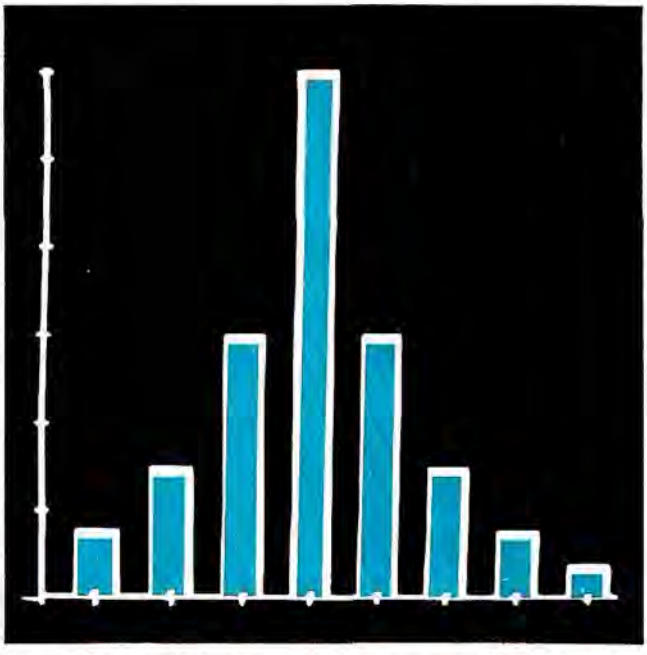

Photo 1. Program Listing 1 generates bar charts on the PMODE3 graphics screen and allows you to color the bars red, white, blue, or black.

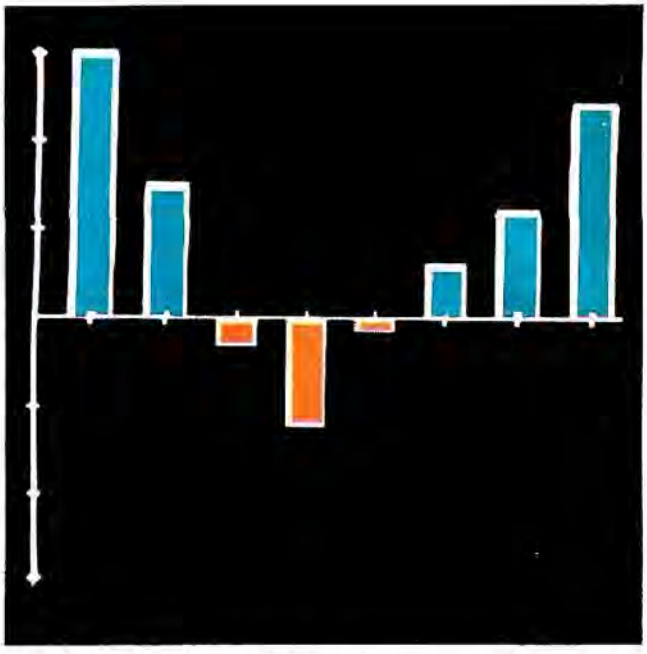

Photo 2. Some bar charts include bars that represent both negative and positive values. See Table I for details on modifying Program Listing 1 to produce these graphs.

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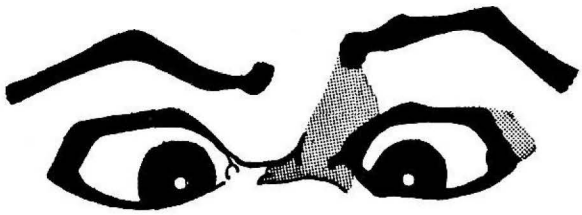

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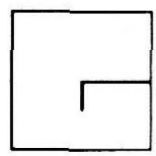

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```
4998 REM  **** SHADE THE BARS  (OPTIONAL)  ****
4999 :
5000 FOR I=1 TO N
5010 X=(2*I-1)*XS:Y=0:M=-1:GOSUB 10
5020 MY=INT(H(I)/YS+.5)
5030 Y=Y+4:IF Y>MY THEN 5070
5040 X=X+XS:M=1:GOSUB 10 :  REM - DRAW DIAGONAL LINE
5050 X=X-XS:M=-1:GOSUB 10 :  REM - BLANK MOVE BACK ACROSS TO LEF
T SIDE
5060 GOTO 5030
5070 NF=4-(Y-MY)
5080 IF NF=0 THEN 5100
5090 X=X+INT(NF*XS/4+.5):Y=MY:M=1:GOSUB 10
5100 NEXT I
```

Program Listing 2, Bars on the PMODE4 screen can be shaded by drawing a series of diagonal lines across the bars.

Program Listing 3. In statistics, raw data is often organized into a frequency distribution. By altering the first interval, a user can examine a variety of different distributions.

```
1 ' ****************************
2 ' *                          *
3 ' *  THIS PROGRAM CREATES A  *
4 ' *  FREQUENCY DISTRIBUTION  *
5 ' *  BASED ON DATA ENTERED   *
6 ' *  BY THE USER.  THE       *
7 ' *  RESULTS CAN BE SENT TO  *
8 ' *  THE PRINTER OR ALTERED  *
9 ' *  AS DESIRED.             *
10' *                          *
11' ****************************
97 :
98 REM  **** INPUT DATA ****
99 :
100 CLS:INPUT"NUMBER OF DATA ITEMS";ND
110 DIM D(ND),H(20):MD=0:MI=9999
120 FOR I=1 TO ND
130 :  PRINT"DATA ITEM";I;:INPUT D(I)
140 :  IF D(I)>MD THEN MD=D(I)  : REM - FINDS MAXIMUM VALUE IN DA
TA SET
150 :  IF D(I)<MI THEN MI=D{I)  : REM - FINDS MINIMUM VALUE IN DA
TA SET
160 NEXT I
167 :
168 REM - MAKE CORRECTIONS IF NECESSARY
169 :
170 PRINT"ANY CORRECTIONS <N>";A$
180 IF A$<>"Y" THEN 260
190 INPUT"WHICH DATA ITEM";I
200 PRINT"DATA ITEM";I;"WAS ENTERED"
210 PRINT"AS";D(I);"."
220 PRINT"WHAT IS ITS CORRECT"
230 PRINT"VALUE <";D(I);">";:INPUT D
240 IF D<>0 THEN D(I)=D
250 GOTO 170
257 :
258 REM  **** CREATE THE FREQUENCY DISTRIBUTION ****
259 :
260 CLS:PRINT"MAXIMUM DATA VALUE IS";MD
270 PRINT-MINIMUM  DATA  VALUE  IS";MI
280 PRINT-RANGE OF DATA IS";MD-MI+1
290 PRINT
300 PRINT-THE FIRST INTERVAL SHOULD"
310 PRINT"INCLUDE";MI;"."
320 PRINT
330 PRINT"ENTER  FIRST  INTERVAL  AS"
340 PRINT"A PAIR OF NUMBERS A,B."
350 PRINT"(5-9 WOULD BE ENTERED 5,9)
360 PRINT
370 INPUT "FIRST INTERVAL";A,B
380 IF A>MI OR B<MI THEN 300 : REM - MAKE SURE MI IS IN THE 1ST
INTERVAL
390 WW=B-A+1 : REM - WW IS THE INTERVAL WIDTH
398 REM - MAKE SURE THAT THERE WILL BE 20 OR FEWER INTERVALS
399 :
400 IF B+I9*WW<MD THEN PRINT"PICK A WIDER INTERVAL":GOTO 300
407 :
408 REM - COUNT THE INTERVALS AND MAKE SURE THAT THERE ARE 5 OR
MORE
```

Listing continued

compared to the height of the bar (in pixels).

If the y-coordinate is less than this height, a line is drawn from the current pen position to a point on the opposite side of the bar four pixels higher. A blank move is then made horizontally back to the left side of the bar.

This process repeats until the newly calculated y-coordinate is greater than the height of the bar (see Fig. 5). Lines 5070-5090 handle the drawing of the short line at the top of some bars.

The last option I'll consider is for bar charts that show positive and negative values (see Photo 2). Using Listing 1, make the changes indicated in Table 1. Basically, these changes raise the x-axis to the middle of the screen (line 1050) so bars can be drawn above and below.. Bars above the x-axis are colored blue, and those below are colored red (line 5045).

Histograms

As indicated earlier, histograms differ from bar charts only in the rectangles touching. You can easily alter Listing 1 to draw histograms:

```
1070 XS = INT(240/(N + 2))
2000 SCREEN1,1:X = (N + 2)*XS:
Y = 0:M = 1:GOSUB10
DELETE 2010
2020 FOR 1 = 1 TO N + 1
2030 X = I*XS:Y = 2:M = - 1:GOSUB 10
4010 X1 = (I + 1)*XS:W = XS:Y1 = 0:
H = INT(H(I + 1)/YS + .5):GOSUB 31
DELETE 4998-5070
```

An important application of histograms is in statistics, where a set of raw data is often organized into a fre-

See List of Advertisers on page 130

quency distribution and the results portrayed graphically (Fig. 6). Program Listing 3 constructs a frequency distribution from data that you enter. Once you have entered the data (lines 100-160), you have the opportunity to make corrections (lines 170-250).

In lines 260-370 you receive some basic information (high score, low score, and range) and are asked to select the first interval. This selection is checked to make sure that the low score is included in the given interval.

Furthermore, the program determines how many intervals are required to cover the data. If the number is less than five or greater than 20, you must revise your choice. Selecting a wider first interval generates fewer intervals, while selecting a narrower interval results in more intervals.

Line 450 sets all frequencies to zero. The frequency distribution is calculated in lines 460-500. Each data item is compared to the upper limit of successively higher intervals. When the upper limit is greater than or equal to the data element, the frequency corresponding to that interval is increased

Listing continued

```
409 :
410 N=0
420 IF MD=<B+WW*N THEN N=N+1:GOTO 440
430 N=N+1:GOTO 420
440 IF N<5 THEN PRINT"PICK A NARROWER INTERVAL":GOTO 300
450 FOR I=1 TO N:H(I)=0:NEXT I : REM - SET ALL FREQUENCIES TO ZE
RO
457 :
458 REM - COUNT THE THE NUMBER OF DATA ITEMS IN EACH INTERVAL
459 :
460 FOR I=1 TO ND
470 :  FOR J=0 TO N-1
480 :   IF D(I)<=B+J*WW THEN H(J+1)=H(J+1)+1:J=N-1
490 :  NEXT J
500 NEXT I
507 :
508 REM - PRINT OUT THE FREQUENCY DISTRIBUTION ON SCREEN
509 :
510 CLS:PRINT"INTERVAL","FREQUENCY"
520 PRINT
530 FOR I=1 TO N
540 :  PRINT A+(I-1)*WW;"-";B+(I-1)*WW,H(I)
550 NEXT I
557 :
558 REM - SEND TO PRINTER IF DESIRED
559 :
560 PRINT"DO YOU WANT THIS DISTRIBUTION"
570 INPUT"SENT TO THE PRINTER <N>";A$
580 IF A$<>"Y" THEN 630
590 PRINT#-2,,,"INTERVAL","FREQUENCY"
600 FOR I=1 TO N
610 :  PRINT#-2,,,A+(I-1)*WW;"-";B+(I-1)*WW,H(I)
620 NEXT I
627 :
628 REM - ALTER FREQUENCY DISTRIBUTION IF DESIRED
629 :
630 PRINT:PRINT"DO YOU WANT TO ALTER THE"
640 PRINT"DISTRIBUTION BY CHANGING THE"
650 INPUT"FIRST INTERVAL <N>";A$
660 IF A$="Y" THEN 260
670 END
```

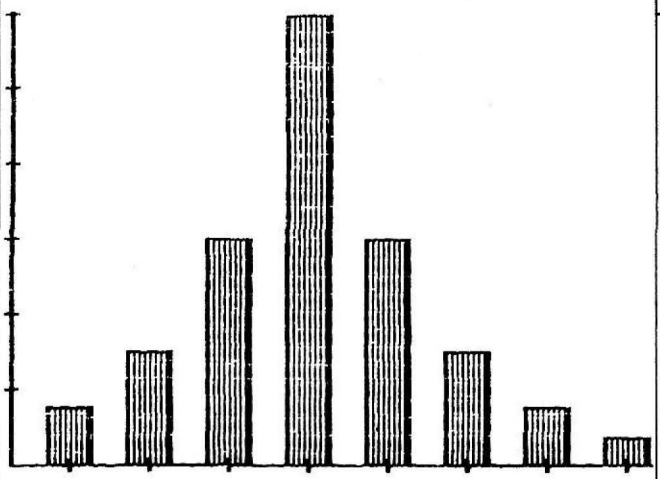

Fig. 3. Graphs generated by Program Listing 1 have shaded bars when the screen display is sent to the printer. (See Photo 1.)

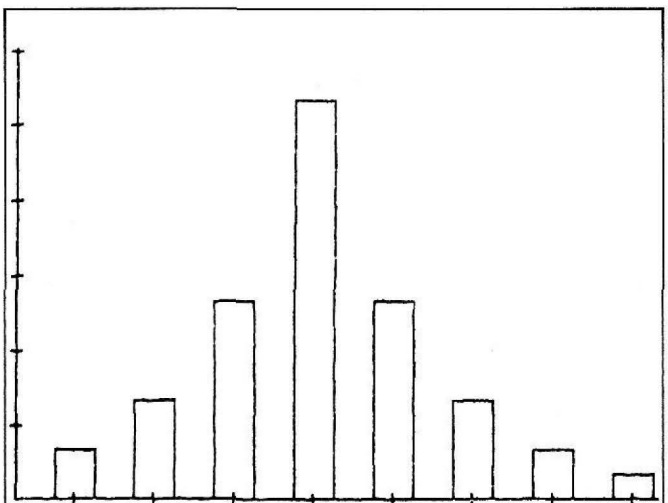

Fig. 4. Listing 1 can be modified to use the PMODE4 graphics screen resulting in a neater printout.

```
 5   9   2   8   3   9   4   9   8   8
 3   3   7   5   6   9   7   4   7   6
 7   10   10   7   8   7   6   7   7   8
 6   10   6   9   9   10   7   4   9   4
 7   7   11   10   2   7   6   7   11   5
 10   11   7   7   11   8   3   5   10   9
 3   6   10   4   12   4   8   7   6   5
 12   11   11   6   8   9   3   3   9   9
 11   2   10   5   9   6   7   6   5   7
 11   4   3   8   8   4   8   7   7   9
```

INTERVAL	FREQUENCY
1 - 2	3
3 - 4	15
5 - 6	18
7 - 8	32
9 - 10	22
11 - 12	10

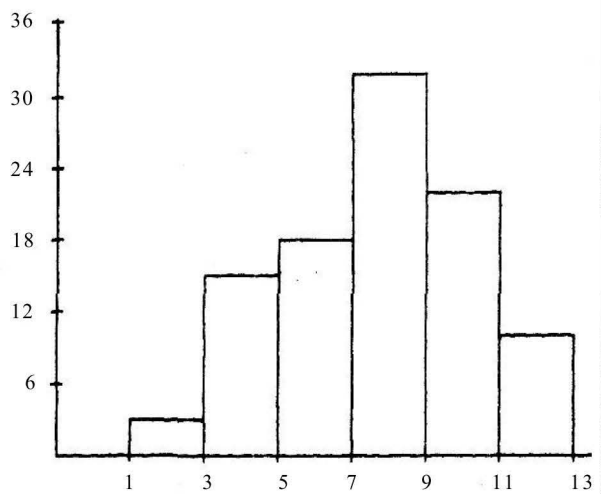

Fig. 6. The raw data at the top was organized into a frequency distribution by Program Listing 3. The histogram was drawn using a modified version of Listing J.

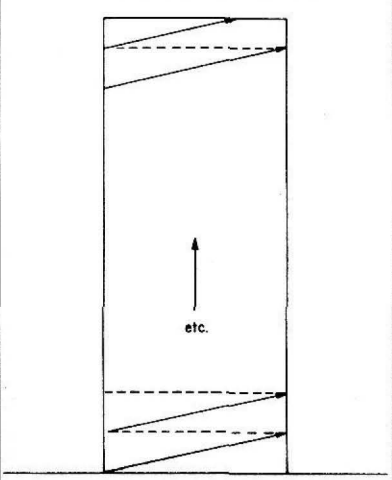

Fig. 5. As an alternative to solid coloring, diagonal lines can be used to provide shading. A blank move back to the left side of the bar is indicated by a dotted line.

by one (line 480).

The frequency distribution is displayed on the screen (lines 510-550) and can be sent to a printer (lines 560-620). You then have the option of altering the frequency distribution by changing the first interval (lines 630-660). Sometimes a slight change in the first interval significantly alters the final results. You can make a histogram of the frequency distribution by using Listing 1 as modified above.

Color Graphic Printer

Program Listing 4 draws bar charts on the Color Graphic Printer (Fig. 7).

Program Listing 4. The Color Graphic Printer produces bar charts including labels and titles. The bars can be shaded with any of four colors.

```
0  PI=3.141592:GOSUB1:GOTO1000
1  PRINT#-2,CHR$(17):PRINT#-2,CHR$(18);"M45,0":PRINT#-2,"I":RETUR
N
27 '
28 ' THE BOXES SUBROUTINE
29 '
30  X1=X-W/2:Y1=Y-H/2
31  X2=X1+W:Y2=Y1+H
32  PRINT#-2,"M";X1;",";Y1
33  DX=X2-X1:DY=Y2-Y1
34 PRINT#-2,"J";DX;",0,0,";DY;",-;-DX;",0 "
35 RETURN
```

Listing continued

Listing continued

```
100 0 READ N :  REM - READ NUMBER OF BARS
1010 DIM H(N):MA=0
1017 :
1018 REM - READ HEIGHTS OF BARS AND FIND MAXIMUM HEIGHT  (M)
1019 :
1020 FOR I=1 TO N
1030 READ H(I)  : IF H(I)>MA THEN MA=H(I)
1040 NEXT I
1060 YS=MA/360 : REM - SCALE PER DOT ON Y-AXIS
1070 XS=INT(275/N)  : REM - BAR WIDTH AND DISTANCE BETWEEN BARS
1080 IF INT(XS/2) OXS/2 THEN XS=XS-1 : REM - MAKE XS AN EVEN NUM
BER
1090 CLS:PRINT"MAXIMUM HEIGHT IS";MA
1100 PRINT:PRINT"THERE ARE 6 TICK MARKS ON THE   Y-AXIS.   EACH
TICK MARK"
1120 PRINT"REPRESENTS";60*YS
1130 PRINT:PRINT"DO YOU WANT TO CHANGE THIS <N>"
1140 INPUT A$:IF A$<>"Y" THEN 2000
1150 PRINT:PRINT"ENTER THE DESIRED VALUE  (IT MUSTBE MORE THAN";6
0*YS;")"
1160 INPUT V:  IF V<60*YS THEN 1150
1170 YS=V/60
1997 :
1998 REM  **** DRAW X-AXIS ****
1999 :
2000 PRINT#-2,"X0,";-2*XS;",";N
2010 PRINT#-2,"J0,";-XS
2997 :
2998 REM  **** DRAW Y-AXIS ****
2999 :
3000 PRINT#-2,"H"
3010 PRINT#-2,"X1,60,6"
3997 :
3998 REM  **** DRAW BARS ****
3999 :
4000 FOR I=1 TO N
4010 :  Xl=0:Yl=-2*I*XS-XS/2:H=XS:W=INT(H(I)/YS+.5):GOSUB 31
4020 NEXT I
4997 :
4998 REM  **** SHADE THE BARS  (OPTIONAL)  ****
4999 :
5000 CLS
5010 PRINT"D0 YOU WISH TO SHADE THE BARS":INPUT "<N>";A$
5020 IF A$<>"Y" THEN 6000
5030 PRINT"0 = BLACK":PRINT"1 = BLUE":PRINT"2 = GREEN":PRINT"3 =
 RED"
5040 INPUT"WHICH COLOR <0>";C
5050 PRINT#-2,"C";C
5060 FOR I=1 TO N
5070 :  X=l:Y=-2*I*XS+XS/2-l:PRINT#-2,"M0,";Y
5080 :  MY=INT(H(I)/YS+.5)
5090 :  X=X+8
5100 :  IF X<MY THEN PRINT#-2,"J8,";-XS+2:PRINT#-2,"R0,";XS-2:G0
TO 5090
5110 :  NF=8-(X-MY)
5120 :  PRINT#-2,"J";NF-l;",";-INT(NF*(XS-2)/8+.5)
5130 NEXT I
5997 :
5998 REM  **** LABEL Y-AXIS ****
5999 :
6000 PRINT#-2,"H":PRINT#-2,"Q1":PRINT#-2,"S1":PRINT#-2,"C0"
6010 FOR I=1 TO 6
6020 :  A$=STR$(60*YS*I):L=LEN(A$):IF L>ML THEN ML=L
6030 :  X=60*I-7
6040 :  Y=12*(L+1)
6050 :  PRINT#-2,"M";X;",";Y:PRINT#-2,"P";A$
6060 NEXT I
6997 :
6998 REM  **** LABEL X-AXIS ****
6999 :
7000 FOR I=1 TO N
7010 :  READ X$:L=INT(LEN(X$)/2)
7020 :  Y=-2*I*XS+11*L
7030 :  PRINT#-2,"M-25,";Y:PRINT#-2,"P";X$
7040 NEXT I
7997 :
7998 REM **** PRINT TITLES ****
7999 :
8000 READ NT
8010 L=N*XS
8020 FOR I=1 TO NT
8030 :  READ T$
8040 :  X=435-20*I:Y=-L+11*INT((LEN(T$)+l)/2)
8050 :  PRINT#-2,"M";X;",";Y:PRINT#-2,"P";T$
8060 NEXT I
8069 :
8070 READ YL$
8080  PRINT#-2,"Q0":X=200-ll*INT(LEN(YL$)/2)
```

Listing continued

This program draws the graph sideways on the paper to produce a bigger graph. This makes the program a little more difficult to follow because the y-axis of the graph is the x-axis of the plotter, and the x-axis of the graph is the negative y-axis of the plotter. The basic logic of the program, however, is the same as in Listing 1.

Drawing the axes (lines 2000-3010) is much simpler because of the X (draw axis) command supported by the Color Graphic Printer. The Boxes subroutine has been slightly modified to omit the drawing of the fourth side of the rectangle. This side lies on the x-axis, which has already been drawn. The shading routine (lines 5000-5130) is basically the same as that in Listing 2 except that the diagonal lines are drawn entirely within the box instead of from one side to the other.

The biggest difference is the inclusion of routines to label the axes and print the titles. In each case the program determines the point at which the printing of a label or title is to begin and then prints that label or title. The numerical labels for the y-axis are based on the scale per tick mark (60*YS) and are printed in lines 6000-6060. The labels for the bars are stored in a data statement (line 9020) and printed in lines 7000-7040.

The title of the graph is stored in line 9030 and printed in lines 8000-8060. Note that the number of lines in the title is stored before the text in line 9030. The title of the y-axis is stored in line 9040 and printed in lines 8070-8100, while the title of the x-axis is stored in line 9050 and printed in lines 8110-8140.

Listing continued

```
8090 PRINT#-2,"M";X;",";11*ML+20
8100 PRINT#-2,"P";YL$
8109 :
8110 READ XL$:PRINT#-2,"Q1"
8120 Y=-N*XS+11*INT(LEN(XL$)/2)
8130 PRINT#-2,"M-44,";Y
8140 PRINT#-2,"P";XL$
8150 PRINT#-2,"Q0":PRINT#-2,"A"
8996 :
8997 REM  **** DATA STORAGE ****
8998 :
8999 REM - NUMBER OF BARS
9000 DATA 8
9008 :
9009 REM - HEIGHT OF BARS
9010 DATA  800,870,950,970,1000,1050,1080,1150
9018 :
9019 REM - LABELS FOR X-AXIS
9020 DATA 75,76,77,78,79,80,81,82
9028 :
9029 REM - NUMBER OF LINES IN TITLE, TEXT FOR TITLE OF GRAPH
9030 DATA 2,"STATE UNIVERSITY TUITION","1975-1982"
9038 :
9039 REM - TITLE OF Y-AXIS
9040 DATA "TUITION IN DOLLARS"
9048 :
9049 REM - TITLE OF X-AXIS
9050 DATA "YEAR"
```

Looking Ahead

Next time I will look at graphs of polar equations. I will develop a two-color (PMODE4) program that draws a grid with labels on the graphics screen and then plots the graph of the equation. In addition, I will consider a four-color (PMODE3) option and a version for the Color Graphic Printer. •

Write Delmar Searls c/o HOT CoCo, *Pine St., Peterborough, NH 03458.*

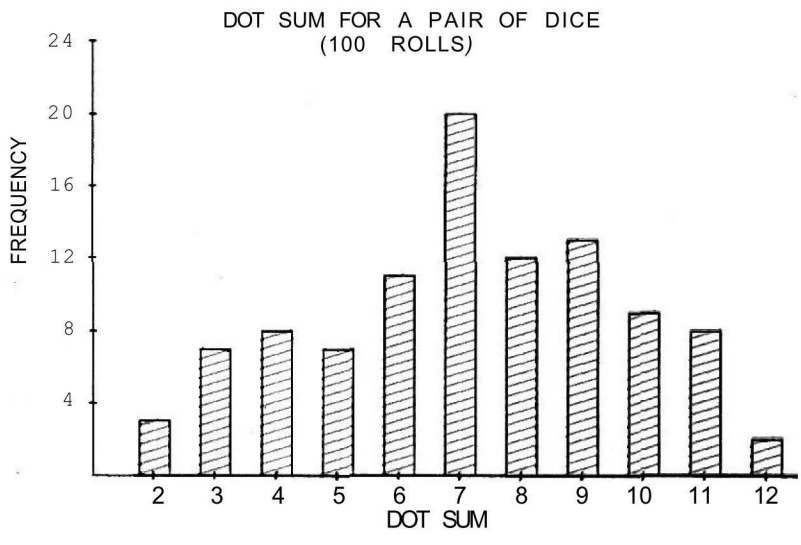

Fig. 7. You can prepare attractive bar charts with the Color Graphic Printer. Drawing the charts sideways on the paper gives you more room for bigger graphs.

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