A WAYNE GREEN PUBLICATION
June 1983 USA $2.95

HOT CoCo

THE MAGAZINE FOR TRS-80 COLOR COMPUTER AND TDP-100 USERS

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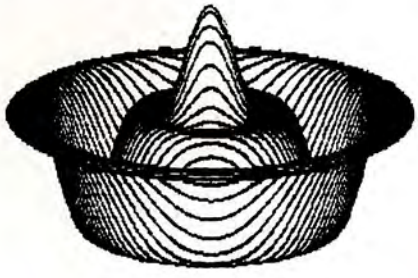
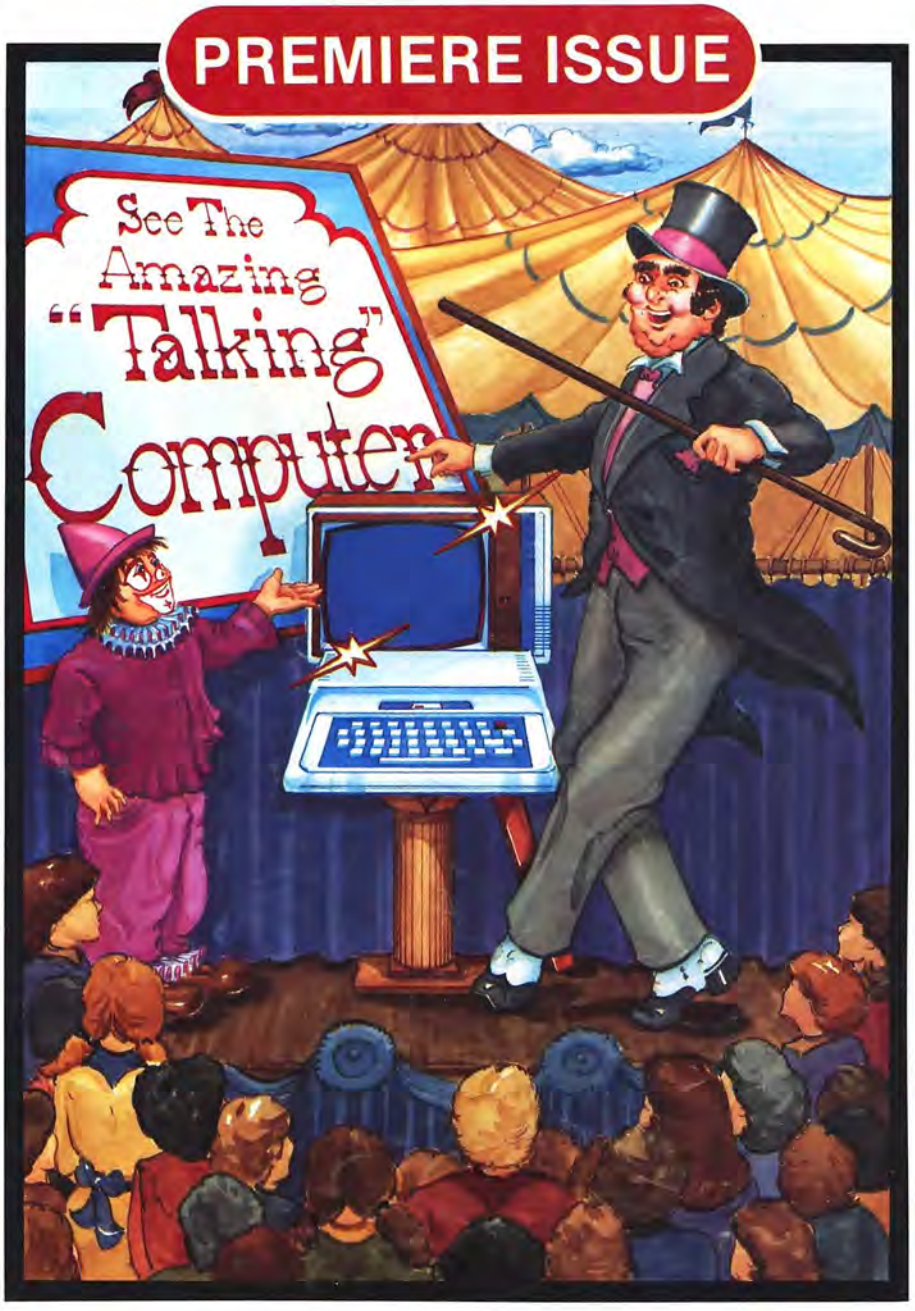
Contour Graphics—See p. 94





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Most of the companies whose advertising you see in magazines like this brag that their programs for the Radio Shack Color Computer are 'just like the arcade games' they're patterned after.

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At **ScreenPlay,** we think the Color Computer is a pretty special machine. We think it deserves better than hundreds of "Chomp-Boy" arcade imitations and "Cavernous Cave" adventures. After all, the 6809 is as powerful as most 16-bit chips, and quicker than all of them. It has nearly unlimited potential.

You know all this. After all, you were smart enough to buy the machine. And people like you aren't going to want to play "Chomp-Boy" forever.

Ken Kalish and Jyym Pearson know the power of the 6809, too. And their programs for **ScreenPlay** will deliver that power to your Color Computer. Arcade programs with bright colors and snappy graphics. Adventure programs with elaborate scenarios and challenging problems. Programs that aren't just like everybody else's games — they're better. More complex. More demanding. More fun.

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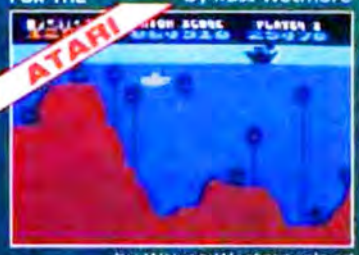

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Off Color

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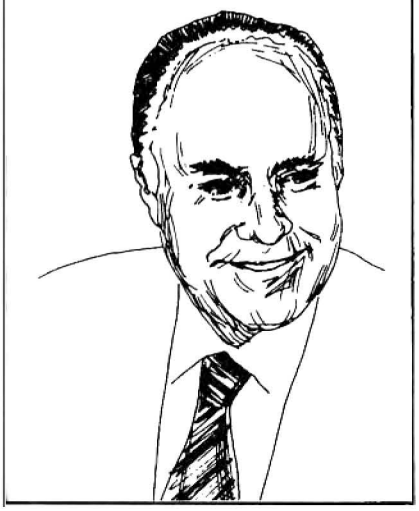
BY WAYNE GREEN



Since a major part of the value—of the fun—of a computer depends on how much you know about it, you want to get all the information you can. This holds particularly true for the TRS-80 Color Computer, which is one of the biggest sleepers in the industry. Indeed, many insiders of the field believe that even the moguls at Radio Shack were not aware of the power of this innocent looking gadget that Radio Shack is selling mostly as a toy.

Well, toys come in all price ranges and powers, as any Maserati owner will admit. In this case you have your choice: one hell of a plaything, a nice little (and inexpensive) business computer of almost unlimited use, or anything else you want in a computer. Even at its list price, this is one of the best values in small computers there is.

Since the real power of the CoCo, as it has come to be called, hasn't yet gotten to be widely understood, the chances are that you lucked into something far beyond what you bargained for when you bought yours. Well, it's nice to luck out now and then. Usually, particularly in computers, luck runs the other way.

Now, in case you are not an old-time reader of *73 Magazine*, a ham magazine I've been publishing for over 20 years, or are a newcomer to computers and thus missed my starting *Byte* in 1975, *Kilobaud Microcomputing* in 1976, *80 Micro* in 1980, *Desktop* in 1981 and *inCider* (for the Apple) a few months ago, let me explain that I've been around ever since the first microcomputer was put on the market, so I have a fair perspective for you on the whole field.

Best, for you, I've been able to attract a fantastic bunch of people to my minipublishing empire—a group able to put out truly professional magazines, yet keep each of them personal in a way. The aim is to publish a good-looking, interesting magazine, yet keep it more like a club newsletter in personal approach. If you come up against a problem with your CoCo and surmount it, please make it your business to send in a letter or article so you can help others over the same rough spot.

Articles—you bet we're looking for them. I chuckle when someone asks what we want articles on. That's so obvious I feel silly writing it. The readers want to know the same things you do. So if you find an interesting use for your CoCo, tell us about it. If you manage to interface something to it, let us know how you did it. And remember that most of us are dummies when it comes to computers and electronics, so we appreciate all the help and ideas we can get.

We all want to know how a new piece of equipment works. We want to know what you thought of a new program. If it's fantastic, do the program publisher a favor and pass along your experience. If it is a bummer, do the rest of us a favor and let us know about that. If you're into writing programs, send 'em along so more of us can use them and enjoy them. What programs? Just about anything, including games, scientific applications, business, home, education...I can't think of anything that will fall on blind eyes. Music isn't very popular with computers yet, but that may be more because we're short of good information and equipment for it.

Submitting articles and letters to *HOT CoCo* is easy. Please type them double-spaced and leave generous margins so our editors can correct spelling and grammatical errors. Try to think in terms of illustration to make reading easier—photographs or whatever—and the bigger and sharper, the better with photos. If you are doing your work on a CoCo with a word processor you might send in a disk copy of the article, too. We're gearing up to typeset directly from disks eventually. We *do* pay for articles, of course.

How long should an article be? Tell the whole story and don't worry about the length. Oh, don't start padding it, just tell the readers what they need to know, remembering that most of us will appreciate your making it as simple as you can. Show us what a great teacher you are, not how smart.

Rank beginners to the CoCo would do well to keep notes on the frustrating route to understanding. If you'll take the time to write some of this down you can, through *HOT CoCo*, make life a lot easier for the next couple of hundred-thousand CoCo owners.

The value of any computer is made up of the quality of the hardware, the software, and the information on how to use the system. I got in a new computer to test the other day. The hardware is first rate, a marvel. The programs for it are really great. But when I sat down to use the contraption, I was totally lost in the inch-thick instruction manual. After a couple of hours of being unable to get anything to run, I gave up. Why in hell should I have to go out and take a course just to start up a computer? That system is

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Off Color

not supported by a magazine, so the chances of my getting much help from anywhere is small. At least, when there is a magazine, you are getting the energies of thousands of people together for the good of all involved.

The ads, which some people gripe about, are another important resource for you. Think about this for a moment. Without a system-specific magazine, how can a small entrepreneur get started in business with a product for the system? If you want a real scare, look at the ad rates for *Byte*. Heh, heh. Few small firms can afford that kind of start-up cost. And remember that only a tiny percentage of the readers of a big magazine like that will even be interested in a product for one specific system.

By bringing you ads for products that you in particular will want to know about, the manufacturer is able to reach you at the lowest possible cost. You win because then he can charge less for the product. A magazine like *HOT CoCo* is thus able to bring you ads on brand-new products at the lowest possible prices.

One more thing. Since the CoCo is sold almost exclusively through Radio Shack stores, the firms making add-ons, programs, and information for the CoCo are unable to reach you any way but via mail order . . . through ads in magazines such as this. Apple supporters have a thousand computer stores anxious to carry Apple-oriented products. Computer stores, for the most part, flatly refuse to touch anything to do with Radio Shack or their computers. It's an emotional thing, complete with sneering references to the Trash-80.

One more important benefit for you yet—and that has to do with discount mail-order selling. Now I'm not a fan of this at all, for in many cases it is pernicious and eventually does in the whole marketing system for a manufacturer. But I'm a realist too, so as long as Radio Shack encourages the discount mail-order selling of their equipment, who am I to tell them they are screwing up? No, I say read the ads and find your bargains where you can, this magazine will have 'em.

We did a study of the discount prices on the Model III and found that a prudent buyer through *80 Micro* could easily save almost a thousand dollars on a system by patronizing mail-order discounters instead of the corner Radio Shack store. The nice folks at Tandy blew a gasket when I mentioned this in a subscription ad for the magazine, but it's all true, whether they want you to know about it or not.

Which brings me to the status of Wayne Green versus Tandy. My basic rule is to tell it like it is and not try to help cover up things that have gone wrong. The chaps at Tandy are not in sympathy with this and seem to feel that we should act more as a division of Tandy, sticking to the company line. They feel strongly enough about this to be amazingly petty. They even refuse to send us new-product information or ask us to showings of their products. Such pressures won't affect our integrity. I far prefer to be friends, but not at the expense of being a lackey.

From your viewpoint this means that we're on your side and not making excuses for Radio Shack where they have screwed up. If you are getting any other TRS magazines, you might just think about that, particularly if you see any Radio Shack ads being run. We tried that with *80* and found that the price asked for running their ads was to be their toady. No way . . . not for a bit of silver.

Getting back to uses for the CoCo . . . and articles. These are nice-looking computers, so we should be seeing them used more often in business. Programs that allow networking, so several CoCos can be hooked together in an office and talk with each other is one way to introduce them to business. We're also looking for programs to permit several to access a hard-disk data base.

Another use that is getting more popular and needs a lot more experimenting is in amateur radio. I assume you're aware that it is not at all difficult to get in touch with people almost anywhere in the world and make contact via voice, or computer to computer. We do need to see interfaces designed for this, frequencies and times set up for networks of users, and so on. If you enjoy getting on one of the telephone nets and talking with others for around $5 an hour, think how much fun you'd have if you could be doing that with people all over the world and at almost $0 per hour.

On a recent trip I found radio amateurs getting geared up for this all around Asia. A good friend in Hong Kong is on, one in Manila, a few hun-

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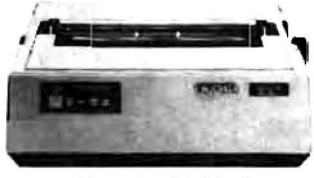

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HOT CoCo

dred (maybe thousands) in Japan, Bangkok, and so on. They'd love to be in touch with you if you get your ham ticket and get on the air. I'd like to see articles on using the CoCo for hamming. Indeed, if we see some action with this, I can run a short course on getting a ham license. Having been in hamming for over 40 years, I have an edge with that.

That brings up Wayne Green. The chances are you already know plenty about me, but if you are new to my publications let me explain that I got into publishing over 30 years ago via amateur radio. Found I liked it better than anything else I'd been doing, such as radio (engineer and announcer), television (engineer, director), or hi-fi manufacturer (loud speaker cabinets, pretty successful, too).

You can see that I'm an entrepreneur, and this is to your advantage if you have even a shred of interest in getting rich. I am a firm believer in as many people taking advantage of technology as possible to get wealthy. It's never been easier, so you'll see my editorials angled in this direction much of the time.

The key is simple. First you want to learn the ropes, which you should do at someone else's expense. Find a small firm and work for them at first until you know everything you need to for success. Remember that 80 percent of small businesses fail because the entrepreneurs haven't taken the time to know the basics of their business, such as advertising, marketing, purchasing, contracts, personnel management, banking, accounting, and so on.

Once you understand the business end of things, all you need is a product or two and you are off and running. Just look at how many products are needed to go with the CoCo computer! We need inexpensive fail-safe power sources, memory expansions, disk units, networking systems, modems, desks, carrying cases, interconnecting cables, conversions of programs from other systems, and so on.

How about developing expansion boards to give us better graphics, better word-processing functions, or control of machinery? You might even want to take the Radio Shack software and upgrade it so it will be better, and sell the upgrades. You have a great little computer sold at a reasonable price with which to work, so what's holding you back?

". . . though we try to put out first-class magazines, we don't sit around taking ourselves too seriously. We wanted to get across that idea in the title."

Now a few personal things about me—yes, I'm a person too. I like cooking (gourmet), traveling (108 countries so far), hamming, and skiing; I aways have dozens of projects going. You'll have to read the editorials in all my magazines to keep up with everything, and that is almost as much a full-time job as writing them all.

We're growing as publishers and need enthusiastic, talented career people to live with us up here in New Hampshire, one of the finest places in the whole world to live. Sure, we need technicians and programmers, but we also need writers, editors, graphic-art people, photographers, people to work with circulation, and so on. It is amazing how many people it takes to keep a magazine good looking and interesting. Oh yes, we also need people to help with marketing, ad sales, promotions, advertising. . . it seems endless.

The people who are working here are our best testimonials. They are a fantastic group and love what they are doing. We are loose enough so people can move around pretty much at will to do different work, developing their careers. But they work together, too. Since we're still growing rapidly, there are plenty of opportunities for talented hard workers to get into the management end of things, but you do have to work for it. I don't think anyone is going to find a better place to work.

So there you are, with a new magazine that I sure hope you are going to enjoy, and the chances to start up a small business at home and catch the golden ring as it goes by. I ask you in particular to make sure that every CoCo owner you know gets to see the magazine. Remember that the more paid readers we have, the more ads we'll have and the more articles we'll be able to publish for you. If you belong to a CoCo club, see what you can do for us, eh? The economics of publishing today make it so that magazines have to run about 50/50 articles and advertising if they are going to be in the black, so the more advertisers you encourage and patronize, the more room we'll have for articles and programs.

Why *HOT CoCo*?

Any reader of my magazines knows by now that though we try to put out first-class magazines, we don't sit around taking ourselves too seriously. We wanted to get across that idea in the title. A magazine should be fun to read. I find that the magazines that I really look forward to each month are those with a light approach, such as *Car and Driver*.

The light touch doesn't mean that there is any short-changing on solid information, only that we are aiming to make it more fun to learn about your computer system. And that's the key to learning, right? If computers weren't fun, you wouldn't even be reading this. ■

We Sell

CHALLENGES

Wargames / Strategy Games for your CoCo

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Fight off Takijiro Onishi's Kamikazes, find and destroy his fleet before it finds you. Hi/res graphics include fighter vs fighter, torpedo and divebomber vs ship, Kamikaze attacks, ship vs ship and more. 4 levels. 32K Cassette

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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

IT ISN'T EASY CHOOSING A TITLE

HOT CoCo? It sounds like a dirty magazine." I heard that comment so many times during the past few months that I was sure there was a conspiracy afoot. *HOT CoCo* is not your typical title for a computer magazine. It isn't techie sounding, like *Digital Design*, and it doesn't have the air of authority that *Business Computer Systems* has. But *HOT CoCo* does have some qualities of its own.

We plan to provide the best possible coverage of the Color Computer, including the latest programming techniques and hardware innovations. Yet, we want to attract the thousands of new CoCo owners who are not yet serious programmers. The name *HOT CoCo* conveys our editorial intent quite nicely.

This makes it sound like the Wayne Green brain trust sat down and carefully, painfully thought out the ideal title. But it didn't happen that way. We started with several lists of potential titles. The *80 Micro* staff included *HOT CoCo* on their list as a joke. (They also included such gems as *Color Hallucineighty*, *CoCo Puffs*, and *Colorado Potato Beetle*—it falls between "colorable" and "coloration" in the dictionary.)

When we sat down to choose one, no one knew what he wanted, only what he didn't want. Some wanted to avoid using "computer" in the title; others didn't want "80," and some didn't want to play too much on the color theme.

After eliminating nearly every choice, someone said, "The only title I really like is *HOT CoCo*." When the chuckles subsided, the rest of us realized that we agreed.

The title *HOT CoCo* tells you that the magazine will publish information to help you get the most from your Color Computer, yet also be fun to read. It's an easy name to remember, too.

Reader Comments

Since we are new, we are eager to hear what you think of *HOT CoCo*. Are we covering your favorite topics? Are our articles easily understood? What are your particular likes and dislikes? Give us a call (603-924-9471) or drop us a line and give us your comments. Just be careful not to snicker when we answer the phone "*HOT CoCo*."

Coming Next Month

If you are a confirmed hardware hacker, you'll like our July issue. Martin Goodman tells you how to build a monochrome monitor driver that will give you super legible characters for word-processing or other text-handling needs.

There's something for the beginning hacker, too. J.J. Barbarello will show you how to make etching your own printed circuit boards as easy as programming. Howard Bassen will provide some cures for video rfi. And Dennis Martin will show you how to get great high-resolution graphics in Basic.

We'll also premiere two columns. Richard Ramella begins Elmer's Arcade. You see, Elmer's this guy with an old-fashioned arcade parlor (you know, the kind with pinball machines and mechanical baseball games). Richard will adapt one of Elmer's games to the CoCo each month.

We'll also be running a tech-tips column. This column is written by you, our readers, and it gives information on overcoming small problems or incorporating new techniques in your programs. By the way, if you have a technical tip you would like to share with your fellow readers, send it in. We will pay $25 for each tip if we use it. Try to keep each tip to one typewritten page in length.—*M.N.* ■

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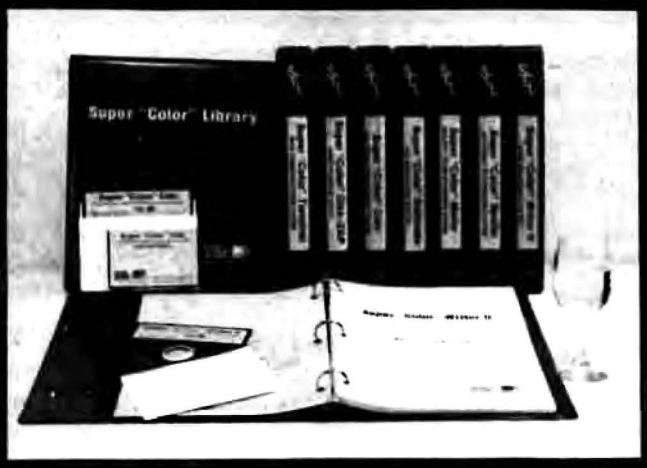
For the TRS-80 Color and TDP System 100 Personal Computers



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— *NEW!* —

64K Compatible

Super "Color" Writer II™

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

VERSION 3.0 By Tim Nelson

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Check These Exclusive Features

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ADDITIONAL DISK FEATURES: Read a directory, Display free granules, Save with Automatic Verification, Load and Append ASCII files, and BASIC programs, Kill files, and Link files from disk for continuous printing. 54K bytes of workspace available with a 64 K system. Only the best offers all of these features.

TAPE $69.95 **ROMPAK $89.95** **DISK $99.95**

Tutorial only $15.00 (Refundable with purchase)
Tape & Disk require 32K for lowercase display
Previous **Super "Color" Writer II** owners call for upgrade policy

Super "Color" Mailer™

By Tim Nelson

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By Peter A. Stark

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NELSON SOFTWARE SYSTEMS 9072 Lyndale Avenue So., Minneapolis, Minnesota 55420 612/881-2777

32x16 & 51-64-85x21&24 Display With Lowercase Descenders And 16 Thru 64K Too!

NEW Super "Color" Calc™

ELECTRONIC SPREADSHEET By Kevin Herrboldt

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Disk requires 32K for lowercase display

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By Tim Nelson

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Version 3.0 By Dan Nelson

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AUTHORS' SUBMISSIONS ARE ENCOURAGED. 128

REVIEWS

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Edited by Barbara Jatkola

CC Professional Keyboard
Micronix Systems
#7 Gibraltar Square
St. Charles, MO 63301
Color Computer, Revision E or earlier motherboard
$79.95

by Scott L. Norman

It's here—a direct-replacement keyboard for your favorite machine, with honest-to-goodness keyswitches for improved typing speed and reliability.

The Micronix 57-key keyboard plugs into the CoCo's motherboard and mounts inside the case, just like the stock keyboard. The only difference is the smoother operation provided by the new keyswitches.

The Micronix product is a professional affair, with full-size, two-color key caps. The alphanumeric characters, punctuation marks, space bar, and clear keys use gray caps, while everything else is in black. Legends are white and molded into the sculptured tops of the keys. A metal bezel finished in flat black completes the package.

Installation is simple if you are not reluctant to open up the computer's case. Begin by removing the six or seven screws holding the top and bottom of the case together, and lift off the top.

You'll find the keyboard attached to the computer's motherboard by a short piece of 16-conductor cable that plugs into a connector just forward of the RF (radio-frequency) shield. Unplug the cable, lift the keyboard off its four locating pins, and set it aside. Then you can install the Micronix keyboard by reversing the procedure.

Those 16-pin cable connectors fit tightly, so work slowly. It's easiest to coax the connectors off and on in small steps, applying pressure first to one end and then the other. It's worth the extra effort to avoid bending one of the pins.

One word of warning: Only motherboards with serial numbers ending in the letters B through E (those sold before late 1982) use plug-in keyboards. On new series-F computers, including the independently marketed TDP-100, the cable is soldered to the motherboard. Consult Micronix concerning the availability of a compatible replacement.

The installation is complete once the new keyboard is plugged in and seated on the locating pins, but heavy users might want to make one further modification. Since pressure exerted on the keys is transmitted directly to the Micronix printed-circuit board, there is a possibility of mechanical damage to the traces and connections due to continued flexing.

I slipped a thin piece of balsa wood between the PC board and the short support post that is molded into the case beneath the middle of the keyboard area. This modification, suggested by Frank Hogg of Frank Hogg Laboratory, provides a solid foundation for the new assembly.

In operation, the Micronix keyboard is very smooth. Key spacing seems to be about the same as on standard typewriter keyboards. The keys on my unit are a bit stiffer than I like, but unlike those on the standard CoCo unit, they don't have to be bottomed to make contact. As a result, I can type at a considerably higher speed than ever before.

The positions of a few of the punctuation marks and function keys have been changed, necessitating some user reeducation. Clear has been relocated to the left of the space bar. The enter key no longer appears just to the right of the semicolon, but has been moved to the extreme right of the second row instead. It has also been relabeled "return." The right shift key has been moved one position further to the right, out of easy reach of my little finger.

These changes have been made in order to make room for four new keys, labeled F1–F4, that occupy previously unfilled spots in the Color Computer's keyboard matrix. These keys don't do anything useful at the moment, but Micronix has promised to make a software driver available to permit their use as programmable function keys.

The only detrimental factor is the inability of the Micronix keyboard (or any full-size keyboard, for that matter) to accept the overlay sheets used by programs that redefine key functions. Examples include Master Control and other programs that permit single-keystroke entry of common Basic commands. The simplest solution is to use decals or dry transfer letters to label the front faces of the redefined keys.

These are all rather specialized points. The Micronix keyboard is a boon to Color Computer users who do significant amounts of word processing, especially people with any aptitude for touch typing. If you are in that category, you will want to check out this long-awaited product. ■

Whether for reasons of feel, appearance, or reliability, you, like most Color Computer owners, would probably prefer a better keyboard.

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TC-8C Cassette Interface
JPC Products Co.
12021 Paisano Court NE
Albuquerque, NM 87112
Color Computer
$129.95

by R. W. Odlin

JPC Products has introduced a version of the Poor Man's Floppy on a ROMpak for the Color Computer. The unit is designed to accommodate two independently addressable cassette decks. In fact, the original cassette port is also fully functional under this system.

The relays installed in the ROMpak appear to be a good deal stouter than Radio Shack's. You can use non-Shack decks with no fear of power surges burning out the relays or damaging the U9 chip.

The multiplication of cassette ports can significantly ease the merging and updating of data files. Also, the actual pulse code the system uses noticeably reduces the error rate.

The interface offers a slight improvement in command structure. Most of its commands differ little from Basic: @SAVEM for CSAVEM, for instance, or @LOADM for CLOADM. The Basic SKIPF is accurately represented by @DIR, and EXEC by @GO.

The command @VERIFY adds something I have sorely missed, and to have the facility extended to machine-language programs through @VERIFYM is far more than I might have hoped for. Auto-run is available for both Basic and machine language with @RUN and @RUNM.

Miscellaneous Features

The I/O error is a thing of the past. The TC-8C may be dropped into the tape anywhere, and it waits contentedly to read a leader block.

After an @SAVE, the computer is returned to command mode as with CLOAD in Color Basic. This means that multiple saves within a loop are no longer practical.

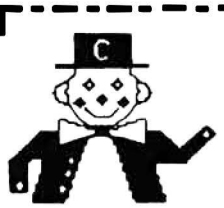
Do not omit the closing quotation marks in the file name. This system demands them more insistently than it demands the file name itself. So far as I can determine, the file name of a data file cannot be input during run time by way of a string variable.

Error codes are clear and distinguishable at a glance from Basic by the ubiquitous @ prefix.

@LOAD and @DIR can be aborted with the break key if the tape is running. This is handy for anyone who has ever entered the wrong file name or misspelled the right one.

There is a possibility of using the interface with the clock speed-up some Color Computers allow. There are patches for this, but the explanation is a little less than satisfactory. Possibly JPC feels that this use is stretching the system, and even the most trustworthy tape, farther than the benefits derived can justify.

Files addressed from machine-language programs must be accessed via the original cassette port, unless you have the source code to patch them or patches from the authors. Addresses must be in hex digits, and exactly four are needed.



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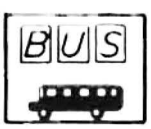

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VISA

No source code is included in the otherwise excellent documentation. However, the table of key variables and addresses should meet the needs of most users.

The system is supposed to be relatively impervious to variations in volume level. This appears true. However, sensitivity to other factors is so extreme that unless your cassette deck can handle the rather high and critical frequencies used, you might as well resign yourself to @CS, or checksum, errors.

A series of inexplicable and infuriating failures ended when I finally incorporated a good stereo cassette deck into the system. The bargain-counter special that had been perfectly serviceable in dealing with CoCo's native frequencies proved absolutely helpless with the TC-8C.

Routine maintenance of the tape heads is necessary; JPC suggests that daily is not too often. Also, you might need a better grade of tape. JPC recommends DuPont Crolyn and Agfa PE-611. This can mean invisible expenses edging you upward toward the disk price bracket.

Failings

The TC-8C's drawbacks include the use of 600 bytes from high memory. That isn't much compared to the 2K necessary for Disk Basic, and you can have it back instantly by typing @KILL, which disables the interface. The computer powers up in Basic, and you access the new facilities with EXEC &HD000, or in Color Basic with EXEC 53248.

The syntax of the data-file statements is less straightforward than it looks. Often a space is needed to make a command work.

No program identification is given until a load is complete; in case of failure to load, you know nothing at all.

Since the unit draws its power from the computer's power supply, you might find the whole system heating up more. This applies particularly to those with home-brew, piggyback, 32K modifications. I hope future versions offer the option of a separate power supply.

JBug

The ROMpak includes a spare EPROM socket, switch-selectable for 2716 or 2732 chips. JPC recommends the EPROM version of its monitor program JBug (cassette $29.95) for this socket, but I cannot.

The monitor is sound enough, offering such features as break-point trapping and register dump. However, the buffer is only 80 characters; the assembler cannot support any sort of symbol table, so all branches must be calculated by hand. Also, the disassembler prints out all numerical source in signed hexadecimal form and cannot indicate forced direct addressing.

The memory spent on such facilities might have gone into beefing up the monitor to provide single-stepping capacity, for instance. Also, in a market that contains Eigen Systems' CCEAD at $6.95, the program is grossly overpriced. However, its manual is good—it includes all the Motorola 6809 data sheets as an appendix—and the convenience of having all this coresident means you will use it when it would not have occurred to you before.

Buy the TC-8C Interface to triple your cassette ports, prolong the life of your 14529 chip, reduce the error rate in your files, and speed up the loading of programs, but pass up JBug. There are many better uses for that EPROM socket. ■

Donkey King
Tom Mix Software
Grand Rapids, MI 49505
32K, Color Computer
$24.95 cassette, $27.95 disk

by Philip N. Wilcox

Donkey King is a perfect game for Kong fans. It loads in roughly two minutes and uses about 20K for the machine-language program. The remaining memory is for graphics, and the graphics are good! Fine detail is in every screen.

You start the game in the lower left corner near an oil drum. Kong drops a barrel that crashes into the oil drum to start a fire, and Mario is off to the first ladder. At the top of the ladder is the familiar hammer.

Donkey King works just the same as the arcade version. It's all there, including the barrels rolling down. They descend a ladder, fall off the end of the ramp, or are hurled in a zigzag pattern by your foe at the top. The

fireball pursues Mario as he tries to rescue the captive maiden crying "Help!" at the top of the screen. He finally reaches the top of the first ramp screen and jumps up on the platform, only to have Kong grab the girl and haul her up to the next level.

The next screen is also almost identical to the arcade game. Mario is at the bottom of a tower of girders held together with pins. He must pull each of the pins while eluding four fireballs. He has two hammers to use in case of emergency or for extra points.

Mario may pick up different objects to increase the score, and he gathers the bonus points left on the timer whenever he reaches the top of the screen. With each additional 20,000 points, you acquire a free man.

After Mario pulls the final pin, Kong rotates and falls on his head. Mario moves up to the platform with the maiden while the Color Computer plays a love song for the reunited couple.

Their joy is short-lived because Mario is soon standing at the bottom of the second ramp screen, the toughest in the game. The barrels arrive fast and furious, often two, three, or four at a time.

The program lets you opt for a regular game, in which a high score will place your name on the scoreboard, or a practice game that gives you twelve men but no chance to be recorded in the hall of fame. At first, only the practice feature will get you past this screen.

The next screen is bouncing jacks, complete with elevator. Mario has to jump from platform to platform, and on and off the elevator. Timing is criti-

cal, as he dodges fireballs, makes split-second jumps, and hops past the falling jacks. A fire that can sense his presence also impedes his progress toward the ladder that leads to Kong's platform.

The second time Mario faces the girders, he must contend with five fireballs as he attempts to pull all the pins. Upon completion of this feat, he faces a relatively easy inclined-ramp screen.

The final screen in the game requires the use of conveyors to get to the ladders. The conveyors can be moving in either direction and can switch direction periodically. Mario must also jump the cars that travel along them. If you succeed in this final screen, the game repeats itself in the same manner as the arcade version.

The program is not flawless. On execution, you must push reset until the screen is red, or your gorilla will be blue. Sometimes you must push reset repeatedly before the color appears correctly. Also, the keyboard locks occasionally. When you reset, the starting address for the program has been cleared so that you must enter EXEC 12803.

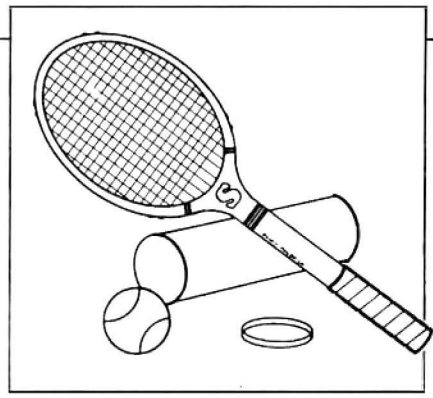
Donkey King does require joysticks, and it does not have a routine to save a data file with the scoreboard. However, the worst problem with the game is its popularity; there's too much competition for a chance to play. ■

Tennis
Tandy/Radio Shack
Fort Worth, TX 76102
Color Computer
$29.95 ROM cartridge

by Carlos Calle

If you are tired of shooting down aliens, sinking submarines, and evading Pac-Man and ghost gobblers, say no more. How about a nice, relaxing game of tennis with your friendly Color Computer?

This entertaining game from Radio Shack presents a nice change of pace



from the space invaders hordes and alien attacks. You can play tennis against the computer using the left joystick or against another player with both joysticks. The screen graphics are realistic; the players do look like players with little white squares with handles for rackets, and their movements can be controlled fairly well in spite of the imprecision of the Radio Shack joysticks.

The beginner level is slow paced and allows you to build up your coordination to try the faster paced expert level. When you play against another human, each of you can select your own level.

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In the beginner level you must position the player behind the bouncing ball on the back court on top of the screen and press the fire button. After the opponent's player returns the ball, all you have to do is place your player behind the incoming ball and it will be returned. In the expert level you must also press the fire button at the same time that the ball strikes your player's racket.

If the player is running to the right when returning the ball, it will be returned to the left side of the opponent's court. To make the game more realistic and help you determine the height of the tennis ball, a shadow is always seen beneath the ball. You can hear the ball each time it hits the rackets or the court, and there are sound effects for the spectators' applause whenever either player scores.

The game is scored according to the standard rules of tennis and appears at both sides of the screen on each player's edge of the court. "Advantage" is abbreviated AD. The server's advantage is shown as I (AD IN); the opponent's advantage appears as O (AD OUT). Even advantage (deuce) is shown as D on the screen. After each game the screen shows the total scores.

Tennis is an entertaining and relaxing game. The $29.95 price is higher than what you pay for most games offered by independent vendors, but it does come in a ROM pack, which is more convenient than loading a tape, even at 1,500 baud. ■

TRS-80 Color Computer Graphics
by Don Inman
Reston Publishing Co. Inc.
Prentice-Hall
$14.95
Softcover
301 pp.

by Stephen G. Stone, III

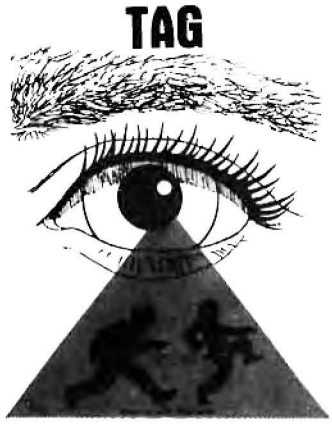
Now that you've decided to start producing some serious graphics on your Color Computer, *TRS-80 Color Computer Graphics* will have you writing sophisticated graphics sooner than you'd have thought possible.

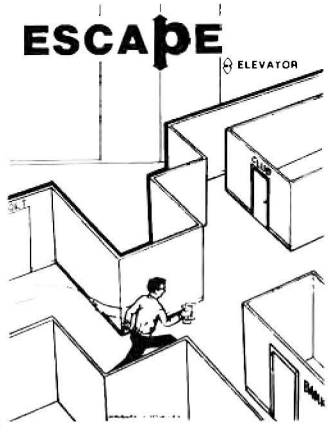
The subject is well covered in 10 chapters and five appendices. Each chapter contains periodic exercises to gauge your grasp of the material.

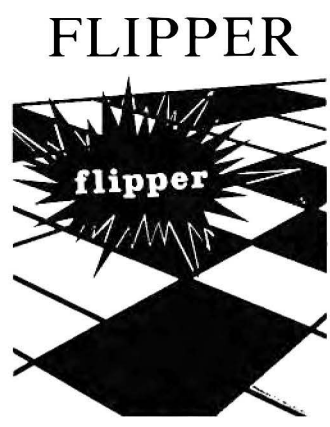
A test with answers to half the questions is included at the end of each chapter. The unanswered questions are teasers; however, the author does provide his address so you can write for the answers if you get stumped.

Don Inman crams a wealth of information into his book and he corrects some oversights in Radio Shack's *Going Ahead with Extended Color Basic.* If you've already read Radio Shack's book, you will at least want to see what *TRS-80 Color Computer Graphics* has to say about creating arcs with the Circle statement and about the G option of the Get statement.

There is a good illustration of how to draw a diagonal line at a heading of other than 45, 135, 225, or 315 degrees. A very busy picture that will make your head spin is shown using the PCOPY statement. This is the best demonstration I have seen of the degree of animation possible with PCOPY.







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The strings necessary to produce text while in the graphics modes are provided in Chapter 8. The graphics modes in the Color Computer don't support the use of text unless each character is laboriously hand-drawn. These strings will save you considerable time.

TRS-80 Color Computer Graphics occasionally diverges from a strictly graphics orientation. Fully 15 pages are devoted to an explanation of joysticks. Several pointers and ideas for use of the Timer function are also explored. The author devotes a good section to an explanation of the USR function and to an easy-to-understand introduction to machine language.

I have only two complaints about the book. There is no glossary of Basic statements for quick reference, and no grid sheets are provided for laying out your graphics masterpieces.

TRS-80 Color Computer Graphics is well written and covers its subject matter admirably. The games presented as examples are better than some I have purchased at my local computer store.

Considering the vast amount of graphics knowledge presented, the $14.95 price tag is more than justified. ■

TRS-80 Color Basic
by Bob Albrecht
John Wiley & Sons
$9.95
Softcover
378 pp.

by Stephen G. Stone, III

TRS-80 Color Basic offers a different slant on the explanations of various Basic functions. It can be valuable if you have questions on any of the points discussed in the books that came with the CoCo.

You already have one, or if you have Extended Color Basic, two, Basic language books, so why buy another? There isn't a book in print that can tell you all you want to know about Color Basic and your machine. *TRS-80 Color Basic* doesn't either, but it does cover some points not handled in the two Radio Shack books.

> *"TRS-80 Color Computer Graphics is well written and covers its subject matter admirably. The games presented as examples are better than some I have purchased..."*

Through 13 chapters and 11 appendices, the book discusses almost everything from setting up your computer to subscripted variables. *TRS-80 Color Basic* does not attempt to discuss Extended Color Basic.

Each chapter has a good test at the end, with the answers to most of the questions. Some are left unanswered for you to ponder.

The book is organized in the programmed-instruction format. Each new idea is presented in a series of numbered paragraphs called frames.

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Most of the frames ask fill-in-the-blank or multiple-choice questions to ensure that you are absorbing the material. The answers to the chapter tests are keyed to the appropriate frame number so you can review easily.

The material is presented in a light-hearted, easy-to-understand manner that will not grate on an adult, but can be understood by a 10-year-old. Strategically placed cartoons and illustrations clarify and emphasize important points. The author even furnishes his address and asks that you write to him with your experiences and questions.

The whole book is suited to the computer novice, but the discussion of RAM and ROM in Chapter 1 is of particular interest. The author makes several comments on program flow and programming style that are of value to the beginner. I wish the book I learned Basic from had had such a good discussion of conditional statements and program flow.

Much attention is given to two of the most important concepts in Basic: string and numeric variables. One chapter is devoted to each.

Chapter 13 contains what every programmer, novice or expert, needs: a Basic glossary. Each Basic keyword is given a short, clear explanation and one or more examples.

Many subjects are discussed in more depth than in Radio Shack's *Getting Started with Color Basic* including the fact that you can solicit two or more variables in a single Input statement.

Bob Albrecht goes to great lengths to demonstrate how to achieve a random number in any range, such as a random 1 or -1, or a random number between 89 and 176. He demonstrates how to use set graphics without causing the screen to scroll, and how to use sound as clues in a guessing game.

There are appendices on the order of precedence in arithmetic, scientific notation, and floating-point notation. The appendix on joysticks goes well beyond *Getting Started with Color Basic.*

The book suffers only a few drawbacks. Chief among them is the omission of any discussion of file handling or cassette I/O (input/output). The lack of even a rudimentary memory map is also a disappointment. Occasional misprints occur, most of which are easily recognizable even by a novice programmer. Most of them seem to be in the chapter on string variables, so be alert when you read that chapter.

TRS-80 Color Basic is a great book from which to learn Basic. It will not discourage the beginning programmer, nor will it put off the more experienced user by oversimplifying. It is a reasonably priced, outstanding companion to *Getting Started With Color Basic.* ■

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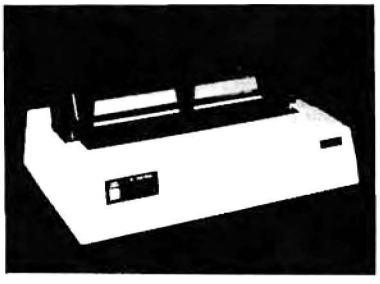

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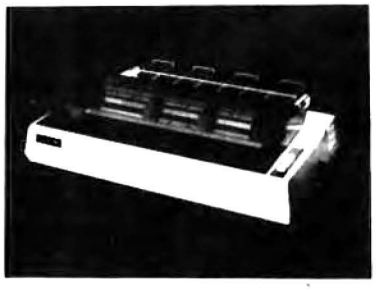

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The Basic Beat

THE FIRST STEPS TO BASIC PROGRAMMING

BY JAMES W. WOOD

This column will introduce you to the commands available on Color Basic for the TRS-80 Color Computer. The material I present will work on any configuration of the TRS-80 Color Computer. I plan to teach several commands each month, following the tentative schedule in Table 1.

There will be sample programs to demonstrate the use of new commands. The programs may not be useful for any purpose other than teaching a command, but they will be short enough to type in quickly. Maybe I'll even give a few pop quizzes.

Basic is the language that is built into your computer. Other languages available include Logo, Pascal, Assembly, and Pilot. To program in these languages, you must tell the computer how to use them. The language must be transferred into the computer's memory from a program pak, a disk, or a tape. Basic, on the other hand, is ready to program as soon as you turn on the computer.

When typing in programs, be careful not to confuse the letters D or O with the number 0. They are not interchangeable. This will drive many typists nuts. Two other characters that might give you trouble are the letter I and the number 1. They look similar on some listings. The computer keyboard has numbers zero through nine. Do not use small L for a number 1; it just won't work.

OK, students, get out your CoCo. I will assume that you can connect the computer to the television and know the location of the power switch and channel selector. If you have trouble, pretend you are going to use a program pak—but do not insert one.

Turning on the computer should result in a green screen with black letters. The letters say something about Tandy or Microsoft. Pushing the clear key will clear the screen. Another way to clear the screen is to type the letters CLS and then push the enter key. The second way leaves an "OK" on the screen.

Notice the small area on the screen that is constantly changing color. That is your cursor—no dirty language, just a marker to show where your next character typed will appear. Try typing the letters CLS followed by a number between zero and eight inclusive. (Don't forget to enter.) Pretty, isn't it? Each number displays a different color screen. If you're like me, you had to try CLS9, and then ran out of colors.

Don't get upset if you start typing green letters on a black background. You can change the printing back to normal by holding down the shift key and typing zero. Shift 0 will change the letters back and forth from green on black to black on green. If you try CLS with green letters on black, it doesn't work. Most commands will not work unless the typing is black letters on a green background.

Another problem is typing an incorrect letter. Suppose you typed CLD instead of CLS. If you have not hit enter, simply push the white left-arrow key to back up one space. If the shift

```
10 CLS
20 PRINT "WELCOME TO COMPUTER CLASS"
30 GOTO 20
```

Program Listing 1

```
10 PRINT "YOUR NAME ";
20 GOTO 10
```

Program Listing 2

```
10 ?"LAZY TYPER'S DELIGHT"
```

Program Listing 3

```
10 NU=9
20 PRINT NU;
30 NU=NU+1
40 GOTO 20
```

Program Listing 4

```
10 A=7
20 B=29
30 PRINT A;
40 PRINT B;
50 A=A+4
60 B=B+3
70 GOTO 30
```

Program Listing 5

```
10 INPUT "WITH WHAT NUMBER
   SHALL I START COUNTING" ;A
20 PRINT A;
30 A=A+1
40 GOTO 20
```

Program Listing 6

key is down when the left arrow is pressed, the cursor will move back to the beginning of your typing, erasing everything in its path. Had you pushed enter, you would have gotten a syntax error and an OK prompt. You just would have had to type CLS again.

Type PRINT MEM and enter. Most commands require pressing the enter key. A number between 2,343 and 32,551 will be displayed. This refers to how many bytes of memory are available. Each byte will hold one letter in the computer's memory. To store information in the memory, you must write a program.

Type in Program Listing 1. Notice that each line starts with a line number. At the end of each line, press enter. Don't worry that line 20 is too long; it will wrap around to the left side of your screen. After entering line 30, type RUN and enter. The screen should fill with the welcome message.

The computer executes a program one line at a time. Line 10 cleared the screen. Line 20 printed the message exactly as it appeared in the quotation marks. Line 30 told the computer to go to line 20. The message is printed again. After executing line 20, the computer proceeds to the next higher line number. Line 30 sends the machine back to line 20 again. You are in a continuous loop.

Push the red break key if you're not afraid of red switches. Type LIST and enter. Your program is listed on the screen. Try typing a new line 20 with some other message inside the quotation marks. (You can edit the line with an Extended Color Basic computer, but this column is for beginners and for all versions of the CoCo.) The new line 20 will replace the original line 20.

List the program to become a believer. If you are still not a believer, try typing the programs in backwards. Type in the highest numbered line first, the lowest numbered line last. Then list the program to see if the computer can rearrange the lines to the correct order.

Line numbers don't have to be multiples of 10. Add line 25 PRINT "STAY TUNED NEXT MONTH" to Listing 1. Line numbers are usually multiples of 10 because of the visual appeal and the need for space to insert other lines.

Add line 27 REM PRINT "THIS LINE WILL NOT PRINT" and run the program. Everything after a REM or an apostrophe in a line is ignored by the computer. It is a remark. I use them at the beginning of a program to record in what issue of what magazine that program was published. When I can't remember how to use the program, I have no trouble finding its accompanying article. You can use remarks for any kind of note within a program.

It's time to move on to Program Listing 2. Type NEW and enter. Type LIST and enter. The program is erased from memory and cannot be listed. Type Listing 2 and run the program. The semicolon tells the computer that whatever is next to be printed should immediately follow what is printed. Your name will be placed across the screen instead of being printed each time on the next line.

Experiment with different numbers of spaces between your name and the second quotation mark. To pause the printing, or any other Basic program operation, hold down the shift key and type @. Touching any other key will then let the computer proceed.

Table 1. Tentative Schedule

Month 1
- line numbers
- variables
- SHIFT left arrow
- PRINT (comma, quotes, semicolon)
- INPUT
- LIST
- GOTO
- CLS
- REM or '
- RUN
- SHIFT 0
- SHIFT @
- NEW
- MEM
- +

Month 2
- colon
- scientific notation
- string variables
- CLOAD
- CSAVE
- If...Then...Else
- <, >, =
- Clear
- -, *, /
- End
- CONT
- Stop

Month 3
- calculator mode
- parenthesis
- For...To...Step...Next
- RND
- Sound
- Set
- Reset
- Point

Month 4
- nested for loop
- PRINT@
- INT
- ABS
- ON...GOTO
- ON...GOSUB
- GOSUB
- Return
- And
- Or
- Not

Month 5
- Read
- Data
- Restore
- ASC
- POKE
- PEEK (video display)
- Print Tab

Month 6
- arrays
- INKEY$
- VAL
- DIM
- SGN
- JOYSTK

Month 7
- Audio
- Motor
- CHR$
- LEFT$
- LEN
- RIGHT$
- MID$

Month 8
- EOF
- Close
- PRINT# - 1
- INPUT# - 1
- Open
- PEEK (keyboard)

Month 9
- EXEC
- USR
- CSAVEM
- CLOADM
- change Assembly listing to Basic
- converting Model I, III to color
- SIN
- how to find a square root

There is one last punctuation mark to learn. Rewrite line 10 of Listing 2 to end with a comma instead of a semicolon. Also, leave out the spaces after your name and before the second quotation mark. If your name is fewer than 16 characters long, the resulting printout is two columns of your name. A comma spaces printing into two columns, each 16 characters wide.

When programming, you will find it's faster to use a question mark for a Print command. Erase the program in memory. (If you don't remember how, just think of getting ready for a NEW program.)

Type Program Listing 3. That didn't take long. Now list the program. By magic, the question mark changed to the word Print.

It's math time, so type in Program Listing 4 and run the program. It assigns the value of 9 to the variable NU. Any one letter, two letters, or one letter followed by a single numerical digit can represent a unique number. It's like having a calculator with several hundred memories. Change line 10 in Listing 4 to 10 TO = 9 and run the program. Notice that this results in an SN (syntax) error. The two-letter combination TO cannot be used as a variable because TO is one of the commands used in Basic. Now, change Listing 4 back to its original form and it will run correctly.

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In line 20, notice that NU is not in quotation marks. This will allow the computer to print the value of NU. Since NU = 9, printing the value of NU results in a 9 being printed. Does line 30 upset your algebraic thinking? Think of line 30 as meaning that NU equals what NU used to equal plus one. Each time through line 30, the value of NU increases by 1.

Line 40 loops back to line 20 to keep printing the value of NU. Line 30 continues to increase the value of NU by 1. Do you remember how to break out of a loop? Could you momentarily freeze the display without pushing break (shift @)? Experiment with Listing 4 by changing the value of NU in line 10, or the number added to NU in line 30.

Study Program Listing 5. Pretend you're the computer and go through the program with pencil and paper. Write down the first six numbers that will be printed. Then type in and run Listing 5 to see if you are correct.

Our last topic for this month is Input. This command will allow you to program the computer to ask a question. Run Program Listing 6. Notice that a question mark is printed by the input statement. Many times, a program must ask you for information. The Input command is usually used for this purpose.

If you answer the question with a number containing more than nine digits to the left of the decimal point, it results in some weird numbers. The printout has numbers with an E in them that are in scientific notation. Unfortunately, scientific notation is one of next month's commands. You will have to wait until then to learn the secret of E.

Try to find a number too large for this program. Any number too large for the computer will result in an OV (overflow) error. There is another way to type an input statement. Line 10 of Listing 6 could be replaced by these two lines:

```
10 PRINT "WITH WHAT NUMBER
SHALL I START COUNTING"
15 INPUT A
```

My computer school has several advantages. Leaving your homework at home won't get you into trouble or lower your grade. It's still a good idea to familiarize yourself with this material to prepare for next month's lesson. ■

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

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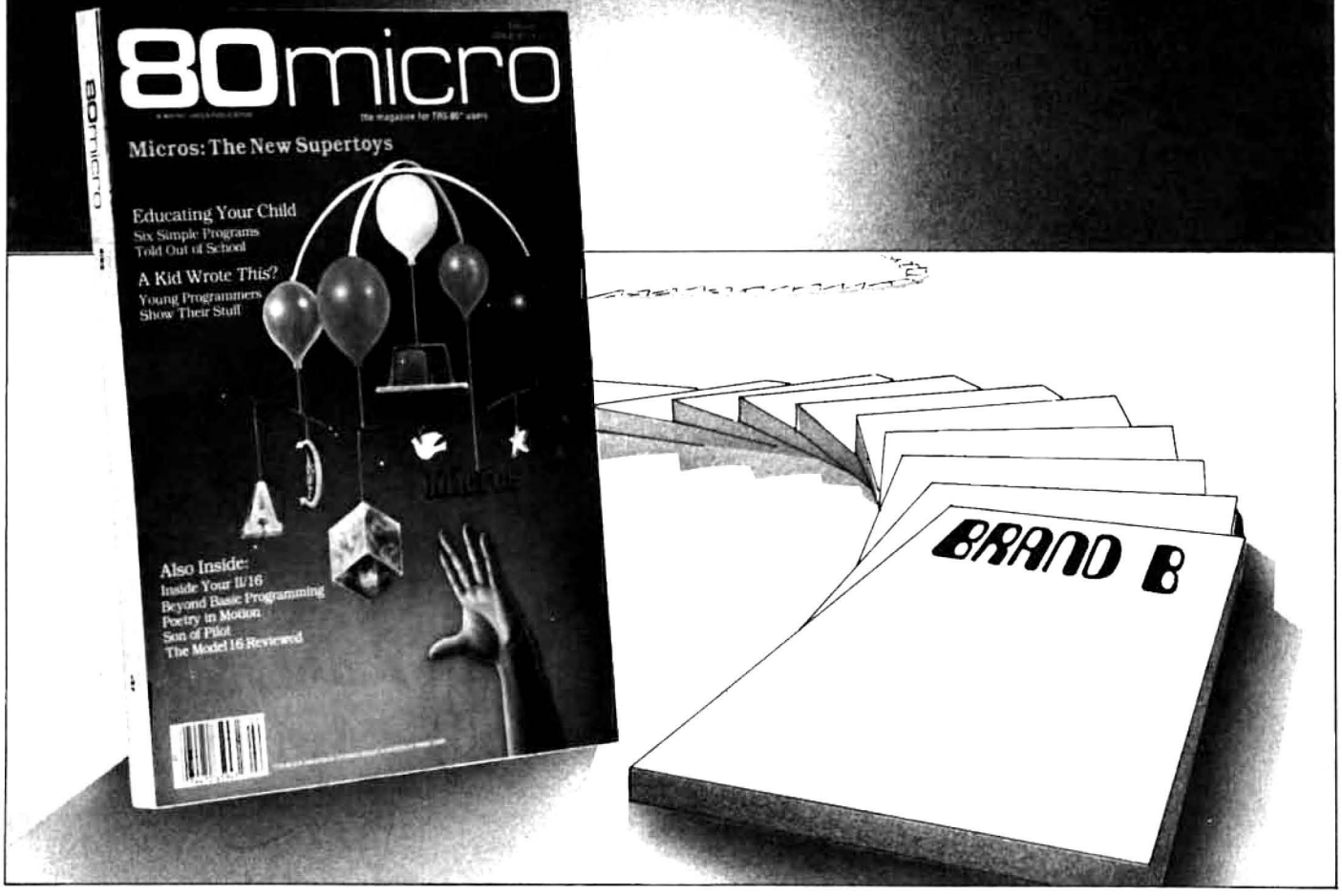

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BY JOHN NICOLETTOS

AUTO-COLOR WRITER

Auto-Color Writer is a simple text processor with a built-in Basic program generator. Auto-Color Writer takes up about 4K of memory; however, the essence of the program takes only 2K. By eliminating the remarks and the text portions of the program, you can use it with the 4K model of the Color Computer.

I have tried to maintain compatibility with standard Basic by not using Extended Basic instructions. Auto-Color Writer is written for cassette-based systems, but it should be fairly simple to modify for a disk-based system.

Program Description

Auto-Color Writer has three major sections: the format menu (lines 10–370), the text processor (lines 380–700), and the Basic program generator (lines 710–1090).

The format-menu section establishes the format for the other sections (margins, tabs, and program line increments). Lines 50–180 allow you to enter a heading, automatically center it, change it to lowercase, and underline it. The centered heading is stored in the text-line variable LN$(0). The underline statement is stored in LN$(1).

System Requirements

16K Color Basic

With this handy text processor, you can leave writing the screen-formatting code to the computer.

Lines 190–220 provide for the addition of a footer to the bottom of the text page. The Basic statement for the footer is stored in LN$(15). The line counter (LN) is augmented to reflect the addition of the heading and footer. Line 240 provides the means to start the computer-generated Basic program at any initial line number (ST).

Lines 250–350 are the change-of-parameters section. This section allows you to change the text processor's right and left margins or tab value. The video screen is prepared for the text processor in lines 360–375.

The text processor starts with line 410, which calculates the location of the last character on the page (CS), and the variables storing the spaces for the left margin (LM$) and for the tab (TB$). Line 420 adds the appropriate number of spaces to the current text-line variable (LN$(LN)) and augments the character counter (CN).

Line 430 calculates the current character position (CP) and tests to see if it has exceeded the page size (either CS or 510). If the page is filled, the program is directed to the Basic program-generator section (lines 740–900). The cursor is developed and the keyboard scanned in line 440. Line 450 provides the repeat-space and backspace functions.

The input character (I$) is checked in line 460 to see if it is a command code. There are five possible command codes: the left arrow (CHR 8), right arrow (CHR 9), down arrow (CHR 10), clear (CHR 12), and enter (CHR 13) keys. A conditional GOTO statement is used, in lieu of several If . . . Then statements, to simplify the program and minimize the time delay of the command-decode function.

Lines 490–510 are executed when the input character is not a command code. These lines will test to see if the input character is a blank. If so, its position will be stored in (E) for use by the overflow section (lines 540–570).

Next, the current character position (CP) is checked. If it is within 10 characters of the end of the text page (CS), a warning beep will sound. The input character is then printed on the video screen and stored in the current text-line variable (LN$).

After incrementing the character counter (CN), the program will return to the input section (lines 420–460). When the number of characters entered exceeds the right margin (RM), the program will execute the overflow routine.

The overflow section (lines 540–570) will first produce an end-of-line beep. The input character will then be tested to see if it is a blank. When the input character is a blank, the line counter (LN) is incremented and the program returns to the input section.

If the input character is not a blank, all the characters to the right of the character position stored in variable E (the last blank) are erased from the

screen and moved to the next line. Additionally, the text-line variables are adjusted to reflect the changes. Both the character counter and the line counter are appropriately adjusted, and the program returns to the input section.

The program executes line 600 when the input character is the enter key. The program will increment the line counter, initialize the character counter, and then return to the input section. If the new line exceeds the bottom line margin (BL), the program will automatically exit the text-processor section.

If the input character is the left arrow, lines 630–640 are executed. The character to the left of the cursor is deleted from both the screen and the current text-line variable. A beep sounds, the character and line counters are decremented, and the program returns to the input section.

The right arrow is the tab function. When this key is pressed, the program executes line 670. The appropriate number of blanks are printed to the screen and stored in the current text-line variable. The character and line counters are augmented, and the program returns to the input section.

Press the clear key to clear the entire page of text. This command sends the program to line 700. The screen is cleared, the character and line counters initialized, and the program sent to the beginning of the text-processor function (line 360).

The final section (lines 710–1090) is the Basic program generator. Once a page of text has been completed, lines 740–850 will format it into Basic program lines (PL$). The first Basic instruction generated is the CLS (line 740).

Each of the following computer-generated Basic program lines will contain two lines of text. After all the text has been formatted into Basic instructions, line 860 prepares the footer instruction.

If you wish to enter more pages of text, lines 870–900 will direct the program back to the format-menu section. Otherwise, the program will file the computer-generated Basic program on tape. Before the Basic program is filed, it will be displayed by lines 910–940 for review. These lines can be deleted once you gain confidence in the Auto-Color Writer program.

The remainder of Auto-Color Writer prompts you to prepare the cassette for recording a file, and then stores the computer-generated program on tape.

Operating Instructions

Heading—Auto-Color Writer is so simple to use that it's habit-forming.

Program Listing

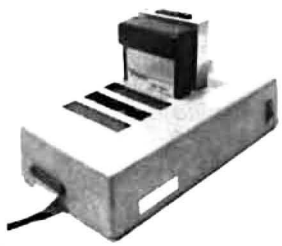
```
10 CLEAR10000:DIM LN$(16),PL$(155)
20 QM$=CHR$(34):LM=0:RM=31:TB=3:INC=10:BL=15:TL=0
30 CLS:LN=0:PRINTTAB(8)"auto"CHR$(128)"color"CHR$(128)"writer"
40 PRINTSTRING$(32,131);
50 PRINT"heading":PRINT"   yES, nO, OR rEPEAT";:INPUT Z$
60 IF Z$="N" THEN TL=0:GOTO190 ELSE IF Z$="R" THEN LN=TL:GOTO230
70 PRINT@131,"ENTER HEADING":LINE INPUT HD$:HL$="":HH$=""
80 IF LEN(HD$)>32 THEN PRINT@160,STRING$(33," "):GOTO70
90 LH=INT((32-LEN(HD$))/2):TL=1:LN=1
100 PRINT"   uPPER OR lOWER CASE";:INPUT Z$:IF Z$="U" THEN HL$=H
D$:GOTO160
110 FOR I=1 TO LEN(HD$):HH=ASC(HD$)
120 IF HH>64 AND HH<133 THEN HH=HH+32:GOTO140
130 IF HH=32 THEN HH$=HH$+QM$+"CHR$(128)"+QM$:HL$=HL$+CHR$(128):
GOTO150
140 HH$=HH$+CHR$(HH):HL$=HL$+CHR$(HH)
150 HD$=RIGHT$(HD$,LEN(HD$)-1):NEXT:HD$=HH$
160 LN$(0)=STRING$(LH," ")+HD$
170 PRINT"   UNDERLINE (yES OR nO)";:INPUT Z$:IF Z$="N" THEN 190
180 LN$(1)="@32,STRING$(32,131);":TL=2:LN=2
190 PRINT:PRINT"footer":PRINT"   yES, OR  nO";:INPUT Z$
200 IF Z$="N" THEN BL=15:GOTO230
210 LN$(15)=" PRINT@484,"+QM$+"PRESS ENTER TO CONTINUE"+QM$+";:L
INEINPUT ZZ$"
220 BL=14
230 IF ST<>0 THEN 250 ELSE PRINT
240 PRINT"initial"CHR$(128)"program"CHR$(128)"line"CHR$(128)"no.
";:INPUTST
250 PRINT:PRINT"change"CHR$(128)"parameters":INPUT"   yES OR nO"
;Z$
260 IF Z$<>"Y" THEN 360
270 CLS:PRINT@64,"DO YOU WANT TO:":PRINT@128,"   1. CHANGE LEFT
MARGIN"
280 PRINTTAB(7)"CURRENT VALUE IS";LM
290 PRINT"   2. CHANGE RIGHT MARGIN":PRINTTAB(7)"CURRENT VALUE I
S";RM
300 PRINT"   3. CHANGE TAB":PRINTTAB(7)"CURRENT VALUE IS";TB
310 PRINT"   4. RETURN TO PROGRAM":PRINT
320 PRINT"ENTER 1, 2, 3, OR 4";:INPUT Z:PRINT:ON Z GOTO 330,340,
350,360
330 PRINT"ENTER NEW LEFT MARGIN":INPUT"RANGE (0 TO 31)";LM:GOTO2
70
340 PRINT"ENTER NEW RIGHT MARGIN":INPUT"RANGE (31 TO 0)";RM:GOTO
270
350 PRINT"ENTER NEW TAB SETTING":INPUT"RANGE(0 TO 31)";TB:GOTO27
0
360 CLS:IF TL=0 THEN 410 ELSE PRINTTAB(LH) HL$
370 IF TL=2 THEN PRINT@32,STRING$(32,131);
375 IF BL=14 THEN PRINT@484,"PRESS ENTER TO CONTINUE";
380 '
390 'THIS IS THE TEXT PROCESSOR
400 '
410 CS=(BL+1)*32-(32-RM):LM$=STRING$(LM," "):TB$=STRING$(TB," ")
420 LN$(LN)=LM$:CN=LM
430 CP=LN*32+CN:IF CP>510 OR CP>CS THEN 740
440 PRINT@CP,CHR$(143);:I$=INKEY$:IF I$<>"" THEN 460ELSEPRINT@CP
,CHR$(128);
450 POKE343,PEEK(343)OR8:POKE345,PEEK(345)OR8:GOTO440
460 ON ASC(I$)-7 GOTO630,670,740,490,700,600
470 '
480 'NORMAL CHARACTERS
490 IF CN>RM THEN 540 ELSE IF I$=" " THEN E=CN
500 IF CP>CS-10 THEN SOUND200,1
510 PRINT@CP,I$;:LN$(LN)=LN$(LN)+I$:CN=CN+1:GOTO430
520 '
530 'OVERFLOW SECTION
540 SOUND180,1:IF I$=" "THEN LN=LN+1:GOTO420
550 LN$(LN+1)=LM$+RIGHT$(LN$(LN),RM-E)+I$:LN$(LN)=LEFT$(LN$(LN),
E)
560 IF E<>RM THEN PRINT@(LN*32)+E," "
570 PRINT@(LN+1)*32,LN$(LN+1);:CN=LEN(LN$(LN+1)):LN=LN+1:GOTO430
580 '
590 'NEW LINE
600 SOUND180,1:IF LN<BL THEN LN=LN+1:GOTO420 ELSE 740
610 '
620 'BACKSPACE
630 PRINT@CP,I$;:CN=CN-1:IF CN<LM THEN CN=RM:LN=LN-1
640 LN$(LN)=LEFT$(LN$(LN),CN):SOUND50,1:GOTO430
650 '
660 'TAB
670 PRINT@CP,TB$;:CN=CN+TB:LN$(LN)=LN$(LN)+TB$:GOTO430
680 '
690 ' CLEAR PAGE
700 CLS:LN=TL:CN=0:GOTO360
710 '
720 'THIS IS FORMAT AND FILE PORTION
```

Listing continues

Listing continued

```
730 '
740 PL$(PL)=STR$(ST)+" CLS":PL=PL+1:ST=ST+INC
750 FOR J=0 TO LN STEP 2
760 PL$=STR$(ST)+" PRINT":ST=ST+INC:LL=LEN(LN$(J))
770 IF J=LN THEN J=J-1:GOTO810
780 IF LL=32 THEN X$=";" ELSE X$=""
790 IF LL<=LM THEN 800 ELSE PL$=PL$+QM$+LN$(J)+QM$+X$
800 PL$=PL$+":PRINT"
810 NL=LEN(LN$(J+1)):IF NL=32 OR J=14 THEN X$=";" ELSE X$=""
820 IF TL=2 AND J=0 THEN PL$=PL$+LN$(J+1):GOTO840
830 IF NL<=LM THEN 840 ELSE PL$=PL$+QM$+LN$(J+1)+QM$+X$
840 PL$(PL)=PL$:PL=PL+1
850 NEXT
860 IF BL=14 THEN PL$(PL)=STR$(ST)+LN$(15):ST=ST+INC:PL=PL+1
870 CLS:PRINT@128,"DO YOU WISH TO:"
880 PRINT:PRINT"   1. CONTINUE WRITING."
890 PRINT:PRINT"   2. FILE INFORMATION."
900 PRINT:INPUT"ENTER 1 OR 2";Z:ON Z GOTO 30,910
910 CLS:FOR I=0 TO PL-1 STEP 6
920 FOR J=0 TO 5:PRINT PL$(I+J):NEXT J
930 PRINT@484,"PRESS ENTER TO CONTINUE";:LINEINPUT Z$:CLS
940 NEXT I
950 CLS:PRINT@34,"PREPARE RECORDER TO RECORD A    FILE BY:":PRIN
T
960 PRINT"1. POSTIONING TAPE PAST LEADER  OR END OF THE PREVIOUS
 FILE."
970 PRINT:PRINT"2. PRESSING THE play AND record BUTTONS.":PRINT
980 PRINT"3. KEEPING A WRITTEN RECORD OF  THE CURRENT COUNTER RE
ADING."
990 PRINT:PRINT"4. IDENTIFYING THIS FILE NAME."
1000 INPUT"   ";B$:B$=LEFT$(B$,8):AUDIOON
1010 OPEN"O",#-1,B$
1020 FOR I=0 TO PL:PRINT#-1,PL$(I):NEXT
1030 CLOSE#-1:AUDIOOFF
1040 CLS:PRINT@32,"WHEN THE RECORDER'S MOTION HAS  STOPPED:":PRI
NT
1050 PRINT"   1. PRESS THE RECORDER'S stop BUTTON.":PRINT
1060 PRINT"   2. rewind THE TAPE TO THE    BEGINING.":PRINT
1070 PRINT"   3. REMEMBER KEEP A WRITTEN   ACCOUNT OF THE ";
1080 PRINT"COUNTER READING  AND THE FILE NAME <"B$">."
1090 END
```


Switchable Expansion Is Here



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Throughout the format-menu section, you will be asked to respond to prompts. You only need to enter the first letter of the appropriate response.

When you first run the program, you will be asked if you have a heading for the text page. You can either enter a heading, decline to enter a heading, or repeat the previous page's format.

When you elect to enter a heading, you will be asked if the heading is upper- or lowercase. If the heading is lowercase, the computer will convert the characters to lowercase and add a black space character (CHR$(128)) between words. All headings will be centered and are limited to 32 characters.

Next, you will be asked if you want the heading underlined. Underlining is achieved by printing 32 graphic characters (CHR 131) on the next line.

Footer—The footer prompt will ask if you want the computer to add a footer. The footer is an input statement with a printed prompt that tells you to press the enter key when you are ready to continue the program.

The footer will be displayed on the last line of the text page. This prompt will not appear if you elect to repeat the heading. Instead, the last footer decision will be repeated.

Initial Line Number—Auto-Color Writer allows you to start the computer-generated Basic program at any line number you choose. This prompt will only be displayed the first time through the program.

After you enter the first line number, all other program lines will be incremented by 10. If you choose not to enter a number, the computer will start the Basic program at line 0.

Change of Format Parameters—The last format prompt will ask if you wish to change any of the format parameters. If you elect to change them, the computer will display their current value and will provide a format-parameter menu.

When you have finished with the format-menu section, the screen will clear and display the heading and footer. A cursor will flash at the current character position.

Text Processing—Auto-Color Writer is now in the text-input mode and you can practice your literary skills. Type your classic onto the screen; the computer will faithfully follow and store every character you type.

Should you make a mistake, simply hit the left arrow as you normally would. With Auto-Color Writer, the backspace and space keys will repeat if

held down. You will also hear a beep when you are backspacing.

One of the nicest features of the program is word wrap-around. If the word you are typing is too long to fit on the current line, the word will be wrapped around to the next line. You no longer need trial-and-error methods for making everything fit and for hyphenating words.

New Line/Tab/Clear—Hitting the enter key will immediately move you to the beginning of the next line. To tab, press the right arrow the desired number of times.

To clear the entire text page, press the clear key. You are now ready to start at the top of the text page.

End of Page—Auto-Color Writer will warn you as you approach the end of a page by beeping as the last 10 characters are entered. The program will automatically exit the text processor when the page is filled.

If you want to exit sooner, press the down arrow. The program will not allow you to print a character in the very last screen position (location 511). All other characters and functions are normal.

File Preparation—Once the page is completed, Auto-Color Writer will ask if you have completed the text. If not, it will return to the format-menu section, and the text-input process will be repeated.

When the text is completed, Auto-Color Writer displays the Basic program it generated, six lines at a time. Upon completion of the review, the program prompts you to prepare your tape recorder to record a file. After you record the file, a final prompt reminds you to keep a record of the file location.

Using the File—To use the file, you must CLOAD it. Once CLOADed, the computer-generated program can be listed, edited, or run as you would any other program. If you run the program, the video screen will display your text exactly as you entered it.

Now that you have entered the text into your computer, you can type any additional Basic instructions needed to complete your program. When you are done, CSAVE the new program. If you wish to include the text as part of another program, use the merge technique described in "Cassette Merge" (*80 Micro*, January 1983, p. 310).

Final Thoughts

Auto-Color Writer represents a Basic text-processing capability and a demonstration of a self-programming technique. There are many other features that you can add to the text-processor to make it more useful. Auto-Color Writer's simplicity allows you to tailor the program to meet your text-processing needs.

Programming the computer to create Basic program lines and store them in a data file for later use is a powerful tool. Auto-Color Writer is only one example of how this technique can be used to save time and effort.

To use this technique, you must first decide what part of your program can be generated by the computer. It is most useful for those program functions that are repetitious and tedious.

Next, define and characterize the process you would use to program the repetitive function. Now, write a program that will create the strings needed to form the Basic statements that perform the repetitive function. The final step is to create an interactive program for entering the nonrepetitive information. ■

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

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BY DON LEROI

SERIAL-TO-PARALLEL INTERFACE

Many Color Computer owners are frustrated to find out that their computer's RS-232C output port supports only serial-input printers and cannot directly interface with many of the popular printers on the market. Adding to the frustration is the fact that, at this writing, Radio Shack does not offer a serial-to-parallel interface for the Color Computer. Unless the owner wants to purchase a Radio Shack printer, he is left to his own devices to find the appropriate printer interface.

Many older, high-quality, parallel-input printers, like the Radio Shack Line Printer II, actually a Centronics 730-1 in disguise, are still around and available for a fraction of their original prices. Also, many of the newer parallel-input printers, the Epson MX-80 for example, are available at bargain prices.

Interfacing such printers to the Color Computer is not difficult and needn't be expensive. The RS-232C to parallel-input printer interface described in this article allows the Color Computer to be used with a variety of popular printers. Using readily available parts, the unit can be constructed for under $25.

You are not limited to just Radio Shack printers. Build this interface and use other popular brands.

The Serial Interface

The Radio Shack Color Basic ROM supports operation of a serial printer via the computer's RS-232C connector. The pin assignments of the connector are illustrated in Fig. 1.

While performing printer operations, the computer monitors the status input line (pin 1) to determine if the printer is ready to accept data. If the status line is high (logical 1), the computer may output data on pin 4. A low level (logical 0) on the status line indicates to the computer that the printer is busy and cannot accept data.

Data is transmitted, in ASCII-encoded words, 1 bit at a time. These ASCII words define the characters to be printed or operations to be performed by the printer. In order for the printer circuitry to identify the beginning and end of each word, each is preceded by 1 start bit (a zero) and followed by 2 stop bits (ones). The ASCII word will be either 7 or 8 bits long depending on which version of Color Basic, 1.0 or 1.1, the computer is running.

The computer normally transmits serial data at 600 baud. This can be varied, under software control, from 120–2,400 baud by POKEing the appropriate values into specific locations in RAM (see the Radio Shack manual *Getting Started with Color Basic*).

EIA (Electronic Industries Association) standard RS-232C dictates that logical 0 bits be represented by a positive potential greater than 3 volts and that logical 1 bits be represented by a negative potential greater than 3 volts. The Color Computer outputs positive and negative 12 volts, respectively, to satisfy this requirement.

System Requirements

4K RAM
Cassette Basic
Parallel Printer

Color Computer Serial Interface

Pin #	Signal
1	Busy Signal
2	Serial In
3	Ground
4	Serial Out

Fig. 1. RS-232 Pin Arrangement

Parallel-Input Printers

Parallel printers are designed to accept data a whole word at a time. This requires that all 7 or 8 data bits be transmitted simultaneously and that the printer be advised when the data has been made available. Typically, a parallel-output device transmits the information on eight data lines and then outputs a strobe pulse on another line to signal that the data is available for transfer.

Upon receiving the strobe, the printer accepts the data and acknowledges its receipt by outputting a busy signal on yet another line. The busy signal remains until the printer is ready to accept another data word. This sequence is repeated until the print operation is completed.

Serial-to-Parallel Conversion

A serial-to-parallel interface device converts the computer's signal line (serial) output to an eight-line (parallel) input that the printer can accommodate. To accomplish this, the interface monitors the computer's RS-232C output line until it detects a start bit. It then stores the next several bits in a data register. When a stop bit is detected, the data is transferred in parallel form to eight output lines and a data-ready signal is generated. The sequence is repeated when the next start bit is detected.

The Interface Circuit

The Color Computer to parallel-printer interface is designed around the versatile UART (universal asynchronous receiver-transmitter) integrated

circuit. As shown in Fig. 2, the RS-232C input is buffered by line receiver EC2, which inverts the signal and converts it to the TTL level required by the UART. The signal is then applied to the serial input of the UART, IC1. IC1 pins 35–39 are used to program the UART for various word lengths, number of start and stop bits, and parity.

IC3 is wired as an astable multivibrator to produce a clock frequency of 9,600 Hz, 16 times the baud rate of the incoming signal. If you program a baud rate other than 600, you must adjust the clock frequency to maintain the 16x baud rate relationship. Resistors R1, R2, and capacitor C1 determine the frequency of oscillation. The clock's output is applied to the UART's receiver clock input, pin 17. After the UART detects each start bit, serial data is clocked into its receiver register on every sixteenth clock transition.

When the stop bit is detected, the data is output on pins 5–12 and pin 19 goes high. This signal is inverted by IC4(a) and output to the printer as data strobe. It is also applied, after a short

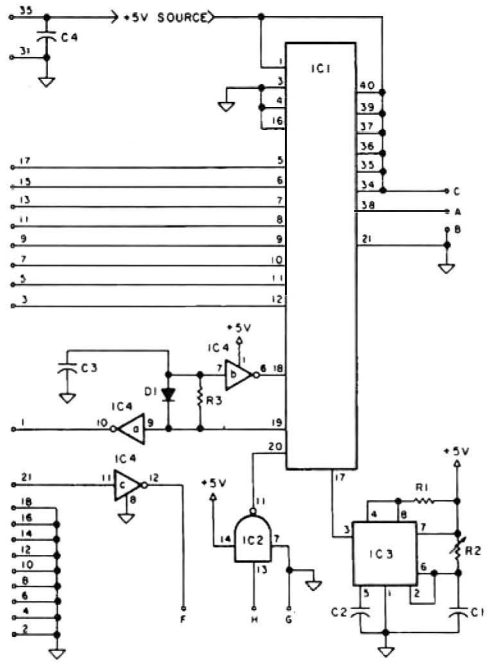

Fig. 2. Schematic for the Serial-to-Parallel Interface

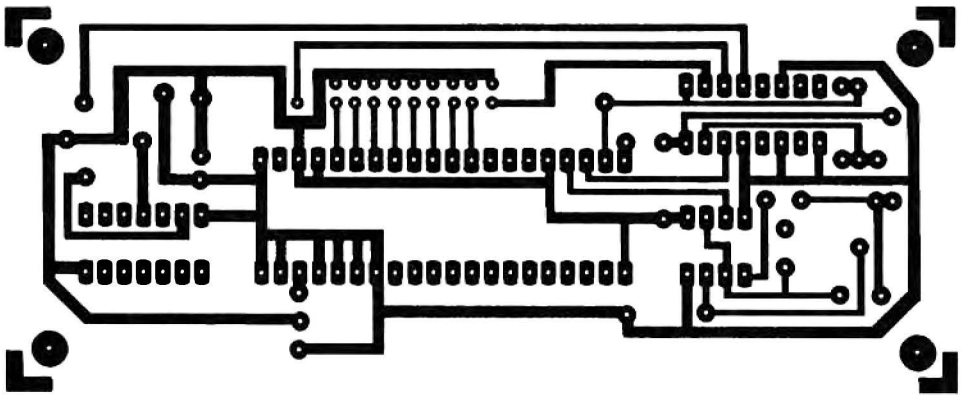

Fig. 3. Foil Pattern of the Single-Sided PC Board

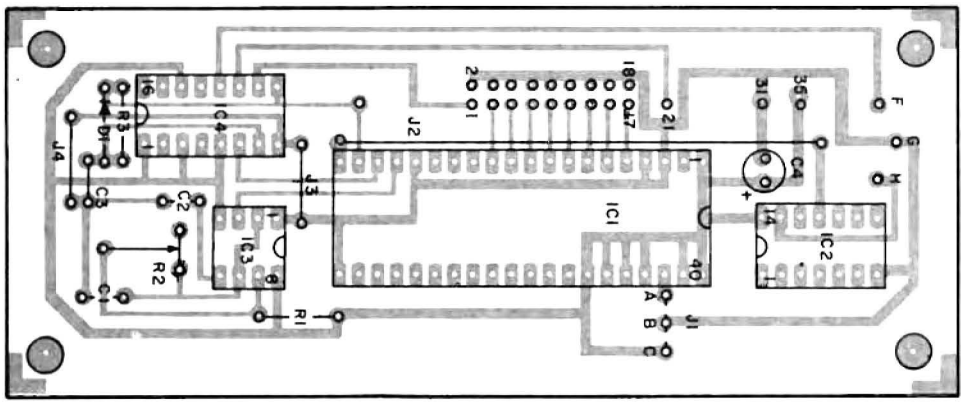

Fig. 4. Component Placement Diagram

delay established by R3 and C3, to IC4(b), which inverts it and applies it to UART pin 18 to reset the data strobe. IC4(c) inverts the printer's busy signal before it is output to the computer's status line. The printer provides power for the interface.

Construction and Calibration

Construct the interface using wire-wrap or point-to-point wiring techniques, or build it on a single-sided printed circuit board. A foil pattern for the PC board is shown in Fig. 3. Assembly is straightforward using the PC board. Refer to the component-placement diagram in Fig. 4 for parts layout.

Begin by installing the four jumper wires. J1 should be installed between points A and B if the interface is going to be used with a computer that has Color Basic version 1.0 or between points A and C for machines with version 1.1.

Next, install the resistors and the diode, making sure to observe the proper polarity when mounting the diode. Mount the IC sockets so that their number 1 pins are oriented as shown in the placement diagram. When installing capacitor C4, be careful that its polarity is as shown in Fig. 4.

Connect 6-inch lengths of wire to points F, G, and H. These will be connected to a 4-pin DIN connector later. Connect wires 1–18 of the ribbon cable to their respective points on the printed circuit board. Connect wires 21, 31, and 35 to their respective points, also.

Place the printed circuit board in the enclosure as it will be mounted, and mark the mounting-hole positions on the case. Remove the board and drill 1/8-inch holes in the case at the points marked. Mark and drill a 9/16-inch hole in the center of one end of the enclosure to accommodate the DIN connector.

Insert the connector in the hole and mark the position of its mounting holes. Remove the connector and drill 1/8-inch holes at the places marked. Cut, nibble, or file a 1/16-inch deep channel on the top edge of the enclosure for the ribbon cable to pass through.

Next, connect the printer connector to the free end of the ribbon cable. If your printer's interface is the standard Centronics parallel type, simply hook wire number 1 to pin number 1, then alternately connect the remaining wires to the top pins and bottom pins on the connector.

Table 1 identifies the wire numbers and signals carried by each conductor. If your printer uses a different style connector, you must refer to a wiring diagram to identify which pins are to be connected.

Mount the completed circuit board in the enclosure, using spacers and the appropriate other hardware. Install the DIN connector and solder wires F, G, and H to pins 1, 3, and 4, respectively.

The printer interface circuit requires +5 volts from the printer's power supply. Centronics-style interfaces conveniently provide +5 volts on either pin 18 or 35, depending on how the connector pins are numbered; check your printer manual.

On some printers, like the Epson MX-80, this voltage is supplied through a pull-up resistor (check your manual again). If this is the case with yours, then bypass the resistor with a piece of wire or isolate that connector pin and run a separate wire to it from the printer's +5 volt source. Wire number 35 of the ribbon cable carries the power from the printer to the interface. If your printer is wired differently, swap wires accordingly.

Before installing the integrated circuits, connect the unit to your printer and apply power. Check the voltage between pin 1 of the UART socket and ground to ensure that it is +5 volts, then turn off the power and insert the integrated circuits.

The clock frequency must be adjusted to 9,600 Hz. If you have a frequency counter, connect it to pin 3 of IC3 and adjust R2 until the counter indicates 9,600 Hz. Alternately, connect your computer to the interface and set up the printer for use. Enter the following program and run it.

```
10 PRINT #-2,"CALIBRATE"
20 FOR X=1 TO 100
30 NEXT X
40 GOTO 10
```

The printer's output will be mostly gibberish until the clock frequency is properly adjusted. Slowly rotate R2 until "calibrate" is accurately and reliably printed. Press break to stop the printer. Replace the interface enclosure's cover and enjoy your computer's expanded capability. ■

Don LeRoi is stationed in Antarctica as a U.S. Navy photographer. Write him at Box 43-62, Port Hueneme, CA 93043.

WIRE #	Signal	Source
1	Data Strobe	Interface
2	Ground	
3	Data Bit 1	Interface
4	Ground	
5	Data Bit 2	Interface
6	Ground	
7	Data Bit 3	Interface
8	Ground	
9	Data Bit 4	Interface
10	Ground	
11	Data Bit 5	Interface
12	Ground	
13	Data Bit 6	Interface
14	Ground	
15	Data Bit 7	Interface
16	Ground	
17	Data Bit 8	Interface
18	Ground	
19	N.C.	
20	Ground	
21	Busy	Printer
22	N.C.	
23	Ground	
24	N.C.	
25	N.C.	
26	N.C.	
27	N.C.	
28	N.C.	
29	N.C.	
30	N.C.	
31	Ground	
32	N.C.	
33	N.C.	
34	N.C.	
35	+5 Volts	Printer
36	N.C.	

Table 1

C1,C2,C3—.01μF disk capacitor
C4—100μF electrolytic capacitor
D1—1N914 diode
IC1—1M6402 UART
IC2—MC1489 quad line receiver
IC3—NE555 timer
IC4—CD4049 hex inverter/buffer
R1—3.9k ohm, ¼W resistor
R2—10k ohm miniature potentiometer
R3—100k ohm, ¼W resistor
Misc.—4-pin DIN connector, plastic case (Radio Shack 270-223 or similar), PC board, IC sockets, 36 conductor ribbon cable, printer connector, hardware, wire, solder, etc.

Table 2. Parts List

Telewriter-64™

the Color Computer Word Processor

- **3 display formats: 51/64/85 columns × 24 lines**
- **True lower case characters**
- **User-friendly full-screen editor**
- **Right justification**
- **Easy hyphenation**
- **Drives any printer**
- **Embedded format and control codes**
- **Runs in 16K, 32K, or 64K**
- **Menu-driven disk and cassette I/O**
- **No hardware modifications required**

THE ORIGINAL

Simply stated, Telewriter is the most powerful word processor you can buy for the TRS-80 Color Computer. The original Telewriter has received rave reviews in every major Color Computer and TRS-80 magazine, as well as enthusiastic praise from thousands of satisfied owners. And rightly so.

The standard Color Computer display of 32 characters by 16 lines without lower case is simply inadequate for serious word processing. The checkerboard-letters and tiny lines give you no feel for how your writing looks or reads. Telewriter gives the Color Computer a 51 column by 24 line screen display with *true lower case characters*. So a Telewriter screen looks like a printed page, with a good chunk of text on screen at one time. In fact, more on screen text than you'd get with Apple II, Atari, 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 cost of a disk.

...one of the best programs for the Color Computer I have seen...
— Color Computer News, Jan. 1982

TELEWRITER-64

But now we've added more power to Telewriter. Not just bells and whistles, but major features that give you total control over your writing. We call this new supercharged version Telewriter-64. For two reasons.

64K COMPATIBLE

Telewriter-64 runs fully in any Color Computer — 16K, 32K, or 64K, with or without Extended Basic, with disk or cassette or both. It automatically configures itself to take optimum advantage of all available memory. That means that when you upgrade your memory, the Telewriter-64 text buffer grows accordingly. In a 64K cassette based system, for example, you get about 40K of memory to store text. So you don't need disk or FLEX to put all your 64K to work immediately.

64 COLUMNS (AND 85!)

Besides the original 51 column screen, Telewriter-64 now gives you 2 additional high-density displays: 64 × 24 and 85 × 24!! Both high density modes provide all the standard Telewriter editing capabilities, and you can switch instantly to any of the 3 formats with a single control key command.

The 51 × 24 display is clear and crisp on the screen. The two high density modes are more crowded and less easily readable, but they are perfect for showing you the exact layout of your printed page, *all on the screen at one time.* Compare this with cumbersome "windows" that show you only fragments at a time and don't even allow editing.

RIGHT JUSTIFICATION & HYPHENATION

One outstanding advantage of the full-width screen display is that you can now set the screen width to match the width of your printed page, so that "what you see is what you get." This makes exact alignment of columns possible and it makes hyphenation simple.

Since short lines are the reason for the large spaces often found in standard right justified text, and since hyphenation is the most effective way to eliminate short lines, Telewriter-64 can now promise you some of the best looking right justification you can get on the Color Computer.

FEATURES & SPECIFICATIONS:

Printing and formatting: Drives any printer (LPVII/VIII, DMP-100/200, Epson, Okidata, Centronics, NEC, C. Itoh, Smith-Corona, Terminet, etc).

Embedded control codes give full dynamic access to intelligent printer features like: underlining, subscript, superscript, variable font and type size, dot-graphics, etc.

Dynamic (embedded) format controls for: top, bottom, and left margins; line length, lines per page, line spacing, new page, change page numbering, conditional new page, enable/disable justification.

Menu-driven control of these parameters, as well as: pause at page bottom, page numbering, baud rate (so you can run your printer at top speed), and Epson font. "Typewriter" feature sends typed lines directly to your printer, and Direct mode sends control codes right from the keyboard. Special Epson driver simplifies use with MX-80.

Supports single and multi-line headers and automatic centering. Print or save all or any section of the text buffer. Chain print any number of files from cassette or disk.

File and I/O Features: ASCII format files — create and edit BASIC, Assembly, Pascal, and C programs, Smart Terminal files (for uploading or downloading), even text files from other word processors. Compatible with spelling checkers (like Spell 'n Fix).

Cassette verify command for sure saves. Cassette auto-retry means you type a load command only once no matter where you are in the tape.

Read in, save, partial save, and append files with disk and/or cassette. For disk: print directory with free space to screen or printer, kill and rename files, set default drive. Easily customized to the number of drives in the system.

Editing features: Fast, full-screen editor with wordwrap, block copy, block move, block delete, line delete, global search and replace (or delete), wild card search, fast auto-repeat cursor, fast scrolling, cursor up, down, right, left, begin line, end line, top of text, bottom of text; page forward, page backward, align text, tabs, choice of buff or green background, complete error protection, line counter, word counter, space left, current file name, default drive in effect, set line length on screen.

Insert or delete text anywhere on the screen without changing "modes." This fast "free-form" editor provides maximum ease of use. Everything you do appears immediately on the screen in front of you. Commands require only a single key or a single key plus CLEAR.

...truly a state of the art word processor... outstanding in every respect.
— The RAINBOW, Jan. 1982

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You can no longer afford to be without the power and efficiency word processing brings to everything you write. The TRS-80 Color Computer is the lowest priced micro with the capability for serious word processing. And only Telewriter-64 fully unleashes that capability.

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BY KEN KNECHT

CoCo Word Processor

This CoCo word processor can print form letters with a mailing-list file, and it can concatenate several documents into one large document. It has an optional variable character-spacing routine for right-justification with printers that use compatible escape sequences. It's written in Basic so you can easily modify it to suit your requirements.

This program was originally written for a MITS Altair 8800; then it was modified for the TRS-80 Model I, Model III, and finally the TRS-80 Color Computer. It would be easy to convert it back to use on the Model I or III.

This word processor requires Extended Color Basic and 16K of memory.

This word processor consists of two Basic programs: the editor, called Edit, which enters the document; and the print formatter, called Author. Once loaded in Basic, the programs can easily be saved on disk or tape.

The Editor

The Edit program lets you insert, delete, and move lines around in the text. You can replace lines and display or print the lines already entered. The editor also allows specific characters, words, or phrases to be located, changed, or deleted in a range of lines.

Write form letters and merge them with other files or use this WP for your other writing needs.

The edit commands consist of single letters, in upper- or lowercase, sometimes accompanied by a plus or minus sign:

- Insert (I)—Typing I begins a document or lets you insert lines in the document. After typing I, the editor gives you a line number, starting with 1. Type your line and hit the enter key. You'll get the next line number; enter another line, hit enter, and so on. To leave the insert mode, hit the enter key without entering a line.

Lines should be 240 characters or less. For 16K computers, the program will accept 200 lines of 40 characters each. If you have 32K, you can have 600 lines of 40 characters. If you use longer lines, you should use fewer of them to avoid running out of memory. If you do run out of memory and the program crashes, type in GOTO 100, and then save the text with the E command.

You can use quotation marks within a line. To end a paragraph, end the last line with an ampersand. Lines are normally connected, with a space between them, by Author when the document is printed. If you end a line with a space, you'll get an extra space between lines. Author puts a blank line between paragraphs, two if you are double-spacing. To begin a paragraph with an indent, put in the spaces wanted at the beginning of the paragraph.

For a line to stand alone, end the previous line with the paragraph marker, the &. Then begin the line to stand alone with a greater-than sign (>); the line will not be connected to any other lines. If you begin several consecutive lines this way, each will stand alone with no blank lines between them.

If you want the lines to be indented, add the appropriate number of spaces between the > and the beginning of that line. The total length of the stand-alone line, not counting the > but including any spaces, must be less than the line length of the printed document. You select this line length when you run Author. The default is 60 characters per line.

Signal the end of the document by typing an @ at the end of the last line in the document.

To start a new page, enter an up arrow on a line by itself.

Don't put an & or an @ on a line by itself. If you like, you can use an up arrow followed by an @ on its own line to start a new page when you are connecting document files.

If you have already entered some lines and wish to insert lines between them, use P after the command prompt * to display the line you wish to follow the inserted lines. Then use I and the editor will print that line number. Enter as many lines as you wish and use the enter key after the line number prompt when you are finished. You can also use

```
FILE NAME? DATAFILE
CREATE NEW FILE? Y
* I
1  Mr. John Brown <enter>
2  10 Main St. <enter>
3  Chicago, IL 60603& <enter>
4  Dear Mr. Brown,& <enter>
5  Ms. Mary Jones <enter>
6  11 Main St. <enter>
7  Chicago, IL 60604& <enter>
8  Dear Ms. Jones,& <enter>
9  <ENTER>
* E
```

Figure 1.

System Requirements

Extended Color Basic
16K RAM
Cassette or Disk
Printer

the – or + commands to find the line to follow your lines.

If there are many lines following the inserted lines, there will be a short pause while the editor moves the lines down to make room for each inserted line. All line numbers following the inserted lines will be corrected.

To add lines to the end of a document, use B or the down arrow after the command prompt. You'll be given the next line number after the last line entered. Then enter your added lines, making sure the original last line does not end with an @ or else your added lines will not be printed.

● Print (P)—Use this command to display any lines already entered. You are asked for the start and end lines of the lines you wish to see. Reply with the enter key to the start line prompt to begin with line 1.

If you use the enter key to respond to the end-line prompt, the last line displayed will be the last line in the document. All lines between the start and end line number will be displayed. If you use the same line number for the start- and end-line number, only that line will be displayed. To temporarily halt the displayed lines, use shift @ and then shift @ to resume the display.

If you use the I command after using P, the lines inserted will precede the last line displayed.

● Line Print (L)—Use this after the command prompt to print all the lines entered. These will not be formatted, but will appear on the line printer just as they appear using the P command on the display. You must use the author program to print the final formatted document.

● Delete (D)—Press D after the command prompt to delete a line. Specify the line number to be deleted. All line numbers following the deleted line will be corrected.

● Replace (R)—If you wish to replace a line, you must specify the line number to be replaced and then type in the new line.

● Display Present Line—A space after the prompt line will display the line that an inserted line would precede. To advance the display one line, use the + or ; command. To back up a line, use the – command. These are useful for checking lines or for finding the correct place for an insert.

● Top Line (T or up arrow)—This will display the first line in the document. You can then follow the document line by line using the + or ;.

● Save (S)—To save the lines you have entered without ending the editing session, type S after the command prompt. You will specify whether you wish to save to a cassette or disk. If you choose cassette, you must be sure the tape recorder is ready. Use this method as you go along as a precaution in case of a power interruption or computer failure.

When the program begins, you must specify a file name for the document you are entering. This name must be eight letters or fewer if you are using a cassette. If you are using a disk, see the manual for permissible file names.

You should use a separate cassette side for each document.

You will see the * command prompt once the document has been recorded.

● End (E)—This works much like save,

Program Listing

```
5 PRINT"PROGRAM COPYRIGHT 1981 BY KENNETH B. KNECHT":PRINT:PRINT
9 PCLEAR1
10 CLEAR 7000:DIM A$(200)
20 INPUT "FILE NAME";FILE$:A=0
30 PRINT"CREATE NEW FILE? ";
31 AN$=INKEY$:IFAN$=""THEN31
32 IFAN$="Y"ORAN$="y"THENA=1:E=0:PRINT:GOTO 100
50 PRINT:GOSUB15100:GOSUB15000
60 OPEN "I",#TD,FILE$
70 IFEOF(TD)THEN90
80 A=A+1:PRINTCHR$(14);:LINEINPUT#TD,A$(A):GOTO 70
90 CLOSE #TD:E=A:A=1:PRINT
100 PRINT"* ";
101 C$=INKEY$:IFC$=""THEN101ELSEPRINTC$:PRINT
102 IFC$="S"ORC$="s"THENPRINT:GOTO440
105 IFC$=" "AND A<E THENPRINTA;A$(A):GOTO100
110 IFC$="I"ORC$="i"THENPRINT:GOTO200
115 IFC$="G"ORC$="g"THENPRINT:GOTO14000
120 IFC$="D"ORC$="d"THENPRINT:GOTO245
130 IFC$="R"ORC$="r"THENPRINT:GOTO265
140 IFC$="Q"ORC$="q"THENPRINT:GOTO290
145 IFC$="B"ORC$="b"ORC$=CHR$(10)THENA=E+1:PRINT:GOTO200
150 IFC$="P"ORC$="p"THENPRINT:GOTO320
155 IF C$="T" OR C$="t" OR C$="^" THEN A=1:PRINT:GOTO 100
160 IFC$="E"ORC$="e"THENPRINT:GOTO400
165 IFC$=";"ORC$="+"THENPRINT:IF A+1>E THENPRINTA;A$(A):GOTO100E
LSEA=A+1:PRINTA;A$(A):GOTO100
170 IFC$="A"ORC$="a"THENPRINT:GOTO6000
175 IFC$="L"ORC$="l"THENPRINT:GOTO13000
180 IFC$="-" AND A>1 THENA=A-1:PRINTA;A$(A):GOTO100ELSEIFC$="-"T
HENPRINT"1 ";A$(1):GOTO100
190 PRINT"ILLEGAL COMMAND":GOTO100
195 'INSERT LINE
200 PRINTCHR$(14);:A$="":PRINTA;:LINEINPUTA$:IFA$=""THEN100
206 IF LEN(A$)>240 THENPRINT"LINE TOO LONG":GOTO 200
210 IF E>1 AND A<E+1 THENGOSUB10000
220 A$(A)=A$:E=E+1:A=A+1
225 IF A>200 THEN PRINT "ONLY 200 LINES":A=A-1:E=E-1
230 GOTO 200
240 'DELETE LINE
245 INPUT"LINE NUMBER";A
250 GOSUB 12000:E=E-1:GOTO 100
260 'DELETE LINE
265 INPUT"LINE NUMBER";A
270 PRINTA;:LINEINPUTA$:IFA$=""THEN100ELSEA$(A)=A$:GOTO100
280 'QUIT?
290 PRINT"QUIT (Y/N)? ";:AN$=""
295 AN$=INKEY$:IFAN$=""THEN295
296 IFAN$="Y"ORAN$="y"THENENDELSEPRINT:GOTO100
310 'PRINT
320 L1=1:L2=E:INPUT"FROM LINE";L1:IF L1<1 THENL1=1
330 INPUT"TO LINE";L2:IF L2>E THENL2=E
335 IFL2=0THENL2=E
360 FOR X=L1 TO L2
370 PRINT X;A$(X)
380 NEXT:A=L2:GOTO100
390 'END EDIT SESSION
400 INPUT"END (Y/N)";AN$:IFLEFT$(AN$,1)="Y"ORLEFT$(AN$,1)="y"THE
N410ELSEGOTO100
410 GOSUB15100:GOSUB15000:OPEN"O",#TD,FILE$:FORX=1 TO E:PRINT#TD
,A$(X):NEXT:CLOSE:CLEAR300:END
440 INPUT"SAVE (Y/N)";AN$:IFLEFT$(AN$,1)="Y"ORLEFT$(AN$,1)="y"TH
EN445ELSE100
445 GOSUB15100:GOSUB15000
450 OPEN"O",TD,FILE$:FOR X=1 TO E:PRINT#TD,A$(X):NEXT:CLOSE:GOTO
100
6000 INPUT"LINE NUMBER";A:IF A>E+1 THENPRINT"NO LINE":GOTO100ELS
EC$=A$(A):LF=1:ZZ=0:D$="":Z1$="":Z4=LEN(C$):PRINTA;
6010 GOSUB 6500
6020 IFZ$=" "THEN6130
6030 IF Z$=>"1" AND Z$<="9" THEN6150
6040 IFZ$="C"ORZ$="c"THEN6170
6050 IFZ$="D"ORZ$="d"THEN6180
```

Listing continued

Listing continued

```
6060 IFZ$="L"ORZ$="l"THEN6230
6070 IFZ$="Q"ORZ$="q"THEN6260
6080 IFZ$="I"ORZ$="i"THEN6270
6090 IFZ$="X"ORZ$="x"THEN6290
6100 IFZ$="H"ORZ$="h"THEN6320
6105 IFZ$=CHR$(8)THEN6370
6110 IFZ$=CHR$(13)THEN6330
6120 GOTO6010
6130 IF LF>Z4 THEN6120
6140 PRINTMID$(C$,LF,1);:D$=D$+MID$(C$,LF,1):LF=LF+1:GOTO6010
6150 Z1$=Z1$+Z$
6160 GOTO6010
6170 IFZ1$=""THEN6174
6171 FORZ2=LF TO LF+VAL(Z1$)-1
6172 GOSUB6500:PRINTZ$;:D$=D$+Z$
6173 NEXT:LF=Z2:Z1$="":GOTO6010
6174 GOSUB6500:PRINTZ$;:LF=LF+1:D$=D$+Z$:GOTO6010
6180 IFZ1$=""THEN6220
6190 PRINT"!";:FORZ2=LF TO LF+VAL(Z1$)-1
6200 PRINTMID$(C$,Z2,1);:NEXT
6210 PRINT"!";:LF=Z2:Z1$="":GOTO6010
6220 PRINT"!";:PRINTMID$(C$,LF,1);:PRINT"!";:LF=LF+1:GOTO6010
6230 IFLF=Z4 AND ZZ=1THENZZ=0:GOTO6255
6235 FORZ2=LF TO Z4
6240 PRINTMID$(C$,Z2,1);:D$=D$+MID$(C$,Z2,1)
6250 NEXT
6255 C$=D$:D$="":PRINT:Z4=LEN(C$):LF=1:GOTO6010
6260 PRINT:GOSUB6510:D$="":GOTO100
6270 GOSUB6500
6272 IFZ$=CHR$(95)THEN6010
6274 IFZ$=CHR$(8)THEN6410
6275 IFZ$=CHR$(13)THEN6330
6280 PRINTZ$;:D$=D$+Z$:GOTO6270
6290 FORZ2=LF TO Z4
6300 PRINTMID$(C$,Z2,1);:D$=D$+MID$(C$,Z2,1)
6310 NEXT:LF=Z4+1:GOTO6270
6320 Z4=LF:ZZ=1:GOTO6270
6330 IF LF=>Z4 THENPRINTCHR$(13):GOSUB6510:A$(A)=D$:GOTO100
6340 FORZ2=LF TO Z4
6350 PRINTMID$(C$,Z2,1);:D$=D$+MID$(C$,Z2,1)
6360 NEXT:PRINTCHR$(13):GOSUB6510:A$(A)=D$:GOTO 100
6370 PRINT "/";
6380 PRINTMID$(D$,LEN(D$),1);:D$=LEFT$(D$,LEN(D$)-1)
6390 GOSUB6500:IFZ$=CHR$(8)THEN6380
6400 PRINT"/";:GOTO6020
6410 PRINT "/";
6420 PRINTMID$(D$,LEN(D$),1);:D$=LEFT$(D$,LEN(D$)-1)
6430 GOSUB6500:IF Z$=CHR$(8)THEN6420
6440 PRINT"/";:GOTO6272
6500 PRINTCHR$(14);:Z$=INKEY$:IFZ$=""THEN6500ELSERETURN
6510 RETURN
9999 REM MAKE ROOM FOR INSERT
10000 IF E+1>200 THENPRINT"ONLY200 LINE NUMBERS":GOTO100ELSEFORI
1=E TO A STEP-1
10010 FORI2=0 TO 3
10015 IF I2=1 THEN 10040
10020 I3=PEEK(VARPTR(A$(I1))+I2)
10030 POKE(VARPTR(A$(I1+1))+I2),I3
10040 NEXT I2,I1:RETURN
11999 REM DELETE A LINE
12000 FOR I1=A+1 TO E
12010 FOR I2=0 TO 3
12015 IF I2=1 THEN 12040
12020 I3=PEEK(VARPTR(A$(I1))+I2)
12030 POKE(VARPTR(A$(I1-1))+I2),I3
12040 NEXT I2,I1:RETURN
13000 FORX=1 TO E
13010 PRINT#-2,X;A$(X)
13020 NEXT:GOTO 100
14000 PRINT "GLOBAL REPLACE (R)":PRINT "DELETE (D), OR FIND (F)?
";
14010 C$=INKEY$:IFC$=""THEN14010
14020 IFC$="R"ORC$="r"ORC$="D"ORC$="d"ORC$="F"ORC$="f"THEN14030E
LSE14000
14030 PRINT:INPUT "FROM LINE";L1:IF L1<1 THENL1=1
14040 INPUT "TO LINE";L2:IF L2>E THENL2=E
14045 IFL2=0THENL2=E
14050 PRINT"STRING TO SEARCH FOR":PRINT"DON'T FORGET THE SPACE":
PRINT"AFTER A WORD.":LINEINPUT"? ";S1$:IFC$="R"ORC$="r"THEN14060
ELSE14070
14060 PRINT "STRING FOR REPLACEMENT":LINEINPUT "? ";S2$
14070 FORX=L1 TO L2
14080 F=INSTR(A$(X),S1$):IF F>0 THEN14100
14090 NEXTX:GOTO100
14100 IFC$="D"ORC$="d"THEN14110ELSE14120
14105 IFF=1THENA$(X)=RIGHT$(A$(X),LEN(A$(X))-LEN(S1$)):GOTO14080
14110 IFF-1+LEN(S1$)=LEN(A$(X))THENA$(X)=LEFT$(A$(X),F-1):GOTO14
```

Listing continued

except that after the document is recorded you will leave the Edit program and return to the Basic command mode.

If you want to make a back-up copy of your document on tape or disk use save for the first copy and then use end to save the back-up copy on another already-initialized disk or cassette.

- Alter (A)—This lets you change part of a line you have already entered. Enter the line number you wish to alter.
- Look (L)—Type L to display the line (or remainder of a line) that you are editing. You can use this subcommand at any time without leaving the A mode.
- Insert (I)—To insert, use the space bar to find the point where you wish to insert. To leave the I submode without leaving the alter mode, use shift up arrow. To leave alter after the insert, use the enter key.
- Change (C)—To change a character in the line, use the space bar to find the character before the one to be changed; type C and the new character. To change more than one consecutive character, precede the C with the number of characters you wish to change.
- Extend (X)—To add characters to the end of the line, type X. This will display the line; then type in the characters to be added. Finish with enter to complete the line, or use shift up arrow and L to work on the line.
- Hack (H)—To delete the end of the line and optionally replace the deleted portion with new characters, use this subcommand. Use the space bar to find the character before the deletion. Type H to delete the rest of the line, and then either type enter to leave the line as it is or type in the new characters. To end the H submode, use enter to leave the alter mode, or shift up arrow followed by L to work on the line.
- Delete (D)—To delete a character, use the space bar to get to the character preceding the one you wish to delete; type D to delete the character or D preceded by a number to delete that number of characters. The deleted characters will be placed within slashes so you can see which ones were deleted.
- Quit (Q)—If you have ruined a line or you wish to abort a program, use the Q subcommand to abort the edit and return you to command mode. You will lose any edits you made since you last used enter to finish a line, and any partly edited line will be restored.
- Back up (left arrow)—To back up while editing use the left arrow key. The characters you have backed over will be displayed within slashes to remind you where you are.

When you begin the Edit program,

FINALLY!

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you can create a new document or edit an old document. If you want to finish or change an old document, answer the "Create new document" query with N, respond to the cassette ready query, and the document will be loaded from tape or disk.

If you respond with a Y, you will receive the command prompt * and you can enter your new document.

The Edit program is set up for 200 lines, assuming the lines will be an average of 40 characters each. If you use all 200 lines, you are warned and not permitted to enter any more. Use E to save the document and start a new one by restarting the Edit program by typing RUN. Be sure to use a different file name for this addition.

You can then use Author to connect the documents. If you are doing this, the sections of the documents should follow each other in the correct order on a single cassette side. If you use a disk, the files need only be on a disk in one of your disk drives.

If you have 32K of memory, you can change the 200 in line 10 (DIM A$ (200)), line 1000 (twice) and line 11010 to 600; and the CLEAR 8000 in line 10 to CLEAR 24000.

While you are running the program, especially when using the alter mode, the computer might seem to freeze and ignore the keyboard. Sit back and wait; eventually all will be well. You have just been treated to the effects of the dreaded garbage collection. Basic does this to reorganize the string space, getting rid of old, no-longer-needed lines. It can take from 10 seconds to several minutes.

- Global (G)—This will replace, delete, or find a specific word or phrase in a document.
- Variable File (<)—This will insert lines from another file for form letters. Use the < followed by a few spaces or any characters (they won't be printed). Author will get the line from another variable file and insert it. The resulting line will stand alone, like a line beginning with a >. See Author documentation for more details.

Author Documentation

This program formats a document to be printed.

The initial raw document data created with the Edit program is stored in one or more files. When Author connects two files, the paging of the document is not interrupted. Each file length is limited only by memory size; thus a document can exceed memory size by many times.

Listing continued

```
090
14115 A$(X)=LEFT$(A$(X),F-1)+RIGHT$(A$(X),LEN(A$(X))-(F-1+LEN(S1
$))):GOTO14080
14120 IFC$="R"ORC$="r"THEN14123ELSE14140
14123 IFF=1THENA$(X)=S2$+RIGHT$(A$(X),LEN(A$(X))-LEN(S1$))):GOTO
14080
14125 IFF-1+LEN(S1$)=LEN(A$(X))THENA$(X)=LEFT$(A$(X),F-1)+S2$:GO
TO14090
14130 A$(X)=LEFT$(A$(X),F-1)+S2$+RIGHT$(A$(X),LEN(A$(X))-(F-1+LE
N(S1$))):GOTO14080
14140 PRINTX;A$(X):PRINT"AGAIN? ";
14150 B$=INKEY$:IFB$=""THEN14150
14160 PRINT:IFB$="Y"ORB$="y"THEN14090ELSE100
15000 IFTD=-1THENINPUT"IS CASSETTE READY";AN$:IFAN$="Y"ORAN$="y"
THENRETURNELSE15000
15010 RETURN
15100 INPUT"TAPE (T) OR DISK (D)";TD$:IFTD$="T"ORTD$="t"THENTD=-
1:RETURN
15110 IFTD$="D"ORTD$="d"THENTD=1:RETURN
15120 GOTO15100
```

Program Listing 2

```
5 PRINT"PROGRAM COPYRIGHT 1981 BY KEN KNECHT"
10 CLEAR7000:PCLEAR 1:N1=0':DIMTD$(200)
11 INPUT"TEXT ON TAPE (T) OR DISK (D)";TD$:IFTD$="T"THENTD=-1:GO
TO20
12 IFTD$="D"THENTD=1ELSE11
20 GOSUB4000
30 L1=0:P2=1:INPUT"JUSTIFY RIGHT";A1$:IFLEFT$(A1$,1)="Y"THENNJ=1
ELSENJ=0
40 INPUT"DOUBLE SPACE";A1$:IFLEFT$(A1$,1)="Y"THEND=1ELSED=0
44 INPUT"FIRST PAGE NUMBER (DEFAULT IS 1)";PN$:IFPN$=""THENPN=1E
LSEPN=VAL(PN$)
45 P2=PN:L1=0:PF=0
46 INPUT"LINE WIDTH (DEFAULT IS 60)";PW$:IFPW$=""THENPW=60ELSEPW
=VAL(PW$)
47 INPUT"LEFT MARGIN (DEFAULT IS 8)";LM$:IFLM$=""THENLM=8ELSELM=
VAL(LM$)
48 PRINT"PRINTED PAGE LENGTH (DEFAULT":INPUT" IS 55 LINES)";PL$:
IFPL$=""THENPL=55ELSEPL=VAL(PL$)
49 PRINT"PHYSICAL PAGE LENGTH DEFAULT":INPUT"IS 66";PP$:IFPP$=""
THENPP=66ELSEPP=VAL(PP$)
50 INPUT"DIABLO PRINTER";A1$:IFLEFT$(A1$,1)="Y"THENP1=1ELSEP1=0
60 INPUT"PAGE NUMBERS";A1$:IFLEFT$(A1$,1)="Y"THENP1=1ELSEP1=0
70 INPUT"TITLE ON EACH PAGE";A1$:IFLEFT$(A1$,1)="Y"THENT=1ELSET=
0:GOTO90
80 INPUT"TITLE";T$:INPUT"SUBTITLE";T1$
90 N=0:DT=0:INPUT"VARIABLES";A1$:IFLEFT$(A1$,1)="Y"THENIFTD=-1TH
ENINPUT"VARIABLES TAPE READY";AN$:DT=1
92 IF LEFT$(A1$,1)<>"Y" THEN100
95 OPEN"I",#TD,DF$
96 IFEOF(TD)THEN98
97 N=N+1:LINEINPUT#TD,DF$(N):GOTO96
98 CLOSE
100 GOSUB1000
110 FORFF=1 TO NF
115 F6=0:F7=0:P7=0:A$="":B$="":C$="":E=0:PG=0
117 IFTD=-1THENINPUT"TEXT TAPE READY";AN$
120 OPEN"I",#TD,A1$(FF)
130 IF B$<>"" AND (RIGHT$(B$,1)="&" OR RIGHT$(B$,1)="@")THENA$=B
$:B$="":J9=LEN(A$):GOTO280
140 IF LEN(B$)>PW THENA$=B$:B$="":J9=LEN(A$):GOTO280
150 IF EOF(TD) OR (B$="" AND E=1)THEN7000
160 LINEINPUT#TD,A$:IFA$=" "THEN160ELSEJ9=LEN(A$):PRINT">";A$;"<"
161 IFLEFT$(A$,1)="^"THENPF=1ELSEIFLEFT$(A$,2)="^@"THENPF=2
162 IFPF=1 AND B$=""THENFORXY=L1+1 TO PP:PRINT#-2," ":NEXTXY:L1=
0:GOSUB1000:PF=0:GOTO150
163 IFPF=1 AND LEN(B$)<=PW THENPRINT#-2,TAB(LM);B$:B$="":FORXY=L
1+1 TO PP:PRINT#-2," ":NEXTXY:L1=0:PF=0:GOSUB1000:GOTO150
164 IFPF=2 AND B$=""THEN7000
165 IFPF=2 AND LEN(B$)<=PW THENPRINT#-2,TAB(LM);B$:B$="":GOTO700
0
166 IFPF=2THENE=1:A$=B$+"@":B$="":J9=LEN(A$):GOTO280
170 IFLEFT$(A$,1)="<"THENN1=N1+1ELSE190
172 IF N1>N THENPRINT"****OUT OF VARIABLES DATA*****":CLOSE:END
175 A$=DF$(N1)
180 A$=">"+A$:J9=LEN(A$)
190 IFLEFT$(A$,1)=">"THENA$=RIGHT$(A$,J9-1)ELSE260
200 IF B$<>"" THENP7=1
210 IFB$=""THENF6=1:J9=LEN(A$):GOTO290
220 IF RIGHT$(B$,1)<>"&" AND LEN(B$)<PW+1 THENPRINT#-2,TAB(LM);B
```

Listing continued

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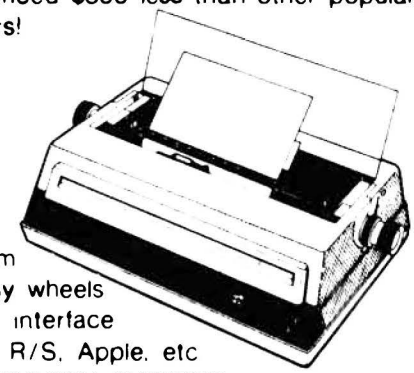

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Listing continued

```
$:B$="":GOSUB2020:P7=0:GOTO210
230 IFRIGHT$(B$,1)="&" AND LEN(B$)>PW+1 THENB$=LEFT$(B$,LEN(B$)-
1):P7=0:PRINT#-2,TAB(LM);B$:PG=1:GOSUB2020:B$=""
240 IFP7=1THENA9$=A$:A$=B$:GOTO410
250 GOTO270
260 IF B$<>"" THEN230
270 IF B$<>"" THENA$=B$+" "+A$:J9=LEN(A$):B$=""
280 IF J9>PW THEN410
290 IFRIGHT$(A$,1)="&"THENPG=1:A$=LEFT$(A$,J9-1):F6=0:J9=LEN(A$)
:GOTO800
300 IFRIGHT$(A$,1)="@"THENE=1:A$=LEFT$(A$,J9-1):F6=0:J9=LEN(A$):
GOTO800
310 IFF6=1THENF6=0:GOTO800
320 B$=A$:GOTO130
410 S=0:FORX=1 TO PW:F$=MID$(A$,X,1):IFF$=" "THENS=S+1
420 C$=C$+F$:NEXTX
430 XX=0:S=S-1
440 FORX=PW TO INT(PW/2) STEP-1
450 F$=MID$(C$,X,1):XX=XX+1
460 IF F$<>" " THENNEXTX
470 B$=RIGHT$(A$,LEN(A$)-(PW+1)+XX):A$=LEFT$(C$,LEN(C$)-XX)
480 IFNJ=0THEN800
490 J9=LEN(A$):Q=PW-J9:S2=0:C$="":TI=0
500 IFDI=1THEN690
510 IF Q<=S THENS1=1:GOTO550
520 IF Q>S*3 THENS1=4:GOTO550
530 IF Q>S*2 THENS1=3:GOTO550
540 IF Q>S THENS1=2
550 FORX=1 TO J9:F$=MID$(A$,X,1)
560 IF F$<>" " THEN660
570 IF S1=1 AND Q-S2=0THENF$=" ":GOTO650
580 IFS1=1THENF$="  ":S2=S2+1:GOTO650
590 IF S1=2 AND Q-S2=S-TITHENF$="  ":S2=S2+1:GOTO650
600 IFS1=2THENF$="   ":S2=S2+2:GOTO650
610 IF S1=3 AND Q-S2=(S-TI)*2THENF$="   ":S2=S2+2:GOTO650
620 IFS1=3THENF$="    ":S2=S2+3:GOTO650
630 IF S1=4 AND Q-S2=(S-TI)*3THENF$="    ":S2=S2+3:GOTO650
640 IFS1=4THENF$="     ":S2=S2+4
650 TI=TI+1
660 C$=C$+F$:NEXTX
670 A$=C$:C$=""
680 GOTO800
690 IFQ=0THEN800
700 HM=INT((Q*12)/J9)+12:HI=(12*PW)-((J9*12)+(J9*(HM-12)))
710 PRINT#-2,TAB(LM);CHR$(27);CHR$(31);CHR$(HM+2);
720 IFHI=0THEN760
730 FORX=1 TO HI
740 F$=MID$(A$,X,1):PRINT#-2,F$;
750 NEXTX
760 PRINT#-2,CHR$(27);CHR$(31);CHR$(HM+1);
770 FORX=HI+1 TO J9
780 F$=MID$(A$,X,1):PRINT#-2,F$;
790 NEXT:PRINT#-2,CHR$(27);CHR$(31);CHR$(13):GOTO820
800 IFRIGHT$(A$,1)="&"THENA$=LEFT$(A$,LEN(A$)-1)
810 PRINT#-2,TAB(LM);A$:A$=""
820 C$="":GOSUB2020:IFP7=1THENP7=0:A$=A9$:A9$="":GOTO220
830 GOTO130
1000 IFP1=1THENPRINT#-2,TAB(39);"(";P2;")":P2=P2+1:PRINT#-2," ":
L1=L1+2
1010 IFT=1THENPRINT#-2,TAB(LM);T$:PRINT#-2,TAB(LM);T1$:PRINT#-2,
" ":L1=L1+3
1020 RETURN
2020 L1=L1+1
2030 IFD=1THENL1=L1+1:PRINT#-2," "
2040 IFPG=1THENL1=L1+1:PG=0:PRINT#-2," "
2050 IFD=1THENL1=L1+1:PRINT#-2," "
2070 IF L1>PL-1 THENFORXY=L1+1 TO PP:PRINT#-2," ":NEXTXY:L1=0:GO
SUB1000
2080 RETURN
3000 L1=0:NEXTFF
3010 CLOSE#TD:INPUT"ANOTHER COPY";A1$
3020 IFLEFT$(A1$,1)="Y"THEN30ELSEEND
4000 INPUT"HOW MANY FILES IN THIS DOCUMENT";NF:DIMA1$(NF)
4010 FORFF=1 TO NF
4020 LINEINPUT"FILE NAME? ";A1$(FF)
4030 NEXTFF
4040 INPUT"IS THERE A VARIABLE FILE";A1$:IF LEFT$(A1$,1)<>"Y" TH
ENRETURN
4050 LINEINPUT"VARIABLE FILE NAME? ";DF$:RETURN
6000 IFRIGHT$(A$,1)="&"THENPG=1:A$=LEFT$(A$,LEN(A$)-1)
6010 IFRIGHT$(A$,1)="@"THENE=1:A$=LEFT$(A$,LEN(A$)-1)
6020 RETURN
7000 E=0:CLOSE#TD:IFPF=2THENPF=0:FORXY=L1+1 TO PP:PRINT#-2," ":N
EXTXY:L1=0:GOSUB1000:NEXTFFELSENEXTFF
7005 FORXY=L1+1 TO PP:PRINT#-2," ":NEXTXY
7010 IFDT=1THENIFN1=NTHEN3010
7020 IFDT=1THENCLOSE#TD:P2=PN:L1=0:GOTO110
7030 GOTO3010
```

Each file is constructed with the Edit program. Lines can be complete or broken between words. The program automatically adds a space between any two connected lines in a file. If you add a space after a line, you'll end up with two spaces in the final printout.

There are five formatting characters to remember:

- The & at the end of the last line in a paragraph will make the next line begin a new paragraph. If you want indented paragraphs, include the indenting spaces at the beginning of every line that starts a new paragraph.
- The @ signals the end of the document.
- Use > if you write a line that you want to appear by itself. The line will be printed exactly as you entered it. Be sure such lines do not exceed your chosen line length.

Use < when you want to use a line from a data file. The dummy < line in the file must consist of several characters.

The up arrow advances the printer to the top of the next page. It can be used for starting a new chapter and the like, but it must stand alone on a line unless it is followed by an @.

Figure 1 is an example of a set of files using the formatting commands.

First, write the optional data file, named Datafile. Remember, this file is only necessary if you wish to print several documents with the same lines to be replaced by your variable file's lines. Figure 1 should make this clear.

To connect two files, refer to Fig. 2. Once you have entered a file such as Fig. 2, you can load Author. Figure 3 shows the prompts and the appropriate answers.

The two letters will be printed in the format specified by Author.

If the Diablo 1620 printer is used, a special routine will take advantage of the variable character spacing when using right-justification. If you are not using the Diablo, answer N to the appropriate query.

Note that you must set the printer at the beginning of the paper where you wish the printout to start. The program uses line feeds instead of the form-feed character, so it will be compatible with all printers.

Some experimentation with this program will help you understand its possibilities better. This is a powerful and easy-to-use word processor. ■

Ken Knecht can be reached at KEN-COM Co., 1263 S. 5th Ave., Yuma, AZ 85364.

```
FILE NAME? LETTER 1
CREATE NEW FILE? Y
* I
1 >             Mr. John Smith
2 >             12 Main St.
3 >             Chicago, IL 60605&
4 >             11/30/81&
5 <XYZ
6 <XYZ
7 <XYZ
8 <XYZ
9    We are writing this letter as an example of
10 how to use this program.
11 In it we will use the "<", ">", "&" and "@"
12 to show the use of the formatting symbols.&
13    Note we used a "&" to end the last
14 paragraph. Note also that we can break up sentences
15 and how we use spaces to indent the first line
16 of a new paragraph.&
17    We will now end the first file.
18 Note the use of the "@" at the end of this line.@
19 <ENTER>
*E
RUN
FILE NAME? LETTER 2
CREATE NEW FILE? Y
*I
1    We are now starting a new file.
2 In the previous file note how we used the ">"
3 to set the sender's name and address off to the
4 right side of the page.&
5    We also used the "<" followed by the dummy line XYZ
6 (we could have used spaces as well, just so something
7 follows the ">").
8 In these lines the program will place the lines
9 from the variable data file, one line from the variable
10 file following each ">".&
11    This sould give you an idea of how to set
12 up your next files.&
13>             Sincerely, &
14>              John@
15<ENTER>
*E
```

Figure 2

```
RUN
HOW MANY FILES IN THIS DOCUMENT? 2
FILE NAME? LETTER 1
FILE NAME? LETTER 2
IS THERE A VARIABLE FILE? Y
VARIABLE FILE NAME? DATAFILE
JUSTIFY RIGHT? Y
DOUBLE SPACE? N
FIRST LINE NUMBER (DEFAULT IS 1)? <ENTER>
LINE WIDTH (DEFAULT IS 60)? <ENTER>
LEFT MARGIN (DEFAULT IS 8)? 10
PAGE LENGTH (DEFAULT IS 55)? 60
DIABLO PRINTER? Y
PAGE NUMBERS? Y
TITLE ON EACH PAGE? Y
TITLE? AUTHOR DOCUMENTATION
SUBTITLE? COPYRIGHT 1981 BY KENNETH B. KNECHT
VARIABLES? Y
```

Figure 3

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BY CHARLES LEVINSKI

CAVEHUNT

Many dangerous creatures await you in this adventure game. Can you find your way out of the maze?

You awake on a cool, hard floor. You see nothing but crude, gray stone. You perceive that you are in some sort of cave. You find you carry only a knife.

You hear a sound nearby. Investigating, you enter another room in what now appears to be a maze of caves. On the far side of the room, a small man crouches. Relieved to find you are not alone, you approach him.

Suddenly, swinging a great ax, the man whirls to face you! You retreat the way you came, running through several rooms. You stumble and fall. Lying beside you is a short object, resembling a flashlight. You retrieve it and turn it on, hoping the batteries aren't dead. A faint purple beam licks out and stops about six feet from the handle.

Some scuffling behind you draws you out of your reverie. You turn to find the short man swinging his ax crazily! In panic, you turn the light toward him. The ax head separates from the handle where the beam touches it. He hesitates to stare at the suddenly bare ax handle long enough for you to recognize him as a troll. Before you can react, he's gone.

Slightly giddy from the encounter, you turn and walk through an opening into the next room—and into the jaws of a giant spider! You drop the light and your knife, and struggle to escape. But it's too late.

Soon silence fills the caves once more as the occupants settle down to await their next meal.

Cavehunt is a fantasy game that places the player near the center of a maze of rooms. The object of the game is to escape alive, a task made extremely difficult by the creatures you encounter en route.

The maze is redesigned for each game so that you can't memorize the escape route. Other features include seven different weapons for you to find, five different creatures to make your life miserable, and a point total awarded for killing the various creatures you encounter.

A graphics display of the cave when the game is over shows its construction and your position at the end of the game.

A(X,Y)	Contents of cave rooms
F(X,Y)	Die-roll modifier chart
KP	Kill points
I	Used for counting loops
N	Used for counting loops and for contents of room North of player
PX	Horizontal player location
PY	Vertical player location
A$	Used for one time alphanumeric inputs
W(1),W(2)	Weapons being carried
X	Horizontal room number
Y	Vertical room number
LX	Last horizontal player location
LY	Last vertical player location
S	Contents of room South of player
E	Contents of room East of player
W	Contents of room West of player
D	Direction player chooses to travel, also indicates player's death
A	Number of weapons being left behind
G	Temporary storage of weapon value during pick up routine—later used for plotting cave shape
RN	Relative probability of escape when running from a creature
AW	Weapon used for an attack
RL	Relative indicator of battle success
TR	Direction scheme for creating an exit to the cave
TX	Horizontal position of test probe
TY	Vertical position of test probe
T1	Random escape direction

Table 1. Variable List

Program Operation

The program establishes a two-dimensional array that represents the cave. The value of any element in the array determines the contents of the room represented by that element. The location A(5,6) represents a room in the cave. If A(5,6) = 3, it would mean there

System Requirements

16K Color Basic

is a giant spider in the room. These room values can represent five different categories. A zero means that the room is empty. A one means the room is solid rock and cannot be entered by anyone. Numbers two through six represent various creatures that occupy the rooms of the cave, while seven through 13 indicate weapons in the room. A negative one indicates that you are outside the cave and therefore have escaped.

The creatures who live in these rooms do not leave them; the rooms are their homes and they don't appreciate interlopers. For simplicity in the program, a room cannot contain both a creature and a weapon.

Battles are resolved with another matrix—the die-roll modifier (DRM), a concept borrowed from assorted war-games such as Squad Leader by Avalon Hill.

A number representing the relative effectiveness of each weapon against a particular creature is set up in another two-dimensional array. When battle takes place, this modifier is added to the die roll (the random number between 1 and 20 that determines the outcome of a fight). This offsets the outcome depending upon the weapon's effectiveness against a particular foe.

The DRM for a knife being used against a wizard is a seven. Since a die roll of five or less is needed to kill a creature, and the lowest die roll possible, a one, plus the DRM, a seven, equals eight, it is obviously impossible to kill a wizard with a knife. His odds of killing you are similarly improved if you are so foolish as to attack.

Line 6 randomizes the random-number generator. Line 10 dimensions the cave and the DRM chart. Line 11 resets the number of points scored each game for killing creatures. Lines 13–19 form the DRM chart.

If you don't like my odds, change the

Program Listing

```
2 'CAVEHUNT,AN ADVENTURE GAME
4 'BY CHARLES B. LEVINSKI, 10 SOUTH SIDE AVENUE, SOUTH RIVER, N.
J. 08882
5 CLS
6 PRINT@236,"CAVEHUNT":PRINT@295,"KEY ENTER TO BEGIN":KP=RND(100
0):IFINKEY$=""THEN6
10 DIMA(22,22):DIM F(5,7)
11 KP=0
12 CLS:PRINT"PROGRAM IS PROCESSING-PLS WAIT"
13 FORI=1TO5
15 FORN=1TO7
16 READ F(I,N)
17 NEXTN,I
19 DATA 7,0,5,-2,-5,5,12,8,4,2,4,0,0,-5,3,3,0,1,1,-4,-8,12,0,12,
-5,0,12,12,6,5,2,4,-1,-2,-7
20 'A(X,Y)=CAVE POSITIONS:0=CLEAR,1=IMPASSABLE,2=WIZARD.3=GIANT
SPIDER,4=TROLL,5=UNDEAD.6=GREAT BEAR
22 'A(X,Y)=-1 INDICATES OUTSIDE OF CAVE AND YOU WIN
25 RESTORE
30 '7=KNIFE,8=MAGIC STAFF,9=BROAD SWORD,10=DIAMOND OF LIFE,11=FI
RE OF THE DEPTHS,12=GREAT AX.13=LASER SWORD
40 'PX.PY=PLAYER POSITION,A$=GARBAGE CHARACTER,W(1),W(2)=WEAPONS
 BEING CARRIED,NSEW=DIRECTIONS,D=DIRECTIONS
70 FORX=0TO21
72 FORY=0TO21
74 A(X,Y)=0
76 NEXTY,X
110 'CREATE CAVE
120 FOR Y=1TO20
130 FOR I=1TO6
135 X=RND(20)
140 A(X,Y)=1
170 NEXTI,Y
172 Y=0
174 FOR X=0TO21:A(X,Y)=-1:NEXTX
176 Y=21
178 FOR X=0TO21:A(X,Y)=-1:NEXTX
180 X=0
182 FORY=1TO20:A(X,Y)=-1:NEXTY
184 X=21
186 FORY=1TO20:A(X,Y)=-1:NEXTY
188 'LOCATE CREATURES
190 FOR Y=1TO20
200 FORI=1TO5
205 X=RND(20)
210 IF A(X,Y)<>0 THEN 205
220 A(X,Y)=RND(5)+1
230 NEXTI,Y
240 'LOCATE PLAYER PX AND PY
250 PX=RND(4)+8
260 PY=RND(4)+8
265 LX=PX:LY=PY
270 'LOCATE WEAPONS
290 FOR Y=1TO20
295 FOR I=1TO3
300 X=RND(20)
310 IFA(X,Y)<>0THEN300
320 A(X,Y)=RND(7)+6
330 NEXTI,Y
```

Listing continued

Listing continued

```
332 GOSUB 4000
340 'START GAME
345 CLS
350 PRINT@0,"YOU FIND YOURSELF IN A DARK "
352 PRINT@32,"CAVE, ARMED ONLY WITH A KNIFE."
354 PRINT@64,"YOU MAY CARRY ONLY TWO WEAPONS,"
356 PRINT@96,"THOSE TWO OF YOUR CHOICE. YOU"
358 PRINT@128,"MAY PICK UP WEAPONS AS YOU GO,"
360 PRINT@160,"BUT MAY HAVE TO PUT SOME DOWN."
362 PRINT@192,"SOME WEAPONS ARE MORE EFFECTIVE"
364 PRINT@224,"THAN OTHERS AGAINST CREATURES "
366 PRINT@256,"YOU MAY MEET. YOU GET POINTS "
368 PRINT@288,"FOR CREATURES YOU KILL. HIT"
370 PRINT@320,"ENTER TO BEGIN. GOOD LUCK!"
371 INPUT A$
375 W(1)=7:W(2)=20
376 '20 IS NO WEAPON CARRIED
380 A(PX,PY)=0
390 CLS
400 PRINT"YOU ARE IN A DARK PASSAGE."
410 PRINT
415 IFA(PX.PY)<0 THEN 3000
420 N=A(PX.PY-1)
430 S=A(PX.PY+1)
440 E=A(PX+1,PY)
450 W=A(PX-1,PY)
455 LX=PX:LY=PY
460 IF N>1  AND N<7 OR S>1 AND S<7 OR E>1 AND E<7 OR W>1 AND W<7
 THEN 510
495 LX=PX:LY=PY
500 GOTO520
510 PRINT"THERE IS A SOUND NEARBY"
515 PRINT
520 PRINT:PRINT"WHICH DIRECTION DO YOU GO?"
530 IF N=1 THEN 550
540 PRINT"NORTH-ENTER 1"
550 IF S=1 THEN 570
560 PRINT"SOUTH-ENTER 2"
570 IF E=1 THEN 590
580 PRINT"EAST -ENTER 3"
590 IF W=1 THEN 610
600 PRINT"WEST -ENTER 4"
610 INPUT D:IF N=1 AND D=1 OR S=1 AND D=2 OR E=1 AND D=3 OR W=1
AND D=4 THEN 610
620 ON D GOTO 650,670,690,710
630 PRINT"INVALID CHOICE-REENTER"
640 GOTO610
650 PY=PY-1
660 GOTO720
670 PY=PY+1
680 GOTO720
690 PX=PX+1
700 GOTO720
710 PX=PX-1
720 IF A(PX,PY)=-1 THEN 3000
721 '3000 IS WIN ROUTINE
725 IF A(PX.PY)<2 THEN 390
729 IF A(PX.PY)>1 AND A(PX.PY)<7 THEN 1080
730 CLS
740 PRINT@0,"YOU ARE PRESENTLY CARRYING "
745 FOR I=1TO2:IFI=2ANDW(2)<>20 THEN PRINT@64,"AND ";
746 IF I=2 AND W(2)=20 THEN 840
750 ON(W(I)-6) GOSUB5000.5010,5020,5030,5040,5050,5060
840 NEXTI
850 PRINT
855 'WEAPONS P/U ROUTINE
860 PRINT:PRINT"IN THIS PLACE YOU FIND "
870 ON A(PX.PY)-6 GOSUB 5000.5010,5020,5030,5040,5050,5060
880 PRINT:PRINT:INPUT"WILL YOU PICK IT UP (Y OR N)";A$
890 IF A$="Y" THEN 920
900 IF A$="N" THEN 1030
910 GO TO 880
920 IF W(1)=20 OR W(2)=20 THEN 1040
930 PRINT:PRINT"WHAT DO YOU WISH TO LEAVE?"
940 ON (W(1)-6) GOSUB 5000.5010,5020,5030,5040,5050,5060
945 PRINT"-1"
950 ON (W(2)-6) GOSUB 5000.5010,5020,5030,5040,5050,5060
955 PRINT"-2"
960 INPUT A
970 IF A=1 THEN 1000
980 IF A=2 THEN 1020
990 PRINT"INVALID":GOTO960
1000 G=A(PX,PY):A(PX.PY)=W(1):W(1)=G:G=0
1010 GOTO1030
1020 G=A(PX.PY):A(PX.PY)=W(2):W(2)=G:G=0
1030 GOTO390
1040 IF W(1)<>20 THEN 1060
1045 W(1)=A(PX.PY):A(PX,PY)=0
```

Listing continued

DRM in line 19. The data sequence is first creature, effectiveness of all weapons in order, second creature, effectiveness of all weapons, and so on.

Lines 20, 22, 30, and 40 tell you the value of each room element and identify some variables. Line 25 restores the data because execution is transferred to line 11 if you want to play again. You can pick up the prompt in line 12. If you don't mind a screen full of garbage while the DRM chart is read, omit line 25 and change line 11 to line 60 and the 11 in line 8020 to 60.

Lines 70–76 reset the cave to a big empty room. Lines 110–170 put up the walls in the cave, while lines 172–186 surround the cave with the great outdoors. Reach this area and you've escaped.

Lines 188–230 randomly locate the creatures in the rooms, while lines 240–265 locate the player's starting position in the cave. Lines 270–330 locate the weapons in the cave, taking care not to put them with creatures.

Lines 350–375 give the player some background and start you out with a knife, while line 380 guarantees that you start the game in an empty room. Lines 390–410 tell you where you are, while line 415 determines whether you've escaped. Lines 420–450 determine your surroundings while line 455 saves your current location.

Line 460 determines if you're adjacent to a creature and gives the warning in lines 510 and 515 if you are.

Lines 520–600 determine the directions in which you can move and line 610 allows you to enter your move and checks it for feasibility. Lines 620 and 650–710 implement your move, while lines 630 and 640 prevent the entering of numbers not recognized as directions.

Line 720 checks to see if you've escaped, while line 725 checks to see that you're in an empty room. If so, the program is routed to line 390. Line 729 jumps to the creature-attack routine if you've entered a room inhabited by one.

Line 730 is the beginning of the weapons routine. The program defaults to line 730 if you haven't escaped, entered an empty room, or found a creature. Lines 740–840 list weapons you are carrying, while lines 855–910 allow you to pick up the weapon you've found. Lines 920–1030 keep you from carrying too many weapons and allow you to leave one behind. If you're not already carrying two, lines 1040–1070 allow you to pick up the weapon.

Line 1080 begins the creature-attack routine. Lines 1090–1100 identify creatures while 1110–1155 remind you what

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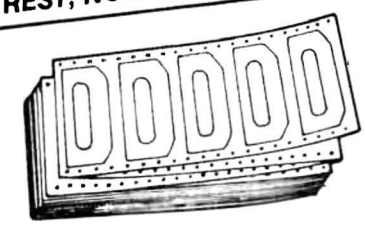

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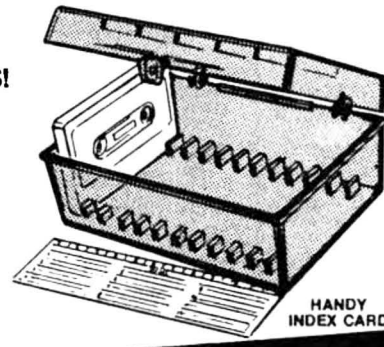

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Listing continued

```
1050 GOTO390
1060 W(2)=A(PX,PY):A(PX,PY)=0
1070 GOTO390
1080 'CREATURE ATTACK ROUTINE
1090 CLS:PRINT"YOU HAVE ENTERED A ROOM WITH"
1100 ON A(PX,PY)-1 GOSUB 5070,5080,5090,5100,5110
1110 PRINT:PRINT"YOU ARE ARMED WITH "
1115 IF W(1)=20 AND W(2)=20 THEN PRINT "NOTHING!"
1120 IF W(1)=20 THEN 1150
1125 ON W(1)-6 GOSUB 5000,5010,5020,5030,5040,5050,5060
1130 IF W(1)=20 OR W(2)=20 THEN 1150
1140 PRINT" AND ";
1150 IF W(2)=20 THEN 1160
1155 ON W(2)-6 GOSUB 5000,5010,5020,5030,5040,5050,5060
1160 PRINT:INPUT"WILL YOU ATTACK OR RUN (A OR R)";A$
1170 IF A$="R" THEN 1200
1180 IF A$="A" THEN 1300
1190 PRINT"INVALID":GOTO1160
1200 'RUN ROUTINE
1220 RN=RND(6)
1225 D=0
1235 'D=1 -YOU'RE DEAD,RUN=PROBABILITY,LX,LY=LAST PX,PY
1240 IF A(PX,PY)=2 AND RN<4 THEN D=1
1245 IF A(PX,PY)<>2 AND RN<2 THEN D=1
1250 IF D=0 THEN 1270
1260 CLS:FOR I=1 TO 16:PRINT"TOO SLOW-YOU'RE DEAD":NEXT I
1262 FORI=1TO500:NEXTI
1265 GOTO8000
1270 PX=LX:PY=LY
1280 CLS:PRINT"YOU RUN BACK THE WAY YOU CAME":FORI=1TO1000:NEXTI
1290 GOTO390
1300 'ATTACK ROUTINE
1302 IF W(1)=20 AND W(2)=20 THEN PRINT"YOU HAVE NO WEAPONS-YOU M
UST RUN":GOTO1160
1310 CLS
1315 FOR I=1TO2
1317 IF W(I)=20 THEN 1340
1320 ONW(I)-6 GOSUB5000,5010,5020,5030,5040,5050,5060
1330 PRINT"-";I
1340 NEXTI
1350 PRINT:INPUT"WHICH WEAPON WILL YOU USE";A
1355 'AW=ATTACKING WEAPON
1360 IF A=1  THEN AW=W(1)
1370 IF A=2 THEN AW=W(2)
1375 GOTO1390
1380 PRINT"INVALID":GOTO1315
1390 RL=RND(20)+F(A(PX,PY)-1,AW-6)
1400 IF RL<5 THEN1620
1410 IF RL>4 AND RL<9 THEN1600
1420 IF RL>9 AND RL<13 THEN 1540
1430 IF RL>12 AND RL<17 THEN 1500
1440 CLS
1450 FORI=1TO16
1460 PRINT"YOU DIED FIGHTING....."
1470 NEXTI
1480 FORI=1TO1000:NEXTI
1490 GOTO8000
1500 CLS:PRINT"YOU LOST BOTH WEAPONS-RUN!!!"
1510 W(1)=20:W(2)=20
1520 FORI=1TO1000:NEXTI
1530 GOTO390
1540 CLS:PRINT"YOU LOSE YOUR ATTACK WEAPON-RUN!"
1545 FORI=1TO1000:NEXTI
1550 IF W(1)=W(2) THEN 1570
1560 IF AW=W(1) THEN W(1)=20
1570 IF AW=W(2) THEN W(2)=20
1590 GOTO390
1600 CLS:PRINT"THE BATTLE'S A DRAW..."
1605 FORI=1TO1000:NEXTI
1610 GOTO1160
1620 CLS
1630 PRINT"SUCCESS-YOU'VE KILLED IT!!!!!!"
1640 IF A(PX,PY)=2 OR A(PX,PY)=3 THEN KP=KP+5
1650 IF A(PX,PY)=4 THEN KP=KP+2
1660 IF A(PX,PY)=5 THEN KP=KP+4
1670 IF A(PX,PY)=6 THEN KP=KP+3
1675 A(PX,PY)=0
1677 FORI=1TO1000:NEXTI
1680 GOTO390
3000 CLS
3005 FORI=1TO10
3010 PRINT"YOU'VE ESCAPED ALIVE!!!"
3020 FOR N=1TO75
3030 NEXTN
3040 CLS:FORN=1TO75:NEXTN
3050 NEXTI
3060 GOTO8000
4000 'ESCAPE PATH ROUTINE
```

Listing continued

your weapons are. Lines 1160–1190 let you choose to fight or run.

There are some interesting strategies possible here. If you fight and don't succeed in killing the creature (there are three other possibilities—you could fight to a draw or lose one or both weapons), you can run past him. This is important because there is no other way through a creature's room except by killing it.

You may find yourself trapped by creatures and looking for a way out. Running away is also not a guaranteed escape. Running exposes you to the possibility of being attacked from behind.

"You can attack with only one weapon at a time. If your combat results in a draw, you can change your choice of weapon."

While these odds are usually in your favor, I suggest you don't try running from wizards too often.

Lines 1220–1265 determine if you were killed while running and end the game if you were. Lines 1270–1290 move your current position if your run was successful. Running always takes you back the way you came. In order to pass through a creature's room, as mentioned earlier, it is necessary for you to do battle with it.

Should you be so brave, line 1300 begins the attack routine. Line 1302 prevents suicide attacks with no weapons. Lines 1310–1380 allow you to select your weapon and make sure your choice is valid. You can attack with only one weapon at a time. If your combat results in a draw, you can change your choice of weapon. Lines 1390–1430 are the area where the computer decides if you live or die.

Line 1390 adds the DRM to a random number between 1 and 20. Lines 1400–1430 decide what happens to you as a result. Lines 1440–1490 are used if you are killed, while 1500–1530 are used if you lose both weapons. Lines 1540–1590 are employed if you lose only the weapon you are wielding, 1600–1610 are for a draw, and 1630–1680 reward your expertise as a warrior.

Listing continued

```
4010 'TX,TY=TEST POSITIONS, TR=TEST RANDOM
4020 TR=RND(8)
4025 TX=PX:TY=PY
4030 ON TR GOSUB 4500.4550,4600,4650,4700,4750,4800,4850
4040 RETURN
4500 IF A(TX,TY)=-1 THEN RETURN
4510 IF A(TX-1,TY)<>0 THEN TX=TX-1:GOTO4500
4520 IF A(TX,TY+1)<>0 THEN TY=TY+1:GOTO4500
4525 T1=RND(2)
4530 IF T1=1 THEN 4540
4535 TX=TX-1:A(TX,TY)=0:GOTO4510
4540 TY=TY+1:A(TX,TY)=0:GOTO4510
4550 IF A(TX,TY)=-1 THEN RETURN
4560 IF A(TX-1,TY)<>0 THEN TX=TX-1:GOTO4550
4570 IF A(TX,TY-1)<>0 THEN TY=TY-1:GOTO4550
4575 T1=RND(2)
4580 IF T1=1 THEN 4590
4585 TX=TX-1:A(TX,TY)=0:GOTO4560
4590 TY=TY-1:A(TX.TY)=0:GOTO4560
4600 IF A(TX,TY)=-1 THEN RETURN
4610 IF A(TX,TY+1)<>0 THEN TY=TY+1:GOTO4600
4620 IF A(TX-1,TY)<>0 THEN TX=TX-1:GOTO4600
4625 T1=RND(2)
4630 IF T1=1 THEN 4640
4635 TY=TY+1:A(TX,TY)=0:GOTO4610
4640 TX=TX-1:A(TX,TY)=0:GOTO4610
4650 IF A(TX,TY)=-1 THEN RETURN
4660 IF A(TX,TY+1)<>0 THEN TY=TY+1:GOTO4650
4670 IF A(TX+1,TY)<>0 THEN TX=TX+1:GOTO4650
4675 T1=RND(2)
4680 IF T1=1 THEN 4690
4685 TY=TY+1:A(TX,TY)=0:GOTO4660
4690 TX=TX+1:A(TX,TY)=0:GOTO4660
4700 IF A(TX,TY)=-1 THEN RETURN
4710 IF A(TX+1,TY)<>0 THEN TX=TX+1:GOTO4700
4720 IF A(TX,TY+1)<>0 THEN TY=TY+1:GOTO4700
4725 T1=RND(2)
4730 IF T1=1 THEN 4740
4735 TX=TX+1:A(TX,TY)=0:GOTO4710
4740 TY=TY+1:A(TX,TY)=0:GOTO4710
4750 IF A(TX,TY)=-1 THEN RETURN
4760 IF A(TX+1,TY)<>0 THEN TX=TX+1:GOTO4750
4770 IF A(TX,TY-1)<>0 THEN TY=TY-1:GOTO4750
4775 T1=RND(2)
4780 IF T1=1 THEN 4790
4785 TX=TX+1:A(TX,TY)=0:GOTO4760
4790 TY=TY-1:A(TX,TY)=0:GOTO4760
4800 IF A(TX,TY)=-1 THEN RETURN
4810 IF A(TX,TY-1)<>0 THEN TY=TY-1:GOTO4800
4820 IF A(TX+1,TY)<>0 THEN TX=TX+1:GOTO4800
4825 T1=RND(2)
4830 IF T1=1 THEN 4840
4835 TY=TY-1:A(TX,TY)=0:GOTO4810
4840 TX=TX+1:A(TX,TY)=0:GOTO4810
4850 IF A(TX,TY)=-1 THEN RETURN
4860 IF A(TX,TY-1)<>0 THEN TY=TY-1:GOTO4850
4870 IF A(TX-1,TY)<>0 THEN TX=TX-1:GOTO4850
4875 T1=RND(2)
4880 IF T1=1 THEN 4890
4885 TY=TY-1:A(TX,TY)=0:GOTO4860
4890 TX=TX-1:A(TX,TY)=0:GOTO4860
5000 PRINT"A KNIFE";:RETURN
5010 PRINT"A MAGIC STAFF";:RETURN
5020 PRINT"A BROAD SWORD";:RETURN
5030 PRINT"A DIAMOND OF LIFE";:RETURN
5040 PRINT"FIRE OF THE DEPTHS";:RETURN
5050 PRINT"A GREAT AX";:RETURN
5060 PRINT"A LASER SWORD";:RETURN
5070 PRINT"A WIZARD.":RETURN
5080 PRINT"A GIANT SPIDER.":RETURN
5090 PRINT"A TROLL.":RETURN
5100 PRINT"ONE OF THE UNDEAD.":RETURN
5110 PRINT"A GREAT BEAR.":RETURN
8000 GOSUB 8050
8005 PRINT@352,"KILL POINTS-";KP
8010 PRINT:PRINT:INPUT"TRY IT AGAIN (Y OR N)";A$
8020 IF A$="Y" THEN 11
8030 IF A$="N" THEN END
8040 GOTO8010
8050 CLS0
8060 FORX=0TO21
8070 FORY=0TO21
8080 IF A(X,Y)<>1 THEN SET(2*X,Y,1):SET(2*X+1,Y,1)
8090 NEXTY,X
8095 FOR G=1TO30
8100 SET(2*PX,PY,1):SET(2*PX+1,PY,1):FORI=1TO50:NEXTI:RESET(2*PX
,PY):RESET(2*PX+1,PY):FORI=1TO50:NEXTI
8105 NEXTG
8110 RETURN
```

Lines 3000–3060 inform you that you've escaped the cave. Line 4000 begins the escape-path routine, which guarantees that there's a way out of the cave. Line 4025 transfers the starting position to a variable that can be moved about without influencing the game. The eight subroutines are identical, except for the directions chosen.

The first lines of the subroutines check to see if the test probe (TX and TY) has escaped the cave. If it has, the routine has found a way out and returns to the beginning of the program.

The second line checks to see if movement in a particular direction (which I call the primary direction) is possible. If it is, the probe is moved to this location and the routine repeats. If not, the probe checks a secondary direction at right angles to the primary direction in the third line.

Since there are four primary directions, and two secondary directions for each (if doubling back were allowed, the routine would loop forever, going back and forth), there are eight possible routines. If the secondary direction is clear, the probe is moved there and the routine is restarted. If not, the routine makes a random choice in the fourth to seventh lines and clears either the primary or secondary direction. This is repeated until the probe reaches the outside.

Lines 5000–5110 store the names associated with the values of the various rooms. Line 8000 sends the program to lines 8050–8110. They draw the cave and place a blinking marker on your ending location.

Line 8005 tells you how many points you have accumulated for killing creatures, and lines 8010–8040 ask if you'd like to continue.

Operation

Cavehunt is easy to play. Load it into your CoCo and type RUN. There will be a 30-second delay as the cave is designed and creatures and weapons are placed.

You should choose a primary and secondary direction. Try to go in the primary direction and use the secondary if necessary. If both are blocked, try to double back and go around the obstacle. ■

Charles Levinski is employed by the Hecon Corp., of Tinton Falls, NJ. For more information, write to him at 10 Southside Ave., South River, NJ 08882.

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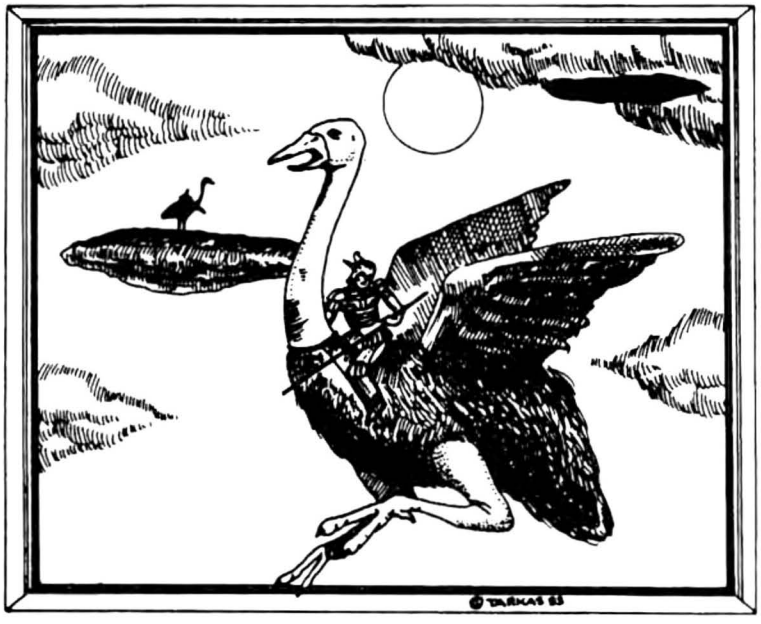

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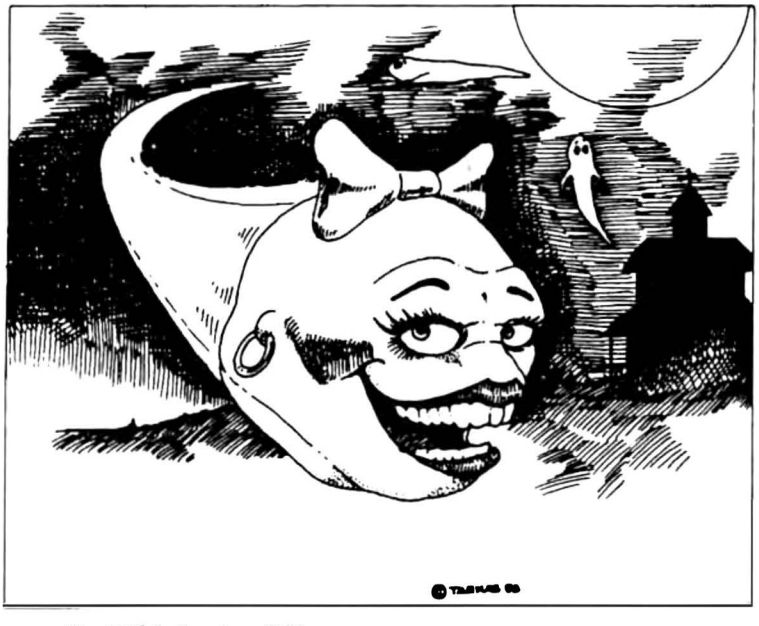

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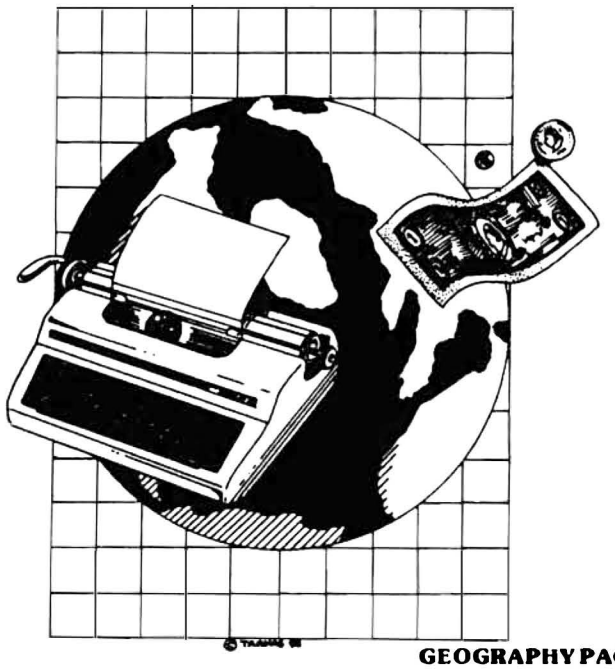

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BY RALPH TENNY

TAPE RELIABILITY

If you've ever had trouble loading cassettes, you'll want to read this author's sage advice.

Due to the high cost of disk systems for the Color Computer, many users continue to use tape for off-line data storage. Unfortunately, a number of users have experienced various troubles with Color Computer cassette data storage.

After many years of using cassette data storage exclusively, I experienced relatively few problems with my Color Computer for three reasons. First, I had developed proven work habits and techniques. Second, I used the recorder recommended by Radio Shack for use with the Color Computer. Finally, I had learned a great deal about buying tape for data storage, and my past experience helped me spot marginal tape operation before I had any serious problems.

My first inkling of pending trouble came when I began to use my Color Computer for generating and editing text—rudimentary word processing, if you will. Although I had many good tapes that had worked well with other computers, the situation was somewhat different when I began manipulating text and generating new text. First, word-processing-type activities generate very large files, and require much tape to store the resulting files. Suddenly, the tapes that had served so well were no longer reliable. With many computer systems, one dropout makes the rest of the tape file inaccessible. As a result, you must retype the rest of the file if you failed to make a back-up tape.

The problem with my tried-and-true tapes was that I was now using hundreds of inches of tape in a single pass instead of the 10 or 15 inches of tape required to store Assembly-language programs.

As soon as I realized the problem, I decided to see how much of it I could short-circuit.

Factors Affecting Reliability

There are many causes of poor reliability in audio recording of digital data. First, the equipment must be in good condition. This implies more than just good mechanical condition. Do not ignore the manufacturer's instructions about cleaning the tape heads, capstan, and pinch roller. Magnetic tape gradually loses some of its oxide coating, and this material accumulates anywhere the tape touches. When the oxide gets on the read/record heads, it prevents good contact between the tape and the head. Thus, during the recording process, the recorded signal is reduced by poor contact. Then, during playback, poor contact further reduces the already low signal.

Another recording problem develops when the record heads gradually become partially magnetized. This has an adverse effect on the record/playback sequence, and results in poor and distorted signals. So, it is important to demagnetize the read/record heads periodically to prevent signal distortion by residual magnetism in the heads.

The next item to consider is the medium itself—the magnetic tape. If the tape has an uneven oxide thickness caused by either wear (excessive use) or from poor quality control during manufacture, the signal coming off the tape will not be of uniform quality, and may be unreadable at some point on the tape. This condition, known as dropout, can cause the tape data to be lost.

Finally, good recording techniques and standardized signal levels will aid the recording process immeasurably. One of the most often overlooked items of procedure is the leader. Tapes that have a clear leader at each end have two problems: First, the leader will not accept a signal, so the tape must be advanced enough to be sure all the signal is recorded on oxide. Second, the leader is spliced to the tape, and this joint is sel-

System Requirements

Cassette System
32K RAM (Optional)

dom perfectly smooth. As a result, the first few turns of tape that wind on top of the splice may be wrinkled as they cross the splice. A wrinkle may not be pulled tightly enough across the head, resulting in poor contact and a potential area of dropouts. Finally, if the cassette is not properly protected from dust and dirt, the ends of the tape may get dust particles on the active tape. These dust particles can also separate the tape from the head and cause dropouts. So, keep those tapes clean, move well into the tape to begin recording, and protect the tape from damage.

Types of Tape Signals

Other important factors in the audio recording of digital data are the type of signal used and the method of data recovery. In general, one of three types of recording/playback is used. The first, used by the TRS-80 Model I, is illustrated in Fig. 1. This is pulse-position encoding, and the data is interpreted as a logic 1 or logic 0 depending on whether the intermediate pulse is present.

The second method (one of the most popular) is shown in Fig. 2. Here, a logic 0 can be represented by one or more cycles of some frequency such as 1,200 Hz, while a logic 1 would be represented by twice as many cycles of 2,400 Hz. The data is recovered by a circuit known as a phase-locked loop (PLL). The PLL is resonant at one of these frequencies, and thus indicates the present value. Note that in Figs. 1 and 2, a bit cell (length of time for one bit) is the same for a 1 and a 0.

In Fig. 3, another method of encoding/recovery is shown. In this case, a logic 0 is one cycle of 1,200 Hz, and a logic 1 is one cycle of 2,400 Hz. Thus, a logic 0 is twice as long as a logic 1. In this method, the bit value (1 or 0) is defined by the length of half a bit cell, or rather the time between zero crossings of each bit waveform. This last scheme is the one used by the TRS-80 Color Computer.

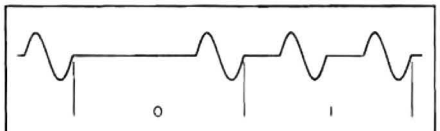


Fig. 1. Tape recording format of the TRS-80 Model I computer, which uses pulse position encoding. If there is a pulse in the center of the bit cell, that bit is a logic 1.

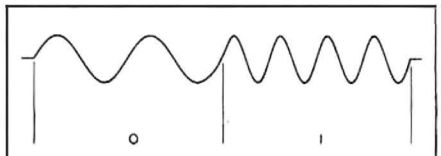


Fig. 2. Dual tone recording, where a bit is represented by a given frequency within the bit cell. Signal recovery is usually via a phase-locked loop circuit.

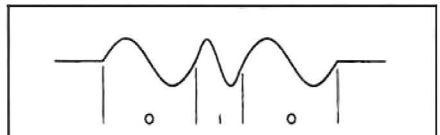
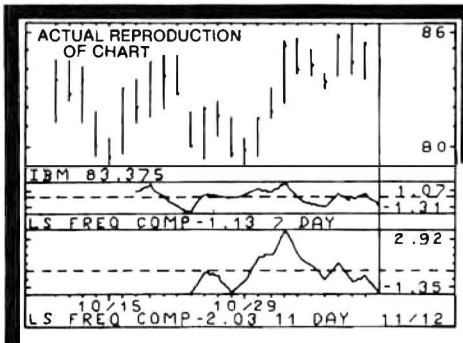


Fig. 3. Recording signal of the TRS-80C Color Computer. A "0" bit cell is twice as long as a "1" bit cell, and the signal is decoded by measuring time between zero crossings of the signal.

Tape Recorder Evaluation

Although one way to evaluate your equipment would be to record and load a number of programs, this will not give much useful information. For example, if this test works, how much margin have you? Can things go wrong before you have a problem, or are you halfway off the cliff without knowing it? You need to make carefully controlled tests to determine just how good (or poor) your equipment is.

Begin by making test recordings of pure tones; if you don't have a signal generator and an oscilloscope, try to borrow these instruments, since a proper evaluation will be very difficult without them. Begin by making a series of recordings of a 1,000-Hz tone, using a different input level on each recording. Since most modern tape recorders (except very expensive ones) have an automatic level control (ALC) circuit as part of the input amplifier, many of these test recordings will give similar results. However, by making the recordings and watching the playback on the oscilloscope, you will find some low level that gives a noisy or unstable playback, and a high input level that gives a distorted playback signal. Between these two extremes, any recording level should yield a tape that can be played back at several different volume levels with a clean, steady, and reasonably noise-free signal showing on the oscilloscope. If you can-



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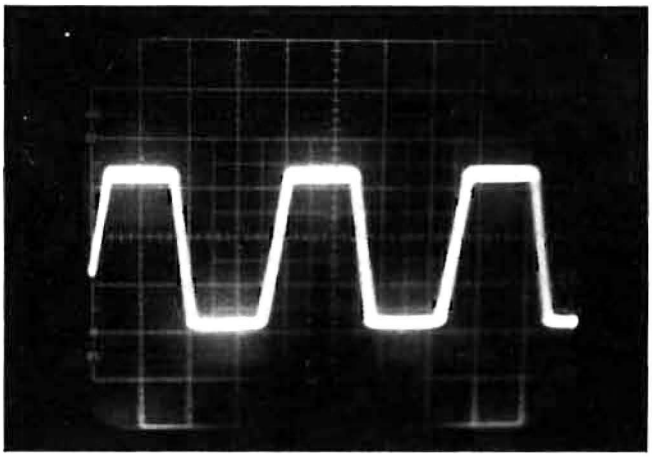

Photo 1. Full-volume output from a good tape on a properly-functioning tape recorder. Signal was recorded from the source shown in Photo 2.

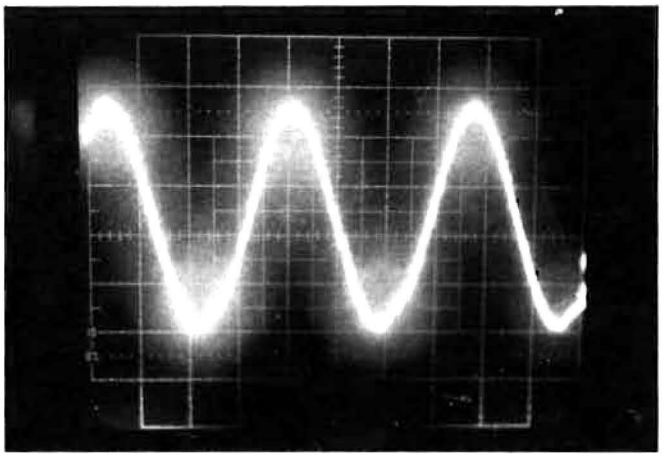

Photo 2. A synthesized sine wave from the Color Computer—an all-ones signal produced under control of TAPTST (Listing 1).

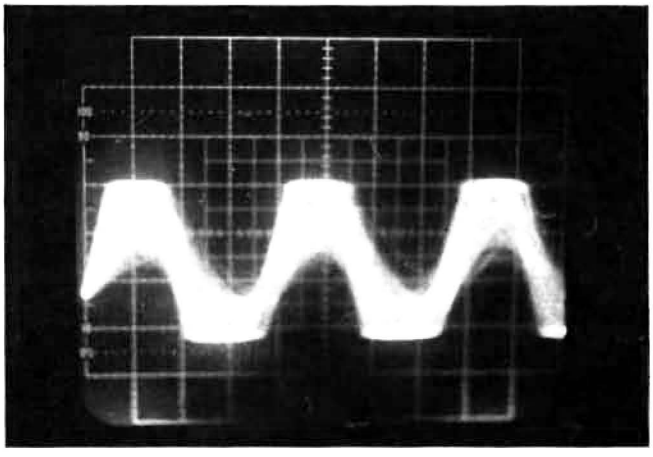

Photo 3. A signal produced by a good recorder and good tape in an erratic-running cassette. Note the signal amplitude variations and timing jitter. This signal was recorded from the source shown in Photo 2.

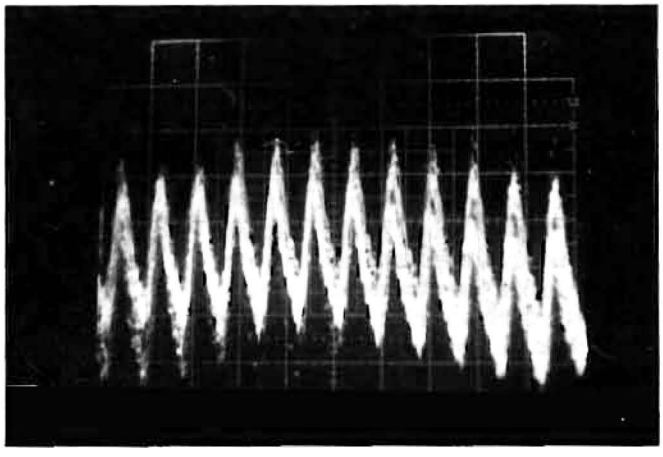

Photo 4. An example of a weak, erratic signal produced by a recorder needing cleaning. This signal was also recorded from the source shown in Photo 2, but the output amplitude was 1/8 as much as the signal in Photo 1.

not achieve this result, the recorder must be repaired or replaced. Conduct this test with two or three different tapes to be sure that unsatisfactory results are not caused by poor tape. You probably will notice some tapes that give better results; save these tapes for future testing.

You should be aware of the causes of poor response that you charted in the tests described above. If the input level is too low, poor playback signals will be caused by nonlinearity and noise in the ALC circuit. Upper-limit distortion is caused by too much signal for the ALC to handle. If the ALC circuit and the rest of the recording circuitry is working properly, the playback should be clean and essentially undistorted, as long as the volume control is set low enough to avoid waveform clipping.

Once the above tests are complete, and you have good tape on a properly functioning recorder, one more test is essential. Play back one of the test tapes while monitoring the output on the oscilloscope. Gradually increase the volume setting until the waveform clips, and then continue increasing the volume setting. The clipping should be uniform. Under some circumstances the waveform may distort with a fold-over as shown in Fig. 4. If this happens, note the volume setting so that you never exceed a setting at which this distortion occurs.

The previous remarks apply directly to the Color Computer, because the recovery circuitry in the computer cannot be overloaded; it can handle any input voltage that does not exceed the breakdown voltage of any of the internal circuit elements. It is important that the waveform clipping be uniform; otherwise, the zero-crossing times of the input signal will be skewed so much that the computer cannot interpret the signals correctly. Similarly, fold-over distortion will also skew the zero-crossing times. Both types of distortion are less important for computers such as the KIM-1, which use a PLL data-recovery circuit. Other computers have similar exemptions. However, some computers are sensitive to the input level (too large a signal can overload the data-recovery circuit) as well as being unable to decode very low signals.

Fig. 4. Foldover distortion caused by nonlinearity of the recorder output drivers. This type of signal must be eliminated by reducing the volume setting of the recorder until the distortion stops.

Evaluation of Magnetic Tape

One aspect of magnetic-tape performance has been neglected until now—mechanical smoothness. You should

automatically reject any tape that chatters, howls, or makes any unusual sound during rewind and fast-forward operation. Not only that, if more than an occasional tape from any one source is noisy, save your money for tapes from sources that sell mechanically quiet cassettes. The dragging that produces unusual noise is still present during normal recording and playback, and will be a source of jitter in the tape movement. Output from such a tape is invariably more erratic than from smooth-running tapes of similar quality. Worse, any change in the condition of such a cassette is likely to be toward more erratic operation, and you may find you can't load a tape that used to work satisfactorily.

There is only one satisfactory method of qualifying tapes—verifying that they have no dropouts—and that is to test every bit position on the section of tape that is to be used for recording. It is possible, though tiring and time-consuming, to record a test tone from one end of the tape to the other and watch the playback on a scope. By the time you have qualified four or five tapes, you will be ready to take chances with unqualified tapes.

It is possible to let your computer check the tapes for you, provided your computer has built-in tape controls. The Color Computer qualifies nicely, and has one of the best cassette-recording and playback sections of any now available. The record signal (Fig. 2) is generated by an on-board digital/analog converter that synthesizes single sine-wave cycles—1,200 Hz for logic 0 and 2,400 Hz for logic 1.

The test tone generated by my Color Computer consists of a continuous string of 1's. Although the signal is not perfect, it is very good for the purpose. This test signal was produced by the Program Listing, and utilizes some of the internal ROM routines.

Note that the listing begins at address $7000—I have expanded my Color Computer to 32K memory. The section from $7000-$700B is a forever loop that produces the test tone. To stop the tone, hit reset. The rest of the program reads the tape output, keeps a continuous record of the time between successive zero crossings of the test tone, and stops the tape recorder if a certain maximum variation is exceeded. This makes it possible to record a test tape, then play it back while the computer monitors the output. Both parts of the test can be left unattended—simply start the test at $7000 with the recorder set to record. Since most modern machines have an auto shutoff, you can come back later, rewind the tape, start the program at $700C, and start the playback. Once again, you can walk away without missing any dropouts on the tape—the computer will shut down the test and wait for you to record the location of the dropout and restart the test.

As shown, the program implements a severe test of both tape and recorder. The byte at $7058 (normally $05) governs the sensitivity of the test. This con-

```
----   PAGE  001 TAPTST
00010                          NAM   TAPTST
00015                          OPT   SO
00020  7000                    ORG   $7000
00025        * THIS PROGRAM WRITES A PATTERN TO CASSETTE TAPE, THEN WILL DECODE
00030        * THE PATTERN, CHECKING FOR TAPE ERRORS AND STOPPING ON ERRORS.
00035        * THE WRITE FUNCTION IS AN ENDLESS LOOP; STOP BY USING RESET.
00040        *
00045  7000 1A  50      CASLD  ORCC  #$50     DISABLE INTERRUPTS
00050  7002 BD  A7CA           JSR   $A7CA     TURN ON MOTOR
00055  7005 86  FF      OUT    LOA   #$FF     ALL ONES PATTERN
00060  7007 BD  A82A           JSR   $A82A     WRITE CHARACTER
00065  700A 20  F9             BRA   OUT      LOOP FOREVER
00070        *
00075        * THIS SECTION READS BACK THE PATTERN AND TIMES THE
00080        * ZERO CROSSINGS.  TAPE SPEED VARIATIONS, LOW RECORD
00085        * LEVELS AND BAD TAPE SKEW THE ZERO CROSSING TIMES.
00090        * IF THE TIMES VARY MORE THAN A SELECTED AMOUNT, THE
00095        * CASSETTE MOTOR IS SHUT OFF TO ALLOW THE OPERATOR
00100        * TO DETERMINE THE SERIOUSNESS OF THE DEFECT.
00105        *
00110  700C 1A  50      CASRD  ORCC  #$50     OISABLE INTERRUPTS
00115  700E BD  A7CA           JSR   $A7CA     TURN ON MOTOR
00120  7011 20  04             8RA   SETUP
00125  7013 BD  A7E9    STOP   JSR   $A7E9     TURN MOTOR OFF
00130  7016 39                 RTS            RETURN TO MONITOR
00135  7017 7F  7060    SETUP  CLR   COUNT1    SET UP BUFFERS
00140  701A 7F  7061           CLR   COUNT2
00145  7010 86  20             LOA   #32      SKIP 32 CHARACTERS
00150  701F B7  7062           STAA  SKIP
00155  7022 5F           TEST   CLRB           WIDTH COUNTER
00160  7023 B6  FF20           LOA   $FF20     READ PORT
00165  7026 46                 RORA           GET BIT INTO CARRY
00170  7027 25  10             BCS   ONE      IS IT A LOGIC ONE?
00175  7029 5C           ZERO   INCB           NO, BIT = 0
00180  702A B6  FF20           LOA   $FF20     READ NEXT BIT
00185  7020 46                 RORA           GET BIT
00190  702E 24  F9             BCC   ZERO     TEST IT
00195  7030 FB  7060           ADDB  COUNT1    ADD TO PREVIOUS COUNT
00200  7033 56                 RORB           DIVIDE BY TWO
00205  7034 F7  7060           STB   COUNT1    SAVE RESULT
00210  7037 20  0E             BRA   SPIN     SKIP 32 CHARACTERS
00215  7039 5C           ONE    INCB           BIT = 1
00220  703A B6  FF20           LOA   $FF20     READ NEXT BIT
00225  7030 46                 RORA           GET BIT
00230  703E 25  F9             BCS   ONE      TEST IT
00235  7040 FB  7061           ADDB  COUNT2    ADD TO PREVIOUS COUNT
00240  7043 56                 RORB           DIVIDE BY TWO
00245  7044 F7  7061           STB   COUNT2    SAVE RESULT
00250  7047 B6  7062    SPIN   LOA   SKIP     GET COUNT OF BITS TO SKIP
00255  704A 27  03             BEQ   COUNT    SAVE RESULT IF COUNT ZERO
00260  704C 7A  7062           DEC   SKIP     OTHERWISE, COUNT DOWN
00265  704F B6  7060    COUNT  LOA   COUNT1    GET FIRST PERIOO
00270  7052 B0  7061           SUBA  COUNT2    COMPARE WITH SECOND
00275  7055 2B  06             BMI   FIX      NEGATIVE, COMPLEMENT IT
00280  7057 81  05      TRY    CMPA  #$05      BIG DIFFERENCE?
00285  7059 23  C7             BLS   TEST     NO, KEEP TRYING
00290  705B 20  B6             BRA   STOP     YES, STOP
00295  7050 40           FIX    NEGA           MAKE IT POSITIVE
00300  705E 20  F7             BRA   TRY      THEN TEST IT
00305  7060 0001       COUNT1 RMB   1
00310  7061 0001       COUNT2 RMB   1
00315  7062 0001       SKIP   RMB   1
00320       7000               END


SYMBOL TABLE :

CASLD =7000  OUT   =7005  CASRD =700C  STOP  =7013  SETUP =7017
TEST  =7022  ZERO  =7029  ONE   =7039  SPIN  =7047  COUNT =704F
TRY   =7057  FIX   =7050  COUNT1=7060  COUNT2=7061  SKIP  =7062

TOTAL ERRORS 00000
```

Program Listing

stant is a measure of the difference between successive signal zero crossings; a tape that runs end to end with no deviations greater than 05 is almost perfect. I have not made a detailed worst-case test, but have arbitrarily accepted tapes that run for most of their length with a test sensitivity of 7, and no dropouts that exceeded 8.

This last information can be gained by examining locations $7060 and $7061 and calculating the difference between the two values recorded there. Typical values that you find there on good tape are (for example) 0A and 10 (difference of 6). If you have a tape with a severe dropout, the numbers will be extreme—5 and 16, for example. Tape that has mild jitter with no imperfections in the oxide may show differences of 6–7; since I had excellent yield from my stock of tapes I have found to be good, my arbitrary test limit of 7 was good enough.

One of my colleagues at work indicated some skepticism over the reliability of this test. I proved to my own satisfaction the test's value by taking known bad tapes, recording the tape counter reading for each dropout, and repeating the test several times. I was satisfied when each dropout was located within one count on successive tests.

Two features of the program should be noted. First, the constant at $701E (normally $20) may need to be increased if your recorder is slow in getting started. This simply allows 32 (or more) zero crossings to be counted before beginning to test; otherwise, the program is too sensitive to minor variations in speed as the tape is coming up to speed. Long-term variations in speed are "averaged out" by the sections from $7030–$7036 and $7040–$7046. The circuit counts pass through a loop to measure the time between successive zero crossings; each count is added to the count from the previous pass, divided by two, and saved to "average" with the next count. In this fashion, all but very short-term variations in tape speed are allowed for.

One other method of tape testing with real computer signals can be effective also: Record pseudorandom number sequences with checksums and play back the tapes. Checksums taken over a very long section of tape (100 or more counts) would also constitute an extremely sensitive test. The drawback of this test is that the whole tape either passes or fails; I have several tapes that are marked with the tape counter values at the extreme ends of the good tape. If most of one side of a tape passed, I tested the back side of the tape and several times this yielded 150–250 counts of good tape, with the good section starting within 20 counts of the tape end. After thorough testing, each tape is marked with the good side (I never use both sides) and the counter values at the start and finish of the qualified section. One other thing I learned from this testing was that few tapes will work satisfactorily closer than five counts from the leader.

Although the operation of the test program has been explained, there are certain precautions that go along with the test program. First, clean and demagnetize the heads before beginning the testing, and repeat the cleaning every couple of tapes.

Tape Recorder Maintenance

I have already discussed most of the basics of recorder maintenance—frequent cleaning, demagnetizing the heads, and general cleaning. Many dealers sell small bottles of head-cleaning solution to be used, but denatured alcohol applied carefully with a cotton swab will work well. The most important thing is to be sure that no cotton lint from the cotton swab is left in the recorder, and that the heads are really clean. You should have a head demagnetizer and use it fairly often. Some demagnetizers are low-power devices, and it may not be obvious that they are working. If you have any doubt, bring the demagnetizer near the head with the play button depressed and you should hear a 60-Hz hum in the speaker if the demagnetizer is working.

Tape Erasing Procedure

Once you have qualified a tape and marked it for identification and to show the good area of tape, keep the tape in a dust cover until used. Once the data on a tape has been made obsolete, be sure to erase the tape. This is important enough for the serious computerist to own his own bulk eraser; the Radio Shack #44-232 is an excellent unit.

The erasing operation should be performed this way: Energize the eraser while holding the tape cartridge in contact with the base of the eraser, then slowly move the cassette straight away from the eraser. Only after the tape is over 18 inches away from the eraser should you de-energize the eraser. With this technique, the tape magnetization level is gradually reduced to zero flux, and if the eraser should be turned off while the line voltage is at a peak, the magnetic surge could leave the tape with a residual magnetic level.

Recording Techniques

I recommend the following recording sequence: Place the recorder in record mode with the cassette fully rewound, then allow the tape to advance to a count of 15 (try 10 or 15 seconds if you have no tape counter). Stop the recorder, but leave the controls set in record mode. Start the computer dump process and allow the dump to finish so the computer will turn off the tape. If you plan to record more data on the same tape, record the counter reading along with the starting counter reading and the name of the file. When a new file is added to the tape, advance the tape to about 10 counts past the end of the first file and begin recording at that location. As before, record starting- and ending-count values along with the file name. Finally, always rewind a tape to clear leader after use, to help minimize the chance of accumulating dust or dirt on the tape oxide.

It is advisable to keep an index record so that any given file can be located easily. Substitute time in seconds as measured with a stopwatch if you have no counter, but keep a record of the file location on the tape. Be sure to leave enough of an interrecord gap so that the tape can be positioned for playback with no chance of beginning the playback in the middle of a file.

Some mention was made above of tape movement between records. If you have the CTR-80A recorder sold with the Color Computer, fast forward and rewind operations bypass the computer control, but the play and erase functions do not. A simple bypass switch (Fig. 5) can be rigged so that any tape movement is possible even though the computer thinks it is in control. If you do not have a recorder with bypass operation, this same switch arrangement will solve the problem. ■

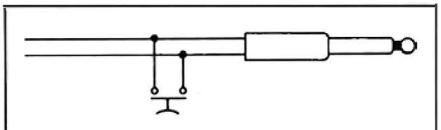

Fig. 5. A simple bypass switch circuit installed in the cassette motor control line allows any recorder to be operated in local mode for tape movement. A momentary switch is most convenient unless you are rewinding long tapes; in that case, use a toggle switch.

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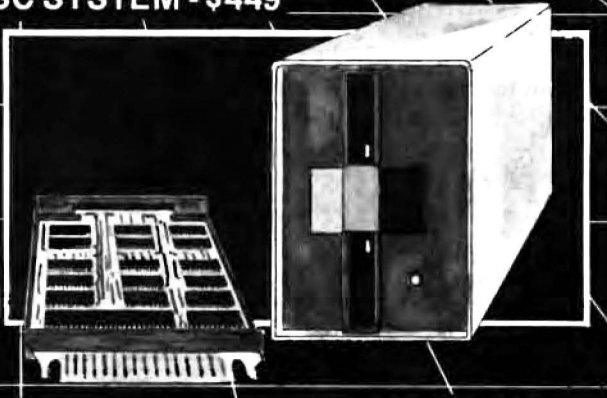

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BY JAMES BARBARELLO

DOCULIST/C

Do you have trouble reading your Basic listings? Here's a neat program that makes neat listings.

While Basic is an easy language to learn and use, its program listings are difficult to interpret. Since Basic allows multiple statements on a numbered line and (in most cases) doesn't care if you put spaces between words, a normal listing can look more like Greek than the King's English.

Doculist/C, a tape utility for Extended Color Basic machines with 16K or more of memory, lets you obtain an easy-to-read printout of any Basic program—including Doculist itself, as shown in Program Listing 1. In addition to detailing Doculist, this article will explain how the Color Computer stores and interprets Basic programs, and how you can merge programs, loading one on top of another.

Basic Line Storage

The Extended Basic command PMODE allows you to select one of five different modes of graphics resolution. There are eight "pages" (blocks) of memory in which graphics information can be defined. PCLEAR lets you reserve all or any portion of this memory for graphics storage, with any Basic program being stored after the last PCLEARed page. When you PCLEAR with a program in memory, the CoCo moves everything around to accommodate your demands for more or less graphics space.

Therefore, the starting address of a Basic program in memory varies. Memory locations 25 through 28 keep track of address information. If you PEEK(25), multiply the result by 256, and add the result of PEEK(26), you come up with a decimal address, which is the first byte of the resident program. You multiply the number in location 25 because it is the most-significant byte (MSB) of the address; since location 26 contains the least-significant byte (LSB), it needs no multiplier.

If you repeat this procedure with locations 27 and 28, you get the location of the end of the program plus two. These additional 2 bytes (both 0) represent the "next" line's address; the zero value indicates there are no more lines.

For example, if you PCLEAR four pages of memory, location 25 will contain a 30 and location 26 a 1. Since (30 × 256) + 1 = 7681, location 7681 is where to look for the start of a Basic program.

If you PCLEAR 4 with a program in memory, location 7681 will contain the MSB of the next program line's address, and the second location the LSB of the address. If location 7681 contains a 30 and location 7682 a 9, the next (second) program line starts at location 7689 (i.e., (30 × 256) + 9).

The following locations—in this case, 7683 and 7684—contain the MSB and LSB of the program line's number. If these are 1 and 4, for example, the line number would be 260 (i.e., (1 × 256) + 4). Succeeding bytes contain the ASCII codes of the characters contained in the line; if the line was 260 A=1, location 7685 would contain 65 (ASCII code for A).

Following this reasoning, you would think that location 7686 would contain 61, ASCII code for =. However, it contains 179. To conserve memory, Basic expressions (such as For, If, PMODE, +, and −) are represented by codes called tokens. If Basic finds a byte greater than 127, it compares the number with a list of Basic expressions to find what the token means (e.g., 179 for =). This list resides at locations 32768 through 49151 in ROM.

For an added complication, in Extended Basic there are 2-byte tokens—the first always a 255 and the second ranging between 128 and 161. Table 1 gives a list of all the tokens, what they represent, and where they begin in the Color Basic and Extended Basic ROMs. Basic ROMs.

To finish our example, location 7687 would contain a 49 (ASCII code for 1) and 7688 a 0, which marks the end of

Program Listing 1

```
63000 '  DOCULIST/C:V1.2
63010 CLEAR  500
      :CLS
      :PRINT
      :PRINT "    doculist - INITIALIZING"
      :GO SUB 63290
      :PRINT
      :PRINT TAB( 12);"PRINTING."
      :PRINT
      :SA = PEEK (25) * 256 + PEEK (26)
      :FA = PEEK (27) * 256 + PEEK (28)
      :LA = SA
63020 NA = PEEK (LA) * 256 + PEEK (LA + 1)
      :LN = PEEK (LA + 2) * 256 + PEEK (LA + 3)
63030 IF  LN = 64000 OR  NA = 0 THEN  END
63040 TXT$ = STRING$ (10 - LEN ( STR$ (LN)),32) + STR$ (LN) + " "
      :CNT = 11
```

Listing 1 continued

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Listing 1 continued

```
63050 FOR I = LA + 4 TO  NA - 2
63060 C = PEEK (I)
      :IF  C = 34 THEN Q = (Q = 0)
63070 IF  C < 128 AND C < > 58 OR Q = - 1 THEN  TXT$ = TXT$ + CHR
       $ (C)
      :CNT = CNT + 1
      :GO TO 63170
63080 IF  C = 58 THEN  63200
63090 '  BYTE IS TOKEN, SO CHECK
63100 IF  C = 255 THEN  I = I + 1
      :C = PEEK (I) - 50
      :ELSE  C = C - 128
63110 IF C = 2 OR  C = 3 THEN  Q = - 1
63120 ' DECODE TOKEN
63130 IF RIGHT$ (TX$,1) < > " " AND RIGHT$ (TX$,1) < > ":" THEN T
       X$ = TX$ + " "
63140 FOR X = A(C) TO  A(C) + 9
      :IF  PEEK (X) > 128 THEN  63160
63150 TXT$ = TXT$ + CHR$ ( PEEK (X))
      :CNT = CNT + 1
      :NEXT X
63160 TXT$ = TXT$ + CHR$ ( PEEK (X) - 128) + " "
      :CNT = CNT + 1
63170 IF  LEN (TX$) > 69 THEN GO SUB 63240
63180 NEXT  I
      :LA = NA
      :GO SUB 63240
      :GO TO 63020
63190 ' CHECK COLON
63200 IF  PEEK (I - 1) < > 58 AND  PEEK (I + 1) = 131 THEN  63170
63210 IF  PEEK (I + 1) = 58 THEN  I = I + 1
      :C = PEEK (I)
      :GO TO  63210
63220 GO SUB  63230
      :GO TO  63170
63230 ' PRINT ROUTINE
63240 IF LEN (TXT$) > 69 THEN  PRINT # - 2, LEFT$ (TXT$,70)
      :TXT$ = STRING$ (12,32) + RIGHT$ (TXT$, LEN (TXT$) - 70)
      :CNT = 13
      :GO TO 63270
63250 IF  LEN (TX$) > 12 THEN PRINT # - 2,TXT$
63260 TX$ = STRING$ (11,32) + ":"
      :CN = 12
      :Q = 0
63270 LI = LI + 1
      :IF  LI < 50 THEN RETURN
      :ELSE LI = 0
      :SOUND 200,20
      :LINE INPUT "CHANGE PAPER,PRESS <ENTER>..";X$
      :RETURN
63280 ' FILL TOKEN ARRAYS
63290 DIM  A(111)
      :A(0) = 43622
      :J = 1
63300 FOR I = 43622 TO 43822
      :IF PEEK (I) > 128 THEN A(J) = I + 1
      :J = J + 1
63310 IF J < 53 THEN NEXT
63320 A(53) = 33155
      :J = 54
      :FOR I = 33155 TO 33355
      :IF PEEK (I) > 128 THEN A(J) = I + 1
      :J = J + 1
63330 IF J < 78 THEN NEXT
63340 A(78) = 43802
      :J = 79
      :FOR I = 43802 TO 44000
      :IF PEEK (I) > 128 THEN A(J) = I + 1
      :J = J + 1
63350 IF J < 98 THEN NEXT
63360 A(98) = 33309
      :J = 99
      :FOR I = 33309 TO 33500
      :IF PEEK (I) > 128 THEN A(J) = I + 1
      :J = J + 1
63370 IF J < 112 THEN NEXT
      :ELSE RETURN
```

the current program line.

Decoding the Token Lists

Before you can list a Basic program, you must first know how to interpret the token lists. Used as counters, the tokens tell you (and Basic) the number of words to skip in the list to find the correct word—but how do you know where one word ends and the next starts? Counting the number of letters is no help; some words (such as +) have one letter and some (such as STRING$) have seven.

Look at the first word on the list, For. If you PEEK locations 43622, 43623, and 43624, you find 71, 85, and 210. The ASCII code for F is 71, and the code for 0 is 85; but 210 is ASCII R (82) plus 128. The secret is that the ASCII code of the last letter of each word has 128 added to it; knowing this, it is an easy task to find a word's end by checking for a value greater than 128.

The Doculist/C Program

Doculist/C is numbered starting at 63000 to allow it to be appended to the program you wish to list (more on that later). The first program line refers to subroutine 63290, which decodes the token list and stores the starting memory address for each of the Basic expression words in an array.

Rather than look through the list each time you encounter a token, you can now access the word by using the token to select the appropriate array variable, pointing you immediately to the start of the word in memory. Line 63010 also calculates SA, the start address of the program to be listed, and equates this to LA, the current program line address.

Line 63020 calculates NA, the address of the start of the next program line, and LN, the current program line's number. Line 63030 checks for the beginning of Doculist/C or the end of the program in memory and ends if either is found; LN, normally 63000, was changed to 64000 in Program Listing 1 to allow Doculist to list itself.

Line 63040 begins the actual decoding. The line to be listed will be stored in TXT$. The first thing to appear, the line number, is tabbed over and right-justified. This allows easy recognition of line numbers and a left margin for three-ring binder storage.

Next, line 63050 searches through all bytes on the current line by way of a For...Next loop. Line 63060 equates the current byte to C and, if it is a quote (ASCII 34), changes the state of the quote flag (Q). A literal expression (one beginning with quotes) will not be interpreted; the Q flag reverses its status with the finding of a closing quote or the end of the program line.

If the byte is either an ASCII code or part of a literal expression, line 63070 adds it to TXT$, increments the text string's length counter (CNT), and jumps to line 63170. Before going back to look at the next byte, line 63170 checks to see if our text line has reached the maximum length we have preset for it. If so, the line is printed before returning for the next byte.

Since the "neat" listing separates multiple program statements, line 63080 checks for the presence of a colon. If found, it is processed in lines 63200–63220.

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If you've gotten this far, the byte is a token and must be decoded. Line 63100 checks for a 255 (double token) and, if found, increments past it and subtracts 50, scaling the second token byte so it can be used to reference our token array. If the token is single, C is scaled using a different factor, based on how we created the array. Line 63110 sets the quote flag for a remark token (REM or '), as 63060 did for a quote.

Lines 36130–63180 decode the token. C selects the array element containing the start address at which to begin looking; each character in the word (value above 128), that character minus 128, is added to TXT$. Then, with the decoding done, control is returned to the main For. . . Next loop.

Lines 63200 and 63210 check any colons found. The latter peels off multiple colons (e.g., J=3:::R=4) until only one is left, avoiding blank lines in the printed listing. Since Basic puts a colon before an apostrophe used as a remark indicator, line 63200 allows only the first of two colons before an apostrophe (ASCII 131) to be printed. For instance, the line "10 I=0:'Initialize I" is stored as 10 I=0::'Initialize I; Doculist/C prints the remark, with only one colon, on a separate line.

Lines 63240–63270 perform the printing, reset the quote flag, and keep track of how many lines have been printed. After 50, line 63270 sounds a beep and alerts you to change paper.

```
63000 ' DOCULIST/C:V1.2
63010 CLEAR 500:CLS:PRINT:PRINT"    doculist - INITIALIZING":GOS
UB63290:PRINT:PRINTTAB(12);"PRINTING.":PRINT:SA=PEEK(25)*256+PEE
K(26):FA=PEEK(27)*256+PEEK(28):LA=SA
63020 NA=PEEK(LA)*256+PEEK(LA+1):LN=PEEK(LA+2)*256+PEEK(LA+3)
63030 IF LN=63000 OR NA=0 THEN END
63040 TXT$=STRING$(10-LEN(STR$(LN)),32)+STR$(LN)+" ":CNT=11
63050 FORI=LA+4 TO NA-2
63060 C=PEEK(I):IF C=34THENQ=(Q=0)
63070 IF C<128 ANDC<>58 ORQ=-1THEN TXT$=TXT$+CHR$(C):CNT=CNT+1:G
OTO63170
63080 IF C=58 THEN 63200
63090 ' BYTE IS TOKEN, SO CHECK
63100 IF C=255 THEN I=I+1:C=PEEK(I)-50 ELSE C=C-128
63110 IFC=2 OR C=3 THEN Q=-1
63120 'DECODE TOKEN
63130 IFRIGHT$(TX$,1)<>" "ANDRIGHT$(TX$,1)<>":"THENTX$=TX$+" "
63140 FORX=A(C) TO A(C)+9:IF PEEK(X)>128 THEN 63160
63150 TXT$=TXT$+CHR$(PEEK(X)):CNT=CNT+1:NEXTX
63160 TXT$=TXT$+CHR$(PEEK(X)-128)+" ":CNT=CNT+1
63170 IF LEN(TX$)>69THENGOSUB63240
63180 NEXT I:LA=NA:GOSUB63240:GOTO63020
63190 'CHECK COLON
63200 IF PEEK(I-1)<>58 AND PEEK(I+1)=131 THEN 63170
63210 IF PEEK(I+1)=58 THEN I=I+1:C=PEEK(I):GOTO 63210
63220 GOSUB 63230:GOTO 63170
63230 'PRINT ROUTINE
63240 IFLEN(TXT$)>69 THEN PRINT#-2,LEFT$(TXT$,70):TXT$=STRING$(1
2,32)+RIGHT$(TXT$,LEN(TXT$)-70):CNT=13:GOTO63270
63250 IF LEN(TX$)>12THENPRINT#-2,TXT$
63260 TX$=STRING$(11,32)+":":CN=12:Q=0
63270 LI=LI+1:IF LI<50THENRETURNELSELI=0:SOUND200,20:LINEINPUT"C
HANGE PAPER,PRESS <ENTER>..";X$:RETURN
63280 'FILL TOKEN ARRAYS
63290 DIM A(111):A(0)=43622:J=1
63300 FORI=43622TO43822:IFPEEK(I)>128THENA(J)=I+1:J=J+1
63310 IFJ<53THENNEXT
63320 A(53)=33155:J=54:FORI=33155TO33355:IFPEEK(I)>128THENA(J)=I
+1:J=J+1
63330 IFJ<78THENNEXT
63340 A(78)=43802:J=79:FORI=43802TO44000:IFPEEK(I)>128THENA(J)=I
+1:J=J+1
63350 IFJ<98THENNEXT
63360 A(98)=33309:J=99:FORI=33309TO33500:IFPEEK(I)>128THENA(J)=I
+1:J=J+1
63370 IFJ<112THENNEXTELSERETURN
```

Program Listing 2

Using Doculist/C

Program Listing 2 contains a normal Doculist/C, which can be typed into your CoCo. When done, CSAVE the program using the name "DOCULIST."

The first step in using Doculist is to load the program you want a listing of (i.e., CLOAD"program name"). To make sure there's sufficient room for Doculist, move the resident program to the page 1 memory area by entering the commands PMODE 0:PCLEAR 1 (press enter). Now you're ready to merge Doculist with the resident program.

Remember, locations 25 and 26 contain the program loading address in MSB/LSB format, and locations 27 and 28 the address of the program's end (including the two zero bytes). Merging simply consists of changing the bytes in 25 and 26 to point to the first of the two end-of-program zero bytes, and then loading the program to be merged.

To do this, type POKE 26,PEEK (28)–2:POKE 25, PEEK(27) and press enter. If location 28 contains a 1 or 0, PEEK(28)–2 will be negative and yield an FC? error. In this event, use the alternate command: POKE 26,PEEK (28)+254:POKE 25,PEEK(25)–1

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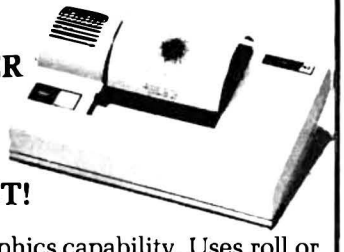

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(press enter). This command simply "borrows" 256 from MSB and adds it to the LSB before subtracting two (256 − 2 = 254).

Single Tokens

Token	Word	Address	Token	Word	Address
128	FOR	43622	186	LET	33174
129	GO	43625	187	LINE	33177
130	REM	43627	188	PCLS	33181
131	'	43630	189	PSET	33185
132	ELSE	43631	190	PRESET	33189
133	IF	43635	191	SCREEN	33195
134	DATA	43637	192	PCLEAR	33201
135	PRINT	43641	193	COLOR	33207
136	ON	43646	194	CIRCLE	33212
137	INPUT	43648	195	PAINT	33218
138	END	43653	196	GET	33223
139	NEXT	43656	197	PUT	33226
140	DIM	43660	198	DRAW	33229
141	READ	43663	199	PCOPY	33233
142	RUN	43667	200	PMODE	33238
143	RESTORE	43670	201	PLAY	33243
144	RETURN	43677	202	DLOAD	33247
145	STOP	43683	203	RENUM	33252
146	POKE	43687	204	FN	33257
147	CONT	43691	205	USING	33259
148	LIST	43695			
149	CLEAR	43699			
150	NEW	43704			
151	CLOAD	43707			
152	CSAVE	43712			
153	OPEN	43717			
154	CLOSE	43721			
155	LLIST	43726			
156	SET	43731			
157	RESET	43734			
158	CLS	43739			
159	MOTOR	43742			
160	SOUND	43747			
161	AUDIO	43752			
162	EXEC	43757			
163	SKIPF	43761			
164	TAB(	43766			
165	TO	43770			
166	SUB	43772			
167	THEN	43775			
168	NOT	43779			
169	STEP	43782			
170	OFF	43786			
171	+	43789			
172	−	43790			
173	*	43791			
174	/	43792			
175	^	43793			
176	AND	43794			
177	OR	43797			
178	>	43799			
179	=	43800			
180	<	43801			
181	DEL	33155			
182	EDIT	33158			
183	TRON	33162			
184	TROFF	33166			
185	DEF	33171			

Double Tokens

Note: Each of the listed tokens is preceded by the number 255.

Token	Word	Address
128	SGN	43802
129	INT	43805
130	ABS	43808
131	USR	43811
132	RND	43814
133	SIN	43817
134	PEEK	43820
135	LEN	43824
136	STR$	43827
137	VAL	43831
138	ASC	43834
139	CHR$	43837
140	EOF	43841
141	JOYSTK	43844
142	LEFT$	43850
143	RIGHT$	43855
144	MID$	43861
145	POINT	43865
146	INKEY$	43870
147	MEM	43876
148	ATN	33309
149	COS	33313
150	TAN	33316
151	EXP	33319
152	FIX	33322
153	LOG	33325
154	POS	33328
155	SQR	33331
156	HEX$	33334
157	VARPTR	33338
158	INSTR	33344
159	TIMER	33349
160	PPOINT	33354
161	STRING$	33360

Table 1. Extended Color Basic Expressions

Now CLOAD"Doculist". When OK appears, type POKE 25,12:POKE 26,1 and press enter. This restores the program start address to its original position (set when you PCLEARed 1). If you list the program, you'll see the first program followed by Doculist. To obtain a listing of the first program, type RUN 63000 (press enter).

When Doculist is run, the screen will clear and an initializing notice will appear. After a few seconds to fill the arrays, the word "Printing" will appear, and printing will begin. When 50 lines have been printed, a tone will sound and the message "Change paper, press (enter)" will be followed by the blinking cursor; when you are ready to print the next page, press enter and the process will continue.

Two Restrictions

The program you list cannot be longer than 11,000 bytes, and cannot contain line numbers above 62999. With these cautions in mind, you can use Doculist to provide you with neat, easily readable program listings. ■

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BY NORMAN MANCHEVSKY

PRINT THAT TRACE

Extended Color Basic provides the programmer with a valuable debugging tool—the trace option. Given a TRON command, the machine displays the line number of every command executed until it encounters a TROFF.

The feature's disadvantage is that it displays these line numbers on the screen only. Often, the piece of trace you want to study has rolled up and off the screen before you can stop it. Also, checking the sequence of commands executed is difficult without a printout. These problems can be solved by redirecting the trace output to the printer.

A section of code located at &H82B9 is executed between each Extended Color Basic command. It tests for various things, including whether or not the trace function has been enabled. The trace routine itself is in locations &H82DE to &H82F1; Program Listing 1 is a commented disassembly printout of it.

The Color Computer uses location &H6F to hold the output device number—0 for screen output, 254 (&HFE) for the printer. Program Listing 2 stores &HFE in this location at the start of the trace routine; after running it, until the machine is switched off and restarted, all TRON commands will generate a printout of line numbers instead of a display. No other changes are required.

Since the trace routine is located in ROM, it cannot be modified naturally. The program copies the relevant portion of ROM into a suitable piece of RAM and modifies it there. All entries to the original routine (through two jumps located in &H19A and &H1A3) are redirected to the new code.

The program is written for a 16K machine. While it will work in a 32K model, it is preferable to relocate it to the high end of memory (around &H7E00). This has been done in Program Listing 3.

Program Listing 4 is a disassembly printout of the new trace routine with comments added. ■

The scroll is quicker than the eye—so print out your trace to follow program flow at your pace.

Norman Manchevsky can be reached at 54 Park Ave., Ottawa, Ontario, Canada K2P 1B2.

System Requirements

16K, 32K RAM
Printer

```
82DE  LDA   <$AF      Load trace indicator
82E0  BEQ   $82F1     0 if off, 79 if on
82E2  LDA   #$5B      Load [
82E4  JSR   >$A282    Go display
82E7  LDA   <$68      Load line number
82E9  JSR   >$BDCC    Go display
82EC  LDA   #$5D      Load ]
82EE  JSR   >$A282    Go display
```

Program Listing 1

Program Listing 2

```
10  REM *** DISPLAY TRACES ON THE PRINTER ***
20  REM *** CLEAR AND RESERVE MEMORY ***
30  CLEAR 200,&H3EB0
40  REM *** COPY RELEVANT PORTION OF ROM INTO RESERVED RAM ***
50  FOR I=&H82B9 TO &H831E
60  POKE I-&H4400, PEEK(I):NEXT
70  REM *** MODIFY THE TRACE ROUTINE ***
80  FOR I=0 TO 2:READ A:POKE I+&H3EE2,A:NEXT
90  FOR I=0 TO 25:READ A:POKE I+&H3F26,A:NEXT
100 REM *** MODIFY THE ROUTINE TO WORK IN ITS NEW LOCATION ***
110 FOR I=0 TO 7:READ A:POKE I+&H3F1E,A:NEXT
120 POKE &H3F0C,&H3E
130 REM *** MODIFY THE TWO ENTRY JUMPS ***
140 POKE &H019B,&H3E:POKE &H01A4,&H3F
150 DATA 126,63,38
160 DATA 134,254,151,111,134,91,189,162,130
170 DATA 150,104,189,189,204,134,93,189,162,130
180 DATA 134,0,151,111,126,62,241
190 DATA 38,3,126,131,34,126,164,76
200 END
```

Program Listing 3

```
10  REM *** DISPLAY TRACES ON THE PRINTER ***
20  REM *** CLEAR AND RESERVE MEMORY ***
30  CLEAR 200,&H7EB0
40  REM *** COPY RELEVANT PORTION OF ROM INTO RESERVED RAM ***
50  FOR I=&H82B9 TO &H831E
60  POKE I-&H400,PEEK(I):NEXT
70  REM *** MODIFY THE TRACE ROUTINE ***
80  FOR I=0 TO 2:READ A: POKE I+&H7EE2,A:NEXT
90  FOR I=0 TO 25:READ A:POKE I+&H7F26,A:NEXT
100 REM *** MODIFY THE ROUTINE TO WORK IN ITS NEW LOCATION ***
110 FOR I=0 TO 7:READ A:POKE I+&H7F1E,A:NEXT
120 POKE &H7F0C,&H7E
130 REM *** MODIFY THE TWO ENTRY JUMPS ***
140 POKE &H019B,&H7E:POKE &H01A4,&H7F
150 DATA 126,127,38
160 DATA 134,254,151,111,134,91,189,162,130
170 DATA 150,104,189,189,204,134,93,189,162,130
180 DATA 134,0,151,111,126,126,241
190 DATA 38,3,126,131,34,126,164,76
200 END
```

Program Listing 4

```
7EE2  JMP  >$7526   Go to new routine
7F26  LDA  #$FE     Load 254 = Printer
7F28  STA  <$6F     Store in Device Number location
7F2A  LDA  #$5B     Load [
7F2C  JSR  >$A282   Go print
7F2F  LDA  <$68     Load line number
7F31  JSR  >$BDCC   Go print
7F34  LDA  #$5D     Load ]
7F36  JSR  >$A282   Go print
7F39  LDA  #$00     Reset Device Number location
7F3B  STA  <$6F
7F3D  JMP  >$7EF1   Return to original code
```


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BY WILLIAM C. CLEMENTS

SPEECH FOR THE COLOR COMPUTER

Make your Color Computer a real conversation piece by building this plug-in speech-synthesis unit.

I recently decided to build a speech synthesizer as an expansion unit for my department's student computer facility. The result was a plug-in synthesizer cartridge that you can program in Basic or in machine language.

The cartridge also has two 24-pin IC sockets, each of which will accept 2K of RAM or EPROM, and adds two hardware timers for control or other applications.

The project is based on a simple speech-synthesizer circuit, built around the Votrax SC-01 integrated circuit that Steve Ciarcia describes in the September 1981 issue of *Byte* (p. 38). The SC-01, a CMOS LSI chip, phonetically synthesizes speech using an 8-bit code, 6 bits of which specify the phoneme. It thus generates 2^6 or 64 possible phonemes in four categories: voiced, fricative, nasal, and silent. The other 2 bits of the code can be used to vary the inflection or pitch of the sounds.

The SC-01 includes on-chip audio generation, waveform shaping, and low-level audio amplification. You need only a latched parallel port and simple logic circuits to interface it to the bus system of the Color Computer.

The Speech-Synthesizer Circuit

With some slight modification, the synthesizer described by Ciarcia can be packaged as a self-contained plug-in unit not much larger than a game cartridge. I decided to build a unit that could contain its own RAM and EPROM, so that it could be used independently of the level of Basic and the amount of available memory in the computer, at least for machine-language speech programming. The circuit diagram of the result is shown in Fig. 1.

One input bit and 9 output bits are needed to interface the SC-01 and associated circuits to the computer. I chose the 6522 Versatile Interface Adapter (VIA) to provide the necessary parallel ports. The 74LS138, a three- to eight-line decoder, separates the 16K address space between $C000–$FFFF into eight 2K partitions and generates a low-true select signal over each partition. The $F000 select is used along with the four lowest-order address lines to address the 16 internal VIA registers between $F000–$F00F, and the $E000 and $E800 lines each select a 24-pin IC socket that can contain either RAM or EPROM.

The VIA includes two parallel I/O ports, called A and B. The bits in each port can be configured individually either as inputs or as outputs by setting or clearing corresponding control bits in the VIA data-direction registers. Port A is used here as an output port to send the phoneme and inflection codes to the SC-01. The 2 lowest-order bits of port B are control lines. PB0 is used as an input

Photo 1. Computer with Speech Synthesizer and Speaker Attached

System Requirements

Extended Color Basic
16K RAM
Printer Optional

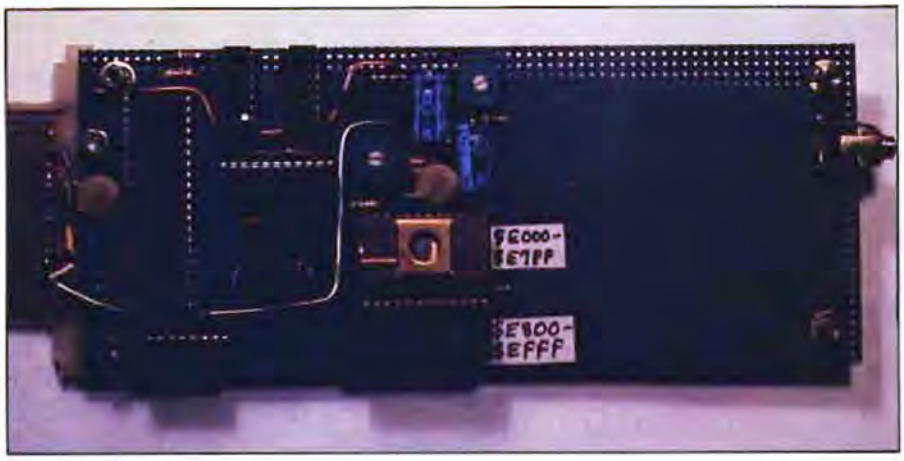

Photo 2. Top View of Circuit Board

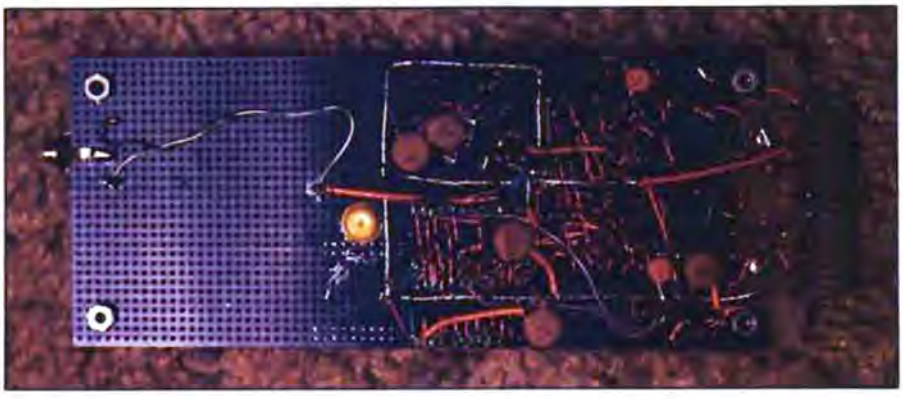

Photo 3. Bottom View of Circuit Board

bit, and accepts the $\overline{A}$/R, or synthesizer-busy, signal from the SC-01. PB1 is an output bit and is used to strobe the synthesizer for each phoneme. The other 6 bits of port B are not used.

The inflection bits, sent out on PA6 and PA7, are latched separately by a 74LS74 dual flip-flop. The low-level audio output from the synthesizer chip is amplified to speaker level with an LM386 power amplifier. The SC-01 control circuits and the audio amplifier come directly from Ciarcia's design; however, his octal data latch on the inflection and phoneme-code lines is replaced by the VIA in my implementation of the synthesizer.

In addition to the ports, the VIA also contains two interval timers, plus registers for serial-parallel data interconversion. These features can be operated using a variety of options unnecessary to this project. You should check the MCS6522 data sheet from MOS Technology for this chip's many features if you're interested in using them in other projects.

Packaging the Synthesizer

First, I made a small etched board with contact fingers to plug into the edge-connector inside the computer's cartridge slot. I found a 30-by-80 mm scrap of double-sided PC board stock and laid down 40 short strips of 1.5-mm wide resist tape, 20 pieces per side, with 2.5-mm spacing to match the cartridge connector. I made these pieces of resist from Scotch filament tape with a razor blade and a ruler, but you can buy precut resist if you wish.

After etching with ferric chloride solution, cleaning, and drying, I trimmed the edge having the contact fingers so it made a snug fit in the computer's edge connector. Do this carefully; the fingers must line up squarely on both sides with the contacts in the computer. It's best to trim conservatively with a fine saw and then finish the job with a hand file and frequent trial plug-ins.

I then cut an 80-by-190 mm piece of Vector perforated board and bolted the small piece with the contacts onto one of the 80-mm ends. This makes a neat, cheap, general-purpose expansion prototype board for the Color Computer, with plenty of room for experimental circuits.

If you prefer not to make the board yourself, you can buy an expansion board for the Apple computer and cut off the side projection with the 25 contact fingers that plug into the Apple. Vector also makes a similar board, the Vector 4609. If you make your own board and are not interested in room for further experiments, you can cut it off at 100 mm (about 4 inches) in length, which is enough for the circuit described here.

You can use any size board that will fit in the computer slot and is at least 100 mm plus the length of the contact fingers. If you do choose the 190-mm length, there's room to mount a 2-inch speaker on the end of the board. I decided to leave that room open for future expansion and mounted a small audio jack for an external speaker on the end of the board. Another possibility is to use the sound input pin on the cartridge connector to feed the speech through the TV audio.

With the board prepared, I inserted low-profile IC sockets as shown in Fig. 2 and fastened each with a dab of epoxy glue at each end. Then I wired the circuit point-to-point using a Vector wiring pencil and a fine-tipped soldering iron. I recommend a magnifier lamp, unless your close vision is better than mine.

Be aware of the space restrictions imposed by the computer slot height. You have only about 12 mm to work in above the board and 8 mm below, where the wiring goes. Lay the disk capacitors down flat and use the small, square-type trimmer potentiometers and the smallest electrolytic capacitors you can find. I got all my parts from Jameco Electronics (1355 Shoreway Road, Belmont, CA 94002) except the SC-01, which came from Micromint (917 Midway, Woodmere, NY 11598). Unfortunately, there's not enough room to use wire-wrap construction. Point-to-point work is tedious but progresses well with practice. If you have experience with PC board design, you might prefer to etch a board for the whole circuit.

If you don't want to experiment with the RAM or EPROM, you can simplify the circuit by using only one chip-enable signal to access the VIA. Two such signals are provided on the cartridge connector, one at $C000 (on pin 32) and one at $FF40 (on pin 36). You can connect either of these to pin 23 of the VIA, leaving out the 74LS138 and associated circuits as well as the 24-pin sockets. If you do, be sure to fix statement 30 in Program Listing 1 to reflect the new VIA address.

You could plug the bare board into the computer, taking care that

the metal door doesn't short anything out, but it's a good idea to protect the ICs and wiring.

If you're not lucky enough to find a suitable box, you might want to make one to hold the circuit board. You can cut down two pieces of perfboard, each to the same dimensions as your circuit board, and bolt one to the top and one to the bottom, using standoffs at the corners. Make sure the finished product will still fit in the computer's slot.

Programming the Synthesizer

Ciarcia's article describes the operation of the synthesizer in detail, and the SC-01 data sheet, which Micromint supplies with the chip, gives timing diagrams and procedures for interfacing and driving the chip. Here, I'll briefly summarize the operation protocol.

To voice a phoneme, take the strobe signal STB (supplied at PB1) low, and place the binary phoneme code onto PA0–PA5 and the inflection code onto PA6 and PA7. After at least a 100-microsecond delay, take STB high to speak the phoneme. The A/R signal, fed through PB0, will be at the low logic level during voicing.

Test PB0 and do nothing until it returns to logic high. When it does, the SC-01 is ready to accept another phoneme. The data on PA0–PA5 must be stable about 450 ns before STB goes high; that requirement is automatically met by the use of latched I/O ports. The 100-μs delay is taken care of by the time required to interpret and execute Basic statements.

These operations are handled easily in Basic by the following statements. POKE&HF002,2:POKE&HF003,255 sets data-direction register B in the VIA to binary 00000010 (configuring PB0 as an input bit and PB1 as an output) and stores binary 11111111 in data-direction register A (configuring all bits of port A as outputs). This statement must be executed before any attempt to voice phonemes. When you want a phoneme spoken, execute the subroutine:

```
100 POKE&HF000,0:POKE&HF001,P:
  POKE&HF000,2
200 IF PEEK(&HF000) AND 1 THEN
  RETURN ELSE 200
```

where the binary value of P contains the bit pattern for the inflection and phoneme code.

A Phoneme-List-Processing Program

To make it easy to try different phoneme combinations and edit a phoneme group to improve enunciation of a phrase, a program should handle the input, deletion, insertion, change, and addition of phonemes, as well as the pronunciation of the phoneme list. Listing 1 presents such a program, written in Extended Color Basic.

When run, the program first directs you to input a series of phonemes using the standard SC-01 mnemonics. If you want to experiment with the inflection, you can preface the phoneme with the digits 1, 2, or 3. These values cause the SC-01 inflection inputs I2 and I1 to take on the binary values 01, 10, or 11, respectively.

The higher the number is, the higher the pitch used to speak that phoneme. If no digit prefaces the phoneme, I2 and I1 are both set to zero, which produces the

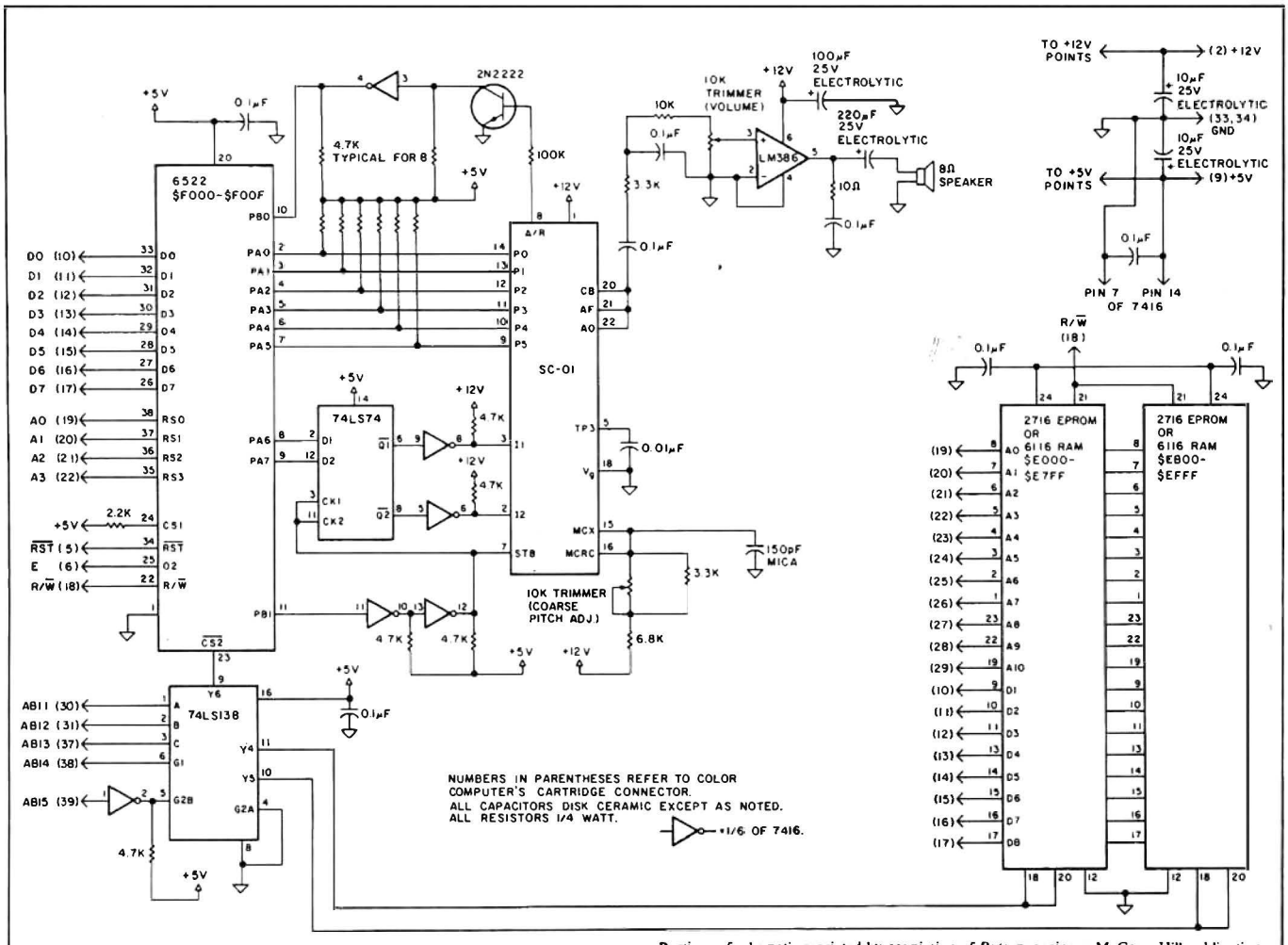

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Fig. 1. Circuit Diagram for the Speech-Synthesizer Plug-In

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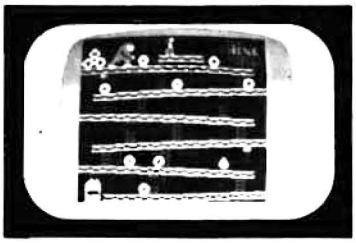

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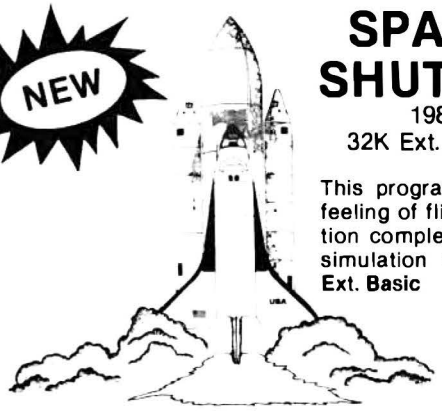

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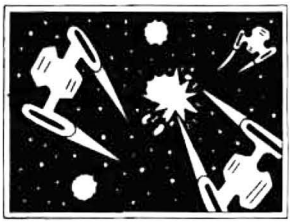

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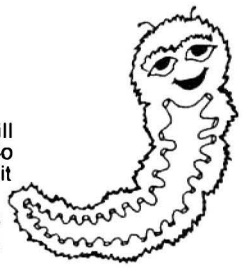

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standard default inflection level. The default level is good enough for most purposes, since the SC-01's internal circuits already produce slight inflection changes to improve the naturalness of the speech.

If you enter a null string instead of a phoneme by pressing just the enter key, you'll get the entire phoneme list. Entering Q in place of a phoneme will quit the entry of the current list and start over with a new list. Entering TAPE instead of a phoneme will enter a routine that lets you save or load the phoneme list using a tape recorder.

Entering EDIT in place of a phoneme will direct the program into a screen-oriented edit mode, allowing you to modify the existing list using commands very similar to the line-editing features of Extended Color Basic. The current phoneme list is displayed at the top of the screen, along with a cursor that can be stepped backwards or forwards using the left-arrow and right-arrow keys. The up-arrow key positions the cursor after the last phoneme, and the down-arrow key sends it to the start of the list.

Modifications to the list occur with the phoneme immediately following the cursor. Press D to delete the phoneme. Press C, type a new phoneme, and press enter to change the phoneme. Press S to speak the whole list, and press Z to speak only that part of the list between the current cursor position and the end. Press P if you want to list all the phonemes on a line printer. Press Q to quit the editing process, delete the whole list, and go back to the start of the program to begin a new list.

As in Extended Color Basic edit commands, several subcommand functions can be entered and exited during the

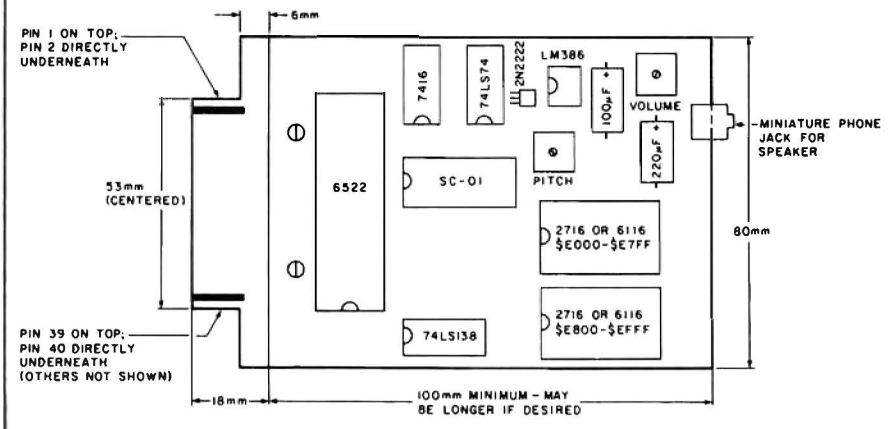


Fig. 2. Top View of Circuit Board, Showing Layout of Major Components

Example Word	Phoneme Symbol	Hex Code	Duration (ms)
pocket	EH3	00	59
end	EH2	01	71
heavy	EH1	02	121
(no sound)	PA0	03	47
putter	DT	04	47
rake	A2	05	71
bail	A1	06	103
measure	ZH	07	90
honest	AH2	08	71
inhibit	I3	09	55
inhibit	I2	0A	80
inhibit	I1	0B	121
maybe	M	0C	103
under	N	0D	80
bolt	B	0E	71
vague	V	0F	71
cheer	CH	10	71
shoe	SH	11	121
zip	Z	12	71
awful	AW1	13	146
sling	NG	14	121
father	AH1	15	146
looking	OO1	16	103
hook	OO	17	185
lie	L	18	103
brick	K	19	80
just	J	1A	47
hope	H	1B	71
gate	G	1C	71
fear	F	1D	103
made	D	1E	55
miss	S	1F	90
game	A	20	185

Example Word	Phoneme Symbol	Hex Code	Duration (ms)
blade	AY	22	65
yell	Y1	22	80
mission	UH3	23	47
hop	AH	24	250
pride	P	25	103
cold	O	26	185
pin	I	27	185
move	U	28	185
only	Y	29	103
tear	T	2A	71
roost	R	2B	90
sleet	E	2C	185
wire	W	2D	80
glad	AE	2E	185
after	AE1	2F	103
salty	AW2	30	90
about	UH2	31	71
uncle	UH1	32	103
supper	UH	33	185
bold	O2	34	80
hoard	O1	35	121
you	IU	36	59
June	U1	37	90
there	THV	38	80
thick	TH	39	71
herd	ER	3A	146
ready	EH	3B	185
be	E1	3C	121
mall	AW	3D	250
(no sound)	PA1	3E	185
(no sound)	STOP	3F	47

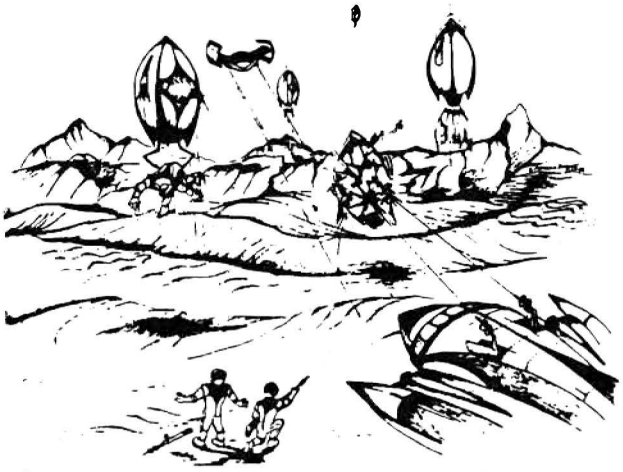
(T must precede CH for a hard CH sound;
D must precede J for a hard J sound.)

Table 1. English-Language Phoneme List

COLOR COMPUTER/TDP-100

COLOR ALIEN DEFENSE

by Doug Schwartz



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COLOR CATERPILLAR®

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Machine Language

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by Rugby Circle

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16K Cassette **$19.95**

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by Larry Ashmun

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Program Listing. Phoneme-List Entry and Editing Program

```
10 'PHONEME-LIST ENTRY AND EDITING PROGRAM
20 'BY WILLIAM C. CLEMENTS, JR.
25 'REQUIRES 16K AND EXTENDED BASIC
30 A=&HF000:Q=247
40 POKEA+3,255:POKEA+2,2 'CONFIGURE VIA
50 DIMC$(64),P$(100),Z(100),LG(100)
60 FORI=1TO64:READC$(I):NEXT
70 P=63:GOSUB580:J=1 'SILENCE SYNTHESIZER & BEGIN NEW LIST
80 CLS:PRINT"BEGIN A NEW LIST OF PHONEMES"
90 INPUTA$:IF A$="EDIT" THEN 120 ELSE IF A$="" THEN 110 ELSE IF
A$="Q" THEN 70 ELSE IF A$="TAPE" THEN 480
100 GOSUB600:J=J+1:GOTO90
110 JM=J-1:GOSUB690:GOTO90 'SPEAK THE LIST
120 JM=J-1 'EDIT MODE BEGINS HERE
130 GOSUB650:LB=LA:PRINT@LB,CHR$(138);:LC=LB:GOSUB710
140 F=1:IF PEEK(343)=Q THEN J=J-1:LC=LB-LG(J)-1:GOSUB670:GOTO140
:ELSE 150 'LEFT ARROW SPACES BACK
150 IF PEEK(344)=Q THEN J=J+1:LC=LB+LG(J-1)+1:GOSUB670:GOTO140:E
LSE160 'RIGHT ARROW SPACES FORWARD
160 IF PEEK(341)=Q THEN J=JM+1:LC=LA:GOSUB680:GOTO140:ELSE170 'U
P ARROW GOES TO END
170 IF PEEK(342)=Q THEN J=1:LC=0:GOSUB680:GOTO140:ELSE180 'DOWN
ARROW GOES TO START
180 IF PEEK(341)=254 THEN PRINT@498,"change";:A$="":GOTO420:ELSE
190 'C-KEY CHANGES ONE PHONEME
190 IF PEEK(338)<>Q THEN 260 'X-KEY EXTENDS THE LIST
200 J=JM+1:LC=LA:PRINT@498,"extend";
210 GOSUB730
220 AA$=INKEY$:IF AA$="" THEN 220 ELSE IF AA$=CHR$(13) THEN 250
ELSE IF AA$=CHR$(95) THEN 240 ELSE 230
230 A$=A$+AA$:GOTO220
240 PRINT@498,"          ";:GOTO140
250 GOSUB720:GOTO220
260 IF PEEK(341)=251 THEN GOSUB690:GOTO140:ELSE270 'S-KEY SPEAKS
 ALL
270 IF PEEK(339)=251 THEN PRINT@490,"          ":GOTO70:ELSE 280 '
Q-KEY STARTS NEW LIST OVER
280 IF PEEK(342)=254 THEN JL=LG(J):FORI=J+1 TO JM:P$(I-1)=P$(I):
Z(I-1)=Z(I):LG(I-1)=LG(I):NEXT:JM=JM-1:GOSUB650:GOSUB680:GOSUB71
0:ELSE290 'D-KEY DELETES ONE PHONEME
290 IF PEEK(338)=253 THEN PRINT@500,"hack";:GOSUB670:A$="":GOTO3
00:ELSE330 'H-KEY ENTERS HACK FUNCTION
300 AA$=INKEY$:IF AA$="" THEN 300 ELSE IF AA$=CHR$(13) THEN 320
ELSE IF AA$=CHR$(95) THEN 240 ELSE 310
310 A$=A$+AA$:GOTO300
320 GOSUB720:JM=J-1:LA=LB:GOTO300
330 IF PEEK(339)=253 THEN PRINT@500,"insert";:GOSUB670:A$="":GOT
O380:ELSE340 'I-KEY INSERTS PHONEMES
340 IF PEEK(342)=251 THEN 480 ELSE 350 'T-KEY ENTERS TAPE MODE
350 IF PEEK(338)=251 THEN PRINT#-2,CHR$(10):FORI=1TOJM:PRINT#-2,
P$(I)+" ";:NEXT:PRINT#-2:GOTO140:ELSE360 'P-KEY PRINTS THE LIST
360 IF PEEK(340)=Q THEN LG=J:GOSUB700:GOTO140:ELSE140 'Z-KEY SPE
AKS LIST AFTER CURSOR
370 ' "INSERT" FUNCTION
380 AA$=INKEY$:IF AA$="" THEN 380 ELSE IF AA$=CHR$(13) THEN 400
ELSE IF AA$=CHR$(95) THEN 240 ELSE 390
390 A$=A$+AA$:GOTO380
400 FORI=JM TOJ STEP-1:P$(I+1)=P$(I):Z(I+1)=Z(I):LG(I+1)=LG(I):N
EXT:GOSUB720:GOSUB650:PRINT@LB,CHR$(138);:GOSUB710:PRINT@498,"in
sert";:GOTO380
410 ' "CHANGE" FUNCTION
420 AA$=INKEY$:IF AA$="" THEN 420 ELSE IF AA$=CHR$(13) THEN 430
ELSE A$=A$+AA$:GOTO420
430 A$=RIGHT$(A$,LEN(A$)-1):GOSUB600:IF J>JM THEN JM=J
440 GOSUB650:GOSUB710
450 LC=LB+LG(J)+1:J=J+1
460 PRINT@LC,CHR$(138);:LB=LC:GOTO140
470 'TAPE MODE
480 PRINT@426,"save or load":PRINT@458,"S or L";:INPUTA$
490 PRINT@489,"file name";:INPUTB$:PRINT@256,"*** press enter to
 begin ***";:INPUTI
500 IF A$="S" THEN 510 ELSE IF A$="L" THEN 520 ELSE 500
510 CLS:PRINT@267,"recording":OPEN"O",#-1,B$:PRINT#-1,JM:FORI=1T
OJM:PRINT#-1,P$(I),Z(I),LG(I):NEXT:CLOSE#-1:J=JM+1:GOTO130
520 CLS:PRINT@267,"loading":OPEN"I",#-1,B$:INPUT#-1,JM:FORI=1TOJ
M:INPUT#-1,P$(I),Z(I),LG(I):NEXT:CLOSE#-1:CLS:PRINT"PHONEMES AND
 CODES ARE LOADED.":PRINT"ENTER MORE, SPEAK, OR EDIT.":J=JM+1:GO
TO90
530 ' PHONEME MNEMONIC LIST
540 DATA EH3,EH2,EH1,PA0,DT,A2,A1,ZH,AH2,I3,I2,I1,M,N,B,V,CH,SH,
Z,AW1,NG,AH1,OO1,OO
550 DATAL,K,J,H,G,F,D,S,A,AY,Y1,UH3,AH,P,O,I,U,Y,T,R,E,W,AE,AE1,
AW2,UH2,UH1,UH
560 DATAO2,O1,IU,U1,THV,TH,ER,EH,E1,AW,PA1,STOP
570 ' *** SUBROUTINES ***
580 POKEA,0:POKEA+1,P:POKEA,2 'SPEAK A PHONEME
590 IF PEEK(A)AND1 THEN RETURN ELSE 590
```

Listing continued

editing process. Pressing X while in edit mode enters the extend function, which positions the cursor after the last phoneme in the list. Typing additional phonemes, each followed by enter, adds them successively to the end of the list.

Pressing H while in edit mode enters the hack function. Hack works like extend, except it deletes all phonemes following the position of the cursor when hack was entered, and lets you extend the list from that point rather than add at the end.

To insert phonemes into a list, first use the arrow keys to place the cursor between the phonemes. Then press I and type the phonemes you want to insert, pressing enter after each. You can insert at the beginning or end of the list if you hit the down- or up-arrow keys, respectively, just before pressing I. The shift up-arrow key combination works as in Extended Color Basic, causing the program to exit the subcommand function and return to edit mode. The edit, change, and subcommand modes are labeled at the last line on the screen as a reminder.

When you're satisfied with a group of phonemes and want to keep it for future use, you can save the phoneme data to tape. The array of phoneme-plus-inflection codes, the total number of phonemes, and the length of each mnemonic are saved to tape, or loaded from a previously saved tape, by typing T when in edit mode and following the instructions printed on the screen. You can also enter the tape mode when you first prepare the list.

Testing the Synthesizer

Now you can check out your synthesizer and start using the program. With the power off, plug the synthesizer into the cartridge slot and attach a speaker. Turn on the computer and enter the program given in Listing 1 omitting the comments, or read it from tape if you've already keyed it in and saved it. Run the program and enter the following phoneme mnemonics:

```
TH I S PA0 PA0 I S S PA0 Y OO  R
PA0 K UH L UH2 R PA0 K UH1 M P H
IU T R PA0 S P E K I NG PA1 PA1
STOP AE1 Y PA0 H O P PA0 Y U1 PA0
H AE1 V PA0 F UH1 N PA1 W EH2 I3
TH PA0 PA0 Y UH R PA0 N IU W
PA0 T AW1 Y Y1 STOP
```

When the phonemes are all entered, press the enter key and you should hear a fair rendition of "This is your Color Computer speaking. I hope you have fun with your new toy." Adjust the pitch and volume trimmers to your lik-

Sugar Software

AUTO RUN

Auto Run is a utility program for the TRS-80* Extended Basic Color Computer. It is used to add convenience and professionalism to your software.

Auto Run will help you create your title screen with the graphics editor. The graphics editor allows you to choose a background color and border style. Using the arrow keys and several other commands you can draw pictures, block letters and also include text.

Auto Run will generate a machine/language loader program to preceed your program on the tape. Then, to start up your program, simply type CLOADM to load in the Auto Run loader program, which will then automatically start itself up, display your title screen, load your program and then RUN or EXEC it.

Also you may record a vocal or musical introduction preceding your program. The Auto Run loader will control the audio on/off.

Basic programs can be set to load anywhere in memory above &H600 (the PCLEAR 0 page).

Software authors: The Auto Run prefix may be appended to your software products.

Auto Run is $14.95 and includes complete documentation and an assembly source listing.
Requires 16K Extended Basic.

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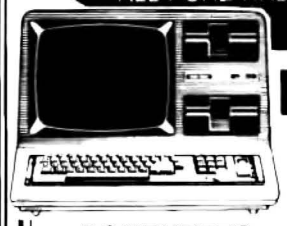

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From Spectral Associates, this "Pac" theme game is the best of it's type. Brilliant color, action and sound, just like an arcade gobble your way to glory, but watch for those ghosts! Get in on the wild fun of this game craze now. Tape: $21.95, Disk: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

DONKEY KING

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

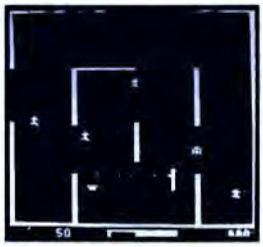
GHOST GOBBLER

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

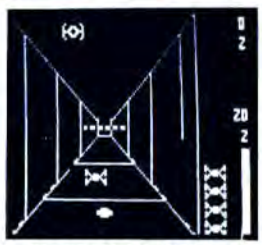


ANDROID ATTACK

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

FROGGER

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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ing while the computer is speaking. Then enter the edit mode and change some of the phonemes, pressing the S key after each change to hear what you did. Now take the phoneme list given in Table 1 and string together some phrases of your own.

It's easy to generate speech with this program and to adjust the phoneme list until it suits you. However, the array dimensions and the limited screen size in edit mode allow you to construct a maximum of 100 phonemes, or about 30 seconds of speech, in one pass of the

Listing continued

```
600 LG=LEN(A$):B$=LEFT$(A$,1):IC=VAL(B$):IF IC<>1 AND IC<>2 AND
IC<>3 THEN B$="":GOTO620:ELSE 610 'FIND PHONEME CODE AND STORE
610 IC=IC*64:A$=RIGHT$(A$,LG-1)
620 FORI=1TO64:IF A$=C$(I) THEN 640 ELSE NEXTI
630 PRINT@457,"re-enter phoneme ";:LINEINPUTA$:PRINT@448,STRING$
(32," ");:GOTO600
640 Z(J)=(I-1) OR IC:P$(J)=B$+A$:LG(J)=LG:RETURN
650 CLS:LA=0:PRINT" ";:FORI=1TOJM:PRINTP$(I)+" ";:LA=LA+LG(I):NE
XT 'PRINT PHONEME LIST
660 LA=LA+JM:RETURN
670 IF J<1 OR LC<0 THEN J=1:RETURN:ELSE 680 'CURSOR HANDLING
680 PRINT@LB,CHR$(143);:PRINT@LC,CHR$(138);:LB=LC:RETURN
690 LG=1 'SPEAK WHOLE LIST
700 FORI=LG TOJM:P=Z(I):GOSUB580:NEXTI:P=63:GOSUB580:RETURN 'SPE
AK PART OF LIST
710 PRINT@489,"edit";:RETURN
720 LG=LEN(A$):A$=RIGHT$(A$,LG-F):F=0:GOSUB600:LC=LC+1:PRINT@LC,
P$(J):LC=LC+LG:J=J+1:JM=JM+1:LA=LA+LG+1 'PHONEME INPUT PROCESSOR
730 PRINT@LB,CHR$(143);:LB=LC:GOSUB670:A$="":RETURN
```

RESISTORS (¼ watt, 5% or 10% carbon except as noted. K = 1,000)

1	10 ohm
1	2.2K
2	3.3K
13	4.7K (Integrated resistor arrays were used for the 5 V pullups)
1	6.8K
1	10K
1	100K
2	10K miniature trimmer potentiometers

CAPACITORS

1	150 pF mica
1	0.01 μF disk ceramic
8	0.1 μF disk ceramic
2	10 μF 25 V electrolytic
1	100 μF 16 V electrolytic
1	220 μF 16 V electrolytic

SEMICONDUCTORS

1	2N2222 transistor
1	6522 IC
1	74LS138 IC
1	74LS74 IC
1	SC-01 IC
1	7416 IC
1	LM386 IC
	2716 EPROM or 6116 RAM, 1 or 2 each, as desired

MISCELLANEOUS

1	8 ohm miniature speaker
1	circuit board
1	speaker jack
	sufficient wire-wrap or wiring-pencil wire for circuit
1	8-pin low-profile socket
2	14-pin low-profile socket
1	16-pin low-profile socket
1	22-pin low-profile socket
1	40-pin low-profile socket
2	24-pin low-profile socket (if you wish to include ROM/RAM)

Table 2. Parts List

program. If you want to put together a longer discourse, you'll have to do it in 100-phoneme chunks, or redimension and revise the program so the screen will scroll when the editing routine runs out of room.

Synthesizer Uses

I haven't yet used the EPROM or RAM in generating speech; however, it wouldn't be hard to code a machine-language driver program with phoneme lists built in for useful phrases such as "prepare your tape recorder," "turn on the printer," or "defend yourself, Captain, the Klingons are attacking." The USR function in Basic could be used to call the speech routine from your programs, and to pass a parameter to it to select a phrase from the stock you built into the EPROM. If you like game programming, this could add a touch to your work.

A more serious task of interest to machine-language programmers would be to write a program that speaks the hexadecimal bytes in a block of memory. A "vocal hex dump" is extremely useful for checking and debugging code.

Another exciting use for speech synthesizers is to read English text aloud. With a suitable text-to-speech algorithm, a synthesizer can become a talking book for the blind or a substitute vocal tract for persons with impaired speech. Several commercially produced synthesizers are available that pronounce ASCII-coded sentences. Ciarcia described a versatile and inexpensive synthesizer in the September and October 1982 issues of *Byte* (pp. 64–88 and 40–64, respectively).

With a clever program, this unit can perform the same tasks: aid the handicapped, read out Basic programs for checking, or read text material to a student. There's no reason why artificial speech couldn't eventually become as common and accepted a form of computer output as video-screen dumps or printed copy.

Other Ideas

You can tailor the unit to your own needs by only building parts of the circuit. A plug-in containing just the 6522 VIA chip would supply two I/O ports, two timers, and a shift register, and could be used to drive many things besides a speech synthesizer. If you'd like a RAM/EPROM board instead, wire a small unit containing the 24-pin sockets plus the circuits involving the 74LS138 and pins 1 and 2 of the 7416. If you want even more memory, you can use the other outputs from the 74LS 138 to drive pins 18 and 20 of up to seven 24-pin memory sockets; the last select can't be used because it would conflict with addresses already used in the computer.

If you want only one of the 2K memory chips, you don't need the 74LS138 and 7416 at all. Use the $C000 select signal already present on the cartridge socket. Of course, if you have your own circuits to try, you can build just the blank expansion board and experiment.

The plug-in I've described gives you a multipurpose peripheral with features you'd have difficulty buying. Your Color Computer has an impressively engineered circuit, and much of its power is waiting to be tapped. There's no better way to learn about your computer than to design and build your own modifications, so start implementing your ideas. ■

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BY JERRY HOGAN

TAPE INDEX SYSTEM

This program will keep an ordered index of the CoCo programs you have on tape. For each tape, it will list up to 40 program names—the largest number that can be displayed at one time.

The program needs 376 bytes of memory to run. All line numbers ending with a 5 are comment lines and must be deleted to run in 4K. If you have 16K memory, change line 1010 to read:

1010 CLEAR 1000,1626: R = 1627: T = 39

Don't waste time looking for one program out of dozens. Use this utility to make a handy index.

```
 0 NAMEFILE     DATAFILE     H0
 3 COMENT1      COMENT2      PAGE1
 6 PAGE2        PAGE3        PAGE4
 9 NAMEFILE     Ov
12 CCBUG        MOUSE        HEXCONV
15 SIX          PHONENUM     CHECKERS
18 LUNERLND     RS232        FORMBILD
21 PAINTLIN     ROADRACE     FIFTEEN
24 BALL         TYPING       FOURTH
27 MICE         BABYBUG      ********
30 ********     ********     ********
33 ********     ********     ********
36 ********     ********     ********
```

Fig. 1. Example of Program Output

Program Listing 1. NAMEFILE

```
1 'COPYRIGHT (C) 1982 BY J O HOGAN  LAST UPDATE 1,13,82
2 GOTO 1010
10 GOTO 1110
1010 CLEAR 400,4062:R=4063:T=39
1020 DIM N$(T)
1030 FOR I=O TO T: N$(I)="********":NEXT
1040 K=0:AUDIO ON
1050 FOR I=0TO21: READ P:POKE(I+R),P :NEXT
1060 OPEN"O",#-1,""
1080 CLOSE#-1:P1$="1982":P2$="DATA"
1110 CLS:PRINT@129,"ENTER DESIRED OPERATION # THEN PRESS ENTER"
1111 PRINT@0,"COPYRIGHT (C) 1982 BY J O HOGAN"
```

Listing continued

To use this technique, fast forward past all the programs on the tape, CSAVE "99999999", and then rewind the tape. Remove that tape, CLOAD "NAMEFILE", type RUN, select option 1, and then load the original tape and press play. An index of all the programs on the tape should appear on the screen.

When you run this program, it will display a menu of five options. The only way to return to Basic is to press break.

Option 1 starts the cassette motor and reads program names, keeping a list of all names until it reads 99999999. It will then display the list of names on the screen for 20 seconds before returning to the menu.

Option 2 reads a data file from a cassette. You are first asked for the name of the data file you wish to read. If you enter a quotation mark and press

System Requirements

4K, 16K RAM
Extended Color Basic

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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**

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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**

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

The Assembler features **all** of the following: complete 6809 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**

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Listing continued

```
1120 PRINT@ 224,"1    READ FILE NAMES FROM TAPE"
1130 PRINT@ 288,"2    READ NAMES FROM DATA FILE"
1140 PRINT@ 352,"3    SAVE NAMES ON DATA FILE"
1150 PRINT@416,"4    LIST FILE TO PRINTER"
1152 PRINT@480,"5    LIST FILE ON SCREEN"
1160 INPUT P : P=INT(ABS(P))
1170 IF NOT(P=1 OR P=2 OR P=3 OR P=4)THEN GOTO 1820
1180 ON P GOTO 1610,1910,1710,1810
1610 EXEC R
1620 A$="":P=(256*PEEK(126))+PEEK(127)
1630 FOR I=P TO P+7: A$=A$+CHR$(PEEK(I)):NEXT
1640 IF A$="99999999" THEN GOTO 1670
1650 N$(K)=A$:K=K+1:PRINT A$:GOTO 1610
1670 CLS:PRINT@ 260,K;" ";"FILES ON THIS TAPE"
1680 GOTO 1820
1710 CLS:PRINT@71,"TYPE IN THE DATE WITHOUT COMMAS THEN PRESS EN
TER"
1720 INPUT P1$
1730 CLS:PRINT@70,"TYPE IN THE DESCRIPTION OF THE CONTENTS OF TH
E TAPE"
1740 PRINT@198,"THEN PRESS ENTER":INPUT P2$
1750 CLS:PRINT@69,"TYPE IN NAME TO BE USED FOR DATA FILE, 8 CHAR
 MAX":INPUTA$
1760 CLS:PRINT@72,"POSITION TAPE AND PRESS INTER":MOTOR ON:INPUT
 P:MOTOR OFF
1770 CLS:PRINT@70,"SET CASSETTE TO RECORD AND PRESS ENTER"
1780 INPUT P:OPEN"O",#-1,A$:FOR I=0 TO T
1790 PRINT #-1,N$(I):NEXT: PRINT #-1,P1$,P2$: CLOSE #-1:GOTO 182
0
1810 OPEN"O",#-2,"":FORI=0TOT-1STEP3:PRINT#-2,I;N$(I);" ";N$(I+1
);
1811 PRINT#-2," ";N$(I+2):NEXT:CLOSE#-2
1820 FOR I=0 TO T-1 STEP 3
1830 PRINT I;N$(I);" ";N$(I+1);" ";N$(I+2):NEXT
1840 PRINT P1$;" ";P2$
1850 FOR I=1 TO 10000 :NEXT: GOTO 1110
1910 CLS:PRINT"TYPE IN NAME OF DATA FILE":INPUTA$:OPEN"I",#-1,A$
1920 FOR I=0 TO T
1930 INPUT #-1,N$(I):NEXT:INPUT #-1,P1$,P2$
1940 CLOSE#-1:GOTO 1820
2010 DATA 173,159,160,4,173,159,160,6,182,0,124,38,247,246,255
2020 DATA 33,196,247,247,255,33,57
```

Program Listing 2. Remarks

```
@5 'ALL LINES ENDING IN 5 ARE COMMENT LINES AND WILL NOT RUN IN 4
K
15 ' GO START WORK
1005 ' SET STRING SPACE, LEAVE ROOM FOR MACHINE-LANGUAGE PROGRAM
1015 ' SET UP ARRAY FOR FILE NAMES
1025 ' INITIALIZE VARIABLES
1045 ' LOAD MACHINE-LANGUAGE PROGRAM
1055 ' GIVE THE ML PROGRAM THE ADDRESS OF TAPE BUFFER
1105 ' PUT MENU ON SCREEN
1115 ' READ NAMES SUB STARTS AT 1610
1125 ' READ FILE SUB STARTS AT 1910
1135 ' SAVE LIST TO DATA FILE STARTS AT 1710
1145 ' LIST FILE TO PRINTER SUB STARTS AT 1810 AND TO SCREEN AT
1820
1155 ' DO YOUR BEST TO MAKE SOMETHING USEFUL OUT OF INPUT
1165 ' ANY OUT-OF-RANGE NUMBER WILL LIST FILE
1605 ' DO THE ML PROGRAM (READ TAPE UNTIL NAME BLOCK IS READ THE
N RETURN TO BASIC)
1615 ' THE ADDRESS OF WHERE THE NAME IS STORED IS AT 126 & 127
1625 ' READ THE NAME INTO A$
1635 ' IF 99999999 YOUR WORK IS ALL DONE GO LIST FILE
1645 ' MORE TO COME STORE NAME IN ARRAY AND GO GET NEXT NAME
1705 ' SUB TO SAVE LIST ON TAPE WE NEED DATE, NAME, AND DESCRIPT
ION
1775 ' OPEN TAPE BUFFER FOR OUTPUT, NOW LOOP "T" TIMES
1785 ' WRITE NAMES TO TAPE, WRITE DATE & DESCRIPTION THEN CLOSE
BUFFER
1805 ' SUB TO LIST NAMES TO PRINTER
1815 ' SUB TO PRINT NAMES ON THE SCREEN
1825 ' WRITE 3 NAMES ON A LINE WITH A NUMBER FOR THE FIRST ONLY
1845 ' GIVE THEM TIME TO READ THE SCREEN AND THEN GO BACK TO MEN
U
1905 ' SUB TO READ A DATA FILE FROM TAPE, WE NEED A FILE NAME
1915 ' LOOP "T" TIMES THE FILE WILL HAVE THAT MANY NAMES
1925 ' READ THE TAPE DATA FILE
1935 ' CLOSE THE BUFFER AND GO LIST THE NAMES
1955 '
1965 '
3005 ' R IS THE STARTING ADDRESS FOR THE ML PGM
```

Listing continued

return, the program will read the next file on the cassette. If you type in a name, the index utility will read past all files until it finds the program with that name. It will then display the contents of that data file on the screen for 20 seconds before returning to the menu.

Option 3 asks you to type in the date, the description of the tape the index is for, and the name to be used for the data file. The program will turn on the cassette motor and ask you to position the tape, and then the program will turn the motor off and ask you to press the record button. At that time, the program will record a data file. The program will again display the contents of the data file on the screen for 20 seconds before returning to the menu.

Option 4 lists the index of names on the printer. Then the program will display the contents of the data file on the screen for 20 seconds before returning to the menu.

"All the line numbers ending with a 5. . . must be deleted to run in 4K."

Option 5 displays the index of names for 20 seconds and then returns to the menu. The display can be held on the screen by pressing the shift key and the @ key at the same time. The display will remain until you press another key.

You can turn up the volume of your TV set and hear when the last program has been read by option 1. You can then stop the tape recorder, remove the tape, insert a tape that has a program named 99999999 and it will display the name file. Or you can press the break key and hold it down; the program will return to Basic the next time it reads any name from the tape. From the command mode, GOTO10 will return you to the menu and leave the name file in memory.

Leave a space at the beginning of each tape. Then load Namefile, use option 1 to build a data file, position the tape at the first file, and use option 3 to record the data file. Then, when you pick up a tape you can load Namefile, select option 2, place the tape in the recorder, rewind, press play, and type in a quotation mark for the name and you will get the full list of names on that tape.

I number my tapes with odd numbers; the flip side has the next larger even number. Tape 1 has nothing but

data files named DATA1, DATA2, DATA3, and so on. My next program will use the data files to build an alphabetic list of all the names, but for now I must read each one until I find the name I want.

The EXEC function is used instead of the USR function to allow the program to run in both regular and Extended Basic.

EXEC calls a machine-language program that will do the following things:

- start the cassette motor.
- mask interrupts.
- synchronize to tape leader.
- read blocks from the tape into memory until a name block is read. *#
- turn off cassette motor.
- return to Basic program.

* A name block is type 0.
A data block is type 1.
An end of file block is type 255.

\# At line 1060, the computer is told where to store the block in memory before this section is executed. The address of the first byte of the buffer is kept at 126,127 (007EH-007FH). ■

Write to Jerry Hogan at 544 Douglas St., Redwood City, CA 94063.

Listing continued

```
3015 ' T IS THE NUMBER OF NAMES WE WILL HAVE IN A DATA FILE MAX
3025 ' N$ IS THE ARAY WE STORE THE NAME IN AS STRING VARIABLES
3035 ' I IS USED AS AN INDEX FOR FOR NEXT LOOPS
3045 ' K IS USED TO COUNT HOW MANY FILES HAVE BEEN READ FROM TAP
E
3055 ' P1$ IS USED TO STORE THE DATE AS A STRING
3065 ' P2$ IS USED TO STORE THE DESCRIPTION OF THE FILE AS A STR
ING
3075 ' P IS USED FOR A DUMMY INPUT
3085 ' P IS USED TO HOLD THE ADDRESS OF "NAME" IN MEMORY
3095 ' A$ IS USED TO STORE A FILE AS A STRING
3105 '
3115 '
4005 ' MACHINE LANGUAGE IN HEX
4015 '      AD 9F     A0 04 JSR        START TAPE
4025 'LOOP AD 9F     A0 06 JSR        READ BLOCK
4035 '      B6        00 7C LDA        GET BLOCK TYPE
4045 '      26 F7           BNE LOOP   GO TO LOOP IF BLOCK TYPE NO
T ZERO
4055 '      F6        FF 21 LDB        GET MASK
4065 '      C4 F7           ANDB       ZERO BIT 3
4075 '      F7        FF 21 STB        TURN ON MOTOR
4085 '      39              RTS        RETURN TO BASIC
4095 '
4105 '
4115 ' CALL "CASRDON" RELATIVE ADDRESS AT A004H, THIS WILL
4125 ' MASK INTERPUTS, START THE CASSETTE MOTOR & SYNCRONIZE TO
THE LEADER
4205 ' CALL "BLKIN" RELATIVE ADDRESS AT A006H, THIS WILL READ ON
E BLOCK
4215 ' FROM THE CASSETTE AND WRITE IT INTO MEMORY AT "BUFIN"
4235 ' "BUFIN" HAS A RELATIVE ADDRESS AT 007EH-007FH
4305 ' "BLOCKIN" STORED THE BLOCK TYPE AT 007CH
4315 ' LINE 4035 READS THE BLOCK TYPE IN THE "A" REGISTER
4405 ' BRANCH BACK TO "LOOP" IF BLOCK TYPE NOT EQUAL TO ZERO
4505 ' THE PIA IS ADDRESSED AT FF21H AND WE NEED TO GET A COPY
4515 ' SO WE CAN CHANGE ONLY BIT 3
4605 ' ZERO BIT 3 OF THE "B" REGISTER
4705 ' ZERO BIT 3 OF THE PIA  THAT WILL TURN OFF CASSETTE MOTOR
4805 ' RETURN TO BASIC
```


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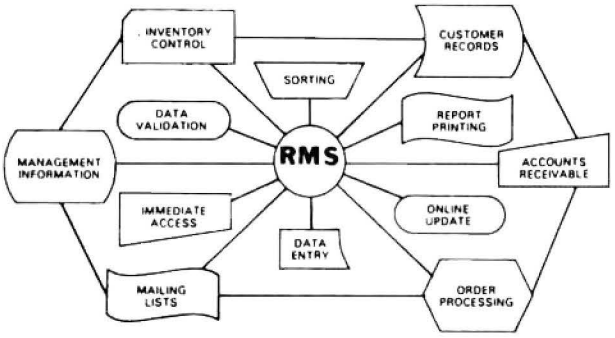

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When you are entering the Program Listing, don't add any extra spaces because there are only about 150 bytes of memory left in the program as listed. If you want to change or add to the program, delete the remark statements for extra space.

Once you've entered the program, you can check it by adding the following program steps. (Steps 30 and 810 should be deleted first.)

```
865 GOTO 5000
5000 D(1)=1:D(2)=13:D(3)=12:D(4)=11:D(5)=10
5010 S(1)=4:S(2)=4:S(3)=4:S(4)=4:S(5)=4
5020 GOTO 870
```

Type RUN, press enter and select 3

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LINE #	Program notes
50-100	Menu selection
110-210	Instructions
220-340	Payoff list
350-730	Store card symbols and numbers
740	Dimension the arrays
750	Set T(1) to T(52) to 0
760-800	Deal 10 random cards out of 52
810-860	Calculate the card suit and value of the 10 cards
870-1680	Display the cards
1690-1850	Card change routine
1860-2060	Compute card holding
2070-2430	Screen displays and sound

Table 1. Program Breakdown

	D(1)	D(2)	D(3)	D(4)	D(5)	S(1)	S(2)	S(3)	S(4)	S(5)	WIN
RF	1	13	12	11	10	1	1	1	1	1	200
SF	9	13	12	11	10	2	2	2	2	2	55
F	8	13	12	11	10	3	3	3	3	3	8
F	8	13	12	11	10	4	4	4	4	4	8
S	8	9	12	11	10	3	4	4	4	4	5
4K	8	8	8	8	10	3	4	4	4	4	25
3K	8	8	8	2	10	3	4	4	4	4	2
FH	8	8	8	2	2	3	4	4	4	4	15

Table 2. Values to Check Winning Combinations

Program Listing

```
10 CLEAR1000:CLS
20 PCLEAR4
30 'DUANE ROUCH, 12620 MEMORY LANE, BOWIE, MD, 20715 - SEPT 1982
40 PRINT@8,"DRAW POKER GAME"
50 PRINT@105,"1. INSTRUCTIONS":PRINT@169,"2. PAYOFFS"
60 PRINT@233,"3. PLAY":PRINT@297,"SELECT OPTION"
70 Z$=INKEY$:IF Z$=""THEN70
80 S=ASC(Z$)-48:IFS<1ORS>3THEN70
90 IFS=3THEN350
100 IFS=2THEN220
110 CLS 'INSTRUCTIONS
120 PRINT "YOU WILL BE DEALT FIVE CARDS."
130 PRINT:PRINT"IF YOU'RE HAPPY WITH THE HAND"
140 PRINT"PRESS <ENTER> TO COLLECT YOUR"
150 PRINT"WINNINGS. TO CHANGE CARDS YOU":PRINT"ARE NOT HAPPY ABO
UT, PRESS THE"
160 PRINT"CARD NUMBERS (1 TO 5) YOU WANT":PRINT"TO CHANGE. IF YO
U MAKE AN"
170 PRINT"ERROR OR CHANGE YOUR MIND JUST":PRINT"PRESS <SHIFT> AN
D THE NUMBER"
180 PRINT"OF THE CARD YOU ERRED ON.":PRINT
190 PRINT "PRESS <ENTER> TO CONTINUE"
200 A$=INKEY$:IFA$=""THEN200
210 CLS:GOTO40
220 CLS'PAYOFF LIST
230 PRINT"HAND                    $$$"
240 PRINT"- - - - - - - - - - - - - - -"
250 PRINT"ROYAL FLUSH             200"
260 PRINT"STRAIGHT FLUSH           55"
270 PRINT"FOUR OF A KIND           25"
280 PRINT"FULL HOUSE               15"
290 PRINT"FLUSH                     8"
300 PRINT"STRAIGHT                  5"
310 PRINT"THREE OF A KIND           2"
320 PRINT:PRINT"PRESS <ENTER> TO CONTINUE"
330 A$=INKEY$:IF A$=""THEN330
340 CLS:GOTO40
350 CLS:PCLEAR4 'STORE SYMBOLS
360 D$="C8S8BM+3,0;H3E3F3G3" 'DIAMOND
370 H$="C8S8BM+3,0;H3U2E1F2E2F1D2G3" 'HEART
380 S$="C6S8BM+2,0;E1U2G1L2U1E3F3D1L2H1D2F1NL2" 'SPADE
390 C$="C6S8BM+1,0;E1U1L2U2R2U2R2D2R2D2L2D1F1NL4" 'CLUB
400 F$="BM+1,0;R1NR1U6G1BM+6,+5" '1
410 O$="NR4U1E1R1E2U1H1L2G1BM+7,5" '2
420 P$="BM+0,-1;F1R2E1H2E2H1L3BM+7,6" '3
430 Q$="BM+3,0;U2NR1L3U1E3D3BM+4,3" '4
440 R$="BM+0,-1;F1R2E1U2H1L3U2R4BM+3,6" '5
450 M$="BM+4,-5;H1L2G1D4F1R2E1U1H1L3BM+7,3" '6
```

Listing continued

(Play). Press enter again after the cards are displayed. You should have the Ace, King, Queen, Jack, and 10 of spades, with WIN $200 and TOTAL $199 displayed on the screen.

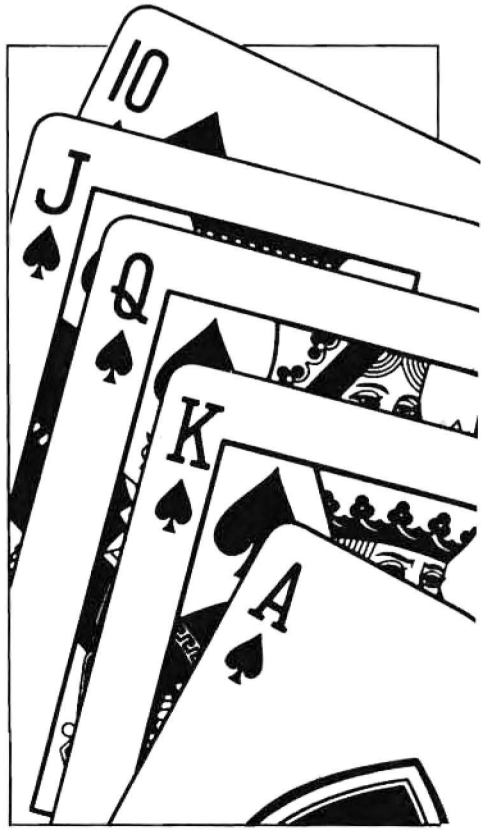
By changing the values of D and S in 5000 and 5010, any combination of cards can be displayed. See Table 2 for the values to be used to check other winning combinations.

In this game, you are initially dealt five cards. You may keep all five, or draw from one to five cards to better your hand. It takes three of a kind or better to win. The computer then lets you know whether you won or lost, and gives a running dollar total.

To play the game, type RUN and press enter. Next select instructions, payoffs, or play from the menu. The instructions or payoffs will be displayed until you press enter again. The program will return to the menu for your next choice.

When the play option is selected, five cards are displayed on the screen with the numbers 1-5 beneath them. If you have a winner (any hand that contains three of a kind or better), press enter to have the winnings added to your total.

If you want to better your holdings, press the number of the card or cards you want to replace; you can replace any or all of them. The remaining cards with the numbers still under them are the cards that you want to hold.



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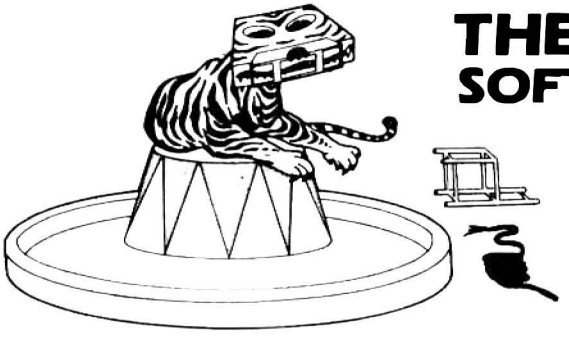

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If you make an error or change your mind about a card you rejected, press and hold the shift key and press the number of the card you want back. When the selection process is completed, press enter to get your replacement cards and see how well you did.

Press enter to deal a new hand and start the card selection process over again, or press any key to return you to the menu.

"It takes three of a kind or better to win."

Remember that there is a $1 ante; so if you win, the total will increase a dollar less than what you win. In other words, if you win $5, the total dollars only increase by $4.

For those of you who aren't card players, I've included a listing of the card values and what makes up a winning hand (see Tables 3 and 4). Table 5 lists the probabilities of winning and the resulting payoff. Good Luck! ■

Write to Duane Rouch at 12620 Memory Lane, Bowie, MD 20715.

Listing continued

```
460 T$="U1E4U1L4BM+7,6" 'T
470 U$="BM+1,0;H1U1E1H1U1E1R2F1D1G1NL2F1D1G1L2BM+6,0" '8
480 V$="BM+0,-1;F1R2E1U4H1L2G1D1F1R2BM+4,3" '9
490 W$="R1NR1U6G1BM+5,+5;H1U4E1R2F1D4G1L2" '10
500 X$="BM+0,-1;F1R1EU5NL1R1" 'J
510 Y$="BM+1,0;H1U4E1R2F1D3G1NH1NF1G1L1" 'Q
520 Z$="U3NU3R1NE3F3" 'K
530 N$="U4E2F2D2NL4D2BM+3,0" 'A
540 G$="BM+3,-2;F1R2E1H1L2H1E1R2F1BH2D6BM+5,0" '$
550 TA$="BM+2,0;U6NL2R2BM+3,6" 'T
560 LA$="NU6R4U1BM+3,1" 'L
570 WA$="NU6E2NU1F2U6BM+3,6" 'W
580 NA$="BM+1,0;R1NR1U6NL1R1BM+4,+6;U6F1D1F2D1F1NU6BM+3,0" 'IN
590 OA$="BM+1,0;H1U4E1R2F1D4G1L2BM+6,0" 'O OR 0
600 AB$="U4NR4U4R4D8BM+5,0"
610 CB$="NR4U8R4BM+4,8"
620 DB$="U8R3F1D6G1NL3BM+5,0"
630 EB$="NR4U4NR3U4R4BM+4,8"
640 GB$="BM+4,-4;D4L4U8R4BM+5,8"
650 HB$="U4NR4U4BR4D8BM+5,0"
660 LB$="NR4U8BM+8,8"
670 NB$="U8D1F6D1NU8BM+4,0"
680 OB$="U8R4D8NL4BM+4,0"
690 PB$="U8R4D4NL4BM+4,4"
700 RB$="U8R4D4L4F4BM+4,0"
710 SB$="R4U4L4U4R4BM+4,8"
720 TB$="BR2U8NL2R2BM+4,8"
730 M=0
740 DIMT(52),D(10),V(14),H(4)
750 FOR A=1TO52:T(A)=A:NEXTA
760 'DEAL THE CARDS
770 FOR A=1 TO 10
780 C=RND(52)
790 IFT(C)=0THEN780
800 D(A)=C:T(C)=0
810 'BREAK INTO SUITS AND VALUES
820 IFD(A)<14THEN S(A)=1:GOTO860
830 IFD(A)<27THEN S(A)=2:D(A)=D(A)-13:GOTO860
840 IFD(A)<40THEN S(A)=3:D(A)=D(A)-26:GOTO860
850 S(A)=4:D(A)=D(A)-39
```

Listing continued

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A(high), K, Q, J, 10, 9, 8, 7, 6, 5, 4, 3, 2, A(low).
The ace is low only in the sequence 5-4-3-2-A.

Table 3. Card Values in Order

1. RF—A, K, Q, J, and 10 in the same suit
2. SF—Five cards in order in the same suit
3. 4K—Four cards of the same value
4. FH—Three cards of one value and two cards of another value
5. F—Any five cards in the same suit
6. S—Five cards in order but not in the same suit
7. 3K—Three cards of one value

Table 4. Rank of Hands

HAND	WAYS	ODDS	%	$$$
RF	4	1 in 649,740	0.00015	200
SF	36	1 in 72,193	0.0013	55
4K	624	1 in 4,165	0.024	25
FH	3,744	1 in 694	0.145	15
F	5,108	1 in 509	0.2	8
S	10,200	1 in 255	0.4	5
3K	54,912	1 in 47	2.1	2

Table 5. Winning Probabilities and Payoff

Abbreviations used in Tables 2, 4 and 5:

RF = royal flush, SF = straight flush, F = flush, S = straight
4K = four of a kind, 3K = 3 of a kind, FH = full house
D column—1 = ace, 13 = king, 12 = queen, 11 = jack
S column—1 = club, 2 = diamond, 3 = heart, 4 = spade

Listing continued

```
860 SS(A)=S(A):DD(A)=D(A):NEXT A
870 PMODE 3,1:PCLS:SCREEN1,1
880 LINE(16,16)-(48,64),PSET,B
890 LINE(64,16)-(96,64),PSET,B
900 LINE(112,16)-(144,64),PSET,B
910 LINE(160,16)-(192,64),PSET,B
920 LINE(208,16)-(240,64),PSET,B
930 L=0:DRAW"C7;"
940 DRAW"S4BM32,72;ND12;":IFL=1THEN1730
950 DRAW"S4BM77,72;R6D6L6D6R6;":IFL=1THEN1730
960 DRAW"S4BM125,84;R6U6NL5U6L6;":IFL=1THEN1730
970 DRAW"S4BM173,72;D6R6NU6D6;":IFL=1THEN1730
980 DRAW"S4BM221,84;R6U6L6U6R6;":IFL=1THEN1730
990 'DISPLAY THE CARDS
1000 FOR A=1TO5
1010 IFA=1THENDRAW"BM30,60;":H=37:GOSUB1640:DRAW"S8BM22,32;":GOS
UB1500
1020 IFA=2THENDRAW"BM78,60;":H=85:GOSUB1640:DRAW"BM70,32;":GOSUB
1500
1030 IFA=3THENDRAW"BM126,60;":H=133:GOSUB1640:DRAW"BM118,32;":GO
SUB1500
1040 IFA=4THENDRAW"BM174,60;":H=181:GOSUB1640:DRAW"BM166,32;":GO
SUB1500
1050 IFA=5THENDRAW"BM222,60;":H=229:GOSUB1640:DRAW"BM214,32;":GO
SUB1500
1060 NEXTA
1070 IFB=0THEN1690
1080 GOTO1860
1500 'CARD VALUE SUBROUTINE
1510 IFD(A)=1THENDRAW"XN$;":RETURN
1520 IFD(A)=2THENDRAW"XO$;":RETURN
1530 IFD(A)=3THENDRAW"XP$;":RETURN
1540 IFD(A)=4THENDRAW"XQ$;":RETURN
1550 IFD(A)=5THENDRAW"XR$;":RETURN
1560 IFD(A)=6THENDRAW"XM$;":RETURN
1570 IFD(A)=7THENDRAW"XT$;":RETURN
1580 IFD(A)=8THENDRAW"XU$;":RETURN
1590 IFD(A)=9THENDRAW"XV$;":RETURN
1600 IFD(A)=10THENDRAW"XW$;":RETURN
1610 IFD(A)=11THENDRAW"XX$;":RETURN
```

Listing continued

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Listing continued

```
1620 IFD(A)=12THENDRAW"XY$;":RETURN
1630 DRAW"XZ$;":RETURN
1640 'CARD SUIT SUBROUTINE
1650 IFS(A)=1THENDRAW"XC$;":PAINT(H,59),6,6:SOUND100,1:RETURN
1660 IFS(A)=2THENDRAW"XD$;":PAINT(H,58),8,8:SOUND100,1:RETURN
1670 IFS(A)=3THENDRAW"XH$;":PAINT(H,58),8,8:SOUND100,1:RETURN
1680 DRAW"XS$;":PAINT(H,59),6,6:PAINT(H,50),6,6:SOUND100,1:RETUR
N
1690 'CARD CHANGE ROUTINE
1700 B=1
1710 DRAW"C2S4BM74,140;XCB$;XHB$;XAB$;XNB$;XGB$;XEB$;BM+8,0;XCB$
;XAB$;XRB$;XDB$;XSB$;"
1720 DRAW"BM80,160;XPB$;XRB$;XEB$;XSB$;XSB$;BM+8,0;XEB$;XNB$;XTB
$;XEB$;XRB$;"
1730 K$=INKEY$
1740 IFK$ <CHR$(13)ORK$ >CHR$(13)ANDK$ <CHR$(33)ORK$ >CHR$(37)AN
DK$ <CHR$(49)ORK$ >CHR$(53)GOTO1730
1750 IFK$="1"THEND(1)=D(6):S(1)=S(6):L=1:DRAW"C5;":GOTO940
1760 IFK$="2"THEND(2)=D(7):S(2)=S(7):L=1:DRAW"C5;":GOTO950
1770 IFK$="3"THEND(3)=D(8):S(3)=S(8):L=1:DRAW"C5;":GOTO960
1780 IFK$="4"THEND(4)=D(9):S(4)=S(9):L=1:DRAW"C5;":GOTO970
1790 IFK$="5"THEND(5)=D(10):S(5)=S(10):L=1:DRAW"C5;":GOTO980
1800 IFK$="!"THEND(1)=DD(1):S(1)=SS(1):L=1:DRAW"C7;":GOTO940
1810 IFK$=CHR$(34)THEND(2)=DD(2):S(2)=SS(2):L=1:DRAW"C7;":GOTO95
0
1820 IFK$="#"THEND(3)=DD(3):S(3)=SS(3):L=1:DRAW"C7;":GOTO960
1830 IFK$="$"THEND(4)=DD(4):S(4)=SS(4):L=1:DRAW"C7;":GOTO970
1840 IFK$="%"THEND(5)=DD(5):S(5)=SS(5):L=1:DRAW"C7;":GOTO980
1850 IF K$=CHR$(13)GOTO870
1860 'CARD HOLDING
1870 FOR X=1TO4:H(X)=0:NEXTX:FOR X=1TO14:V(X)=0:NEXTX
1880 FORX=1TO5:V(D(X))=V(D(X))+1:H(S(X))=H(S(X))+1:NEXTX
1890 'WIN OR LOSE
1900 T=0:FORI=1TO4:IFH(I)<>5THEN1910ELSET=5
1910 NEXTI:I=2
1920 I=I-1:IFI<>0THEN1930ELSEI=13
1930 IFV(I)<1THEN1920ELSEIFI =1 THEN I=14:V(14)=V(1)
1940 I=I+1
1950 Z=5
1960 I=I-1:IFI=0THEN2010ELSEIFV(I)<>1THEN2000
1970 IFZ<>1THENZ=Z-1:GOTO1960
1980 T=T+4:IFT=4THEN2070ELSEIFV(14)=V(13)THENT=10ELSET=9
1990 GOTO2070
2000 IFI<>1THEN1950
2010 IFT=5THEN2070
2020 FORI=1TO13:IFV(I)<>4THEN2030ELSET=7
2030 IFV(I)<>3THEN2040ELSET=T+5
2040 IFV(I)<>2THEN2060ELSEIFT=5THEN2050
2050 T=T+1
2060 NEXTI:IFT<>5THEN2070ELSET=3
2070 'PAYOFF
2080 IFT<3THENSOUND10,4:E=0:GOTO2190 'LESS THEN 3 OF KIND
2090 DRAW"C3S8BM88,110;XWA$;XNA$;XG$;" 'WIN$
2100 FORA=10TO250STEP5:SOUNDA,1:NEXTA
2110 IFT=3THENDRAW"XO$;":E=2:GOTO2180 '3 OF KIND
2120 IFT=4THENDRAW"XR$;":E=5:GOTO2180 'STRAIGHT
2130 IFT=5THENDRAW"XU$;":E=8:GOTO2180 'FLUSH
2140 IFT=6THENDRAW"XF$;XR$;":E=15:GOTO2180 'FULL HOUSE
2150 IFT=7THENDRAW"XO$;XR$;":E=25:GOTO2180 '4 OF KIND
2160 IFT=9THENDRAW"XR$;XR$;":E=55:GOTO2180 'STRAIGHT FLUSH
2170 IFT=10THENDRAW"XO$;XOA$;XOA$;":E=200:GOTO2180 'ROYAL FLUSH
2180 FORZ=1TOE:SOUND200,3:FORB=1TO5:NEXTB,Z
2190 'TOTAL SUBROUTINE
2200 DRAW"C4S8BM56,140;XTA$;XOA$;XTA$;XN$;XLA$;XG$;" 'TOTAL$
2210 M=(M-1)+E
2220 IFM<0 THENDRAW"BM+0,-3;R4BM+3,3"
2230 X=ABS(M):X=X+.1:X=X/100:W=FIX(X):GOSUB2330
2240 F=X-W:X=F*10:W=FIX(X):GOSUB2330
2250 F=X-W:X=F*10:W=FIX(X):GOSUB2330
2260 'NUMBERS
2270 B=0
2280 DRAW"C2S4BM48,180;XPB$;XRB$;XEB$;XSB$;XSB$;BM+8,0;XEB$;XNB$
;XTB$;XEB$;XRB$;BM+8,0"
2290 DRAW"XTB$;XOB$;BM+8,0;XDB$;XEB$;XAB$;XLB$;"
2300 K$=INKEY$:IF K$=""GOTO2300
2310 IFK$=CHR$(13)GOTO750
2320 GOTO40
2330 'NUMBERS FOR TOTAL
2340 IFW=1THENDRAW"XP$;":RETURN '1
2350 IFW=2THENDRAW"XO$;":RETURN '2
2360 IFW=3THENDRAW"XP$;":RETURN '3
2370 IFW=4THENDRAW"XQ$;":RETURN '4
2380 IFW=5THENDRAW"XR$;":RETURN '5
2390 IFW=6THENDRAW"XM$;":RETURN '6
2400 IFW=7THENDRAW"XT$;":RETURN '7
2410 IFW=8THENDRAW"XU$;":RETURN '8
2420 IFW=9THENDRAW"XV$;":RETURN '9
2430 DRAW"XOA$;":RETURN '0
2440 GOTO870
```

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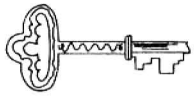

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BY JAMES WOOD

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Add, subtract, and aim light rays: colorful lessons in optics for the classroom on a 16K CoCo.

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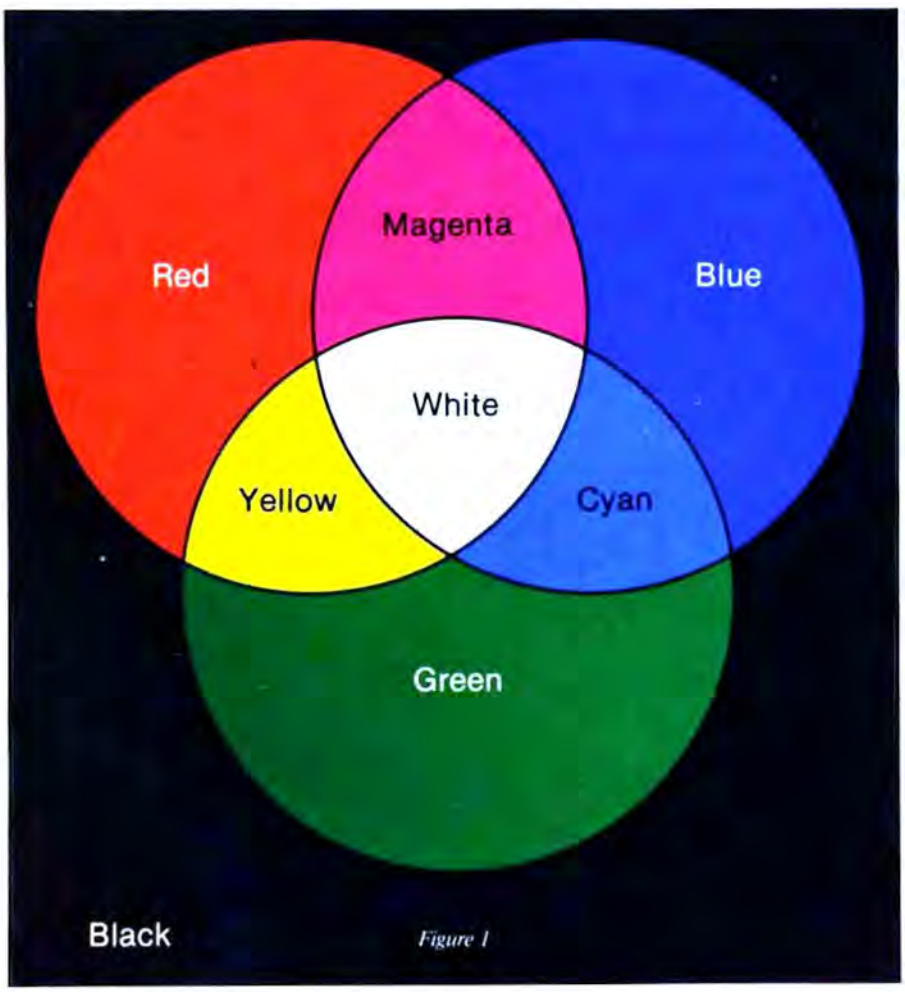

Figure 1

Program Listing 1 gives a brief lesson on the results of adding and subtracting light in different colors. The program's first half simulates the classic experiment of overlapping the beams of three projectors (Fig. 1); the second half explains the use of filters to block or subtract colors.

A knowledge of color addition helps you understand color subtraction. For instance, since yellow is the result of adding red and green, a yellow filter will allow both red and green light to pass. Listing 1 includes a short quiz to test knowledge of both concepts; the questions are shuffled each time the program runs.

The Lenses program (Program Listing 2) uses high-resolution graphics to illustrate the properties of convex and concave lenses (Figs. 2, 3, and 4). It presents ray diagrams and mathematical methods of finding images formed by lenses, and also administers a short quiz. ■

Write to James Wood at 424 N. Missouri, Box 507, Atwood, IL 61913.

System Requirements

16K RAM
Extended Color Basic

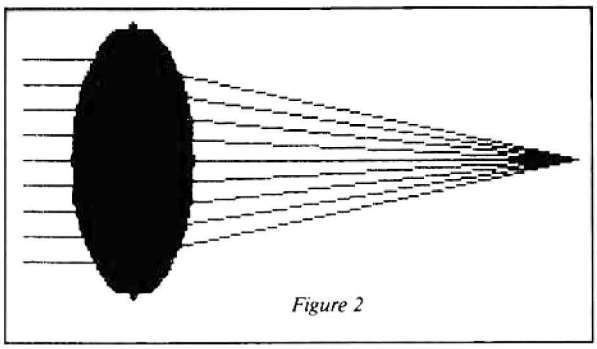

Figure 2

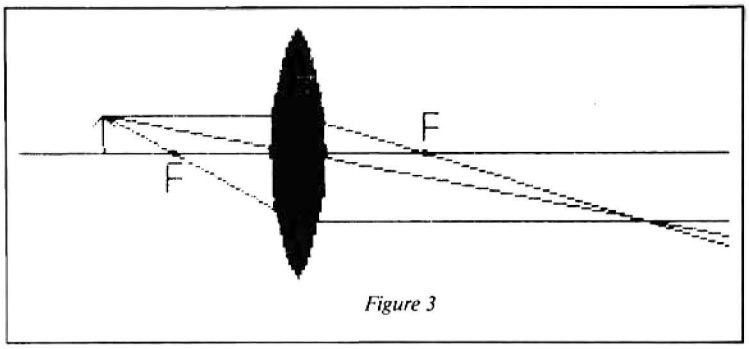

Figure 3

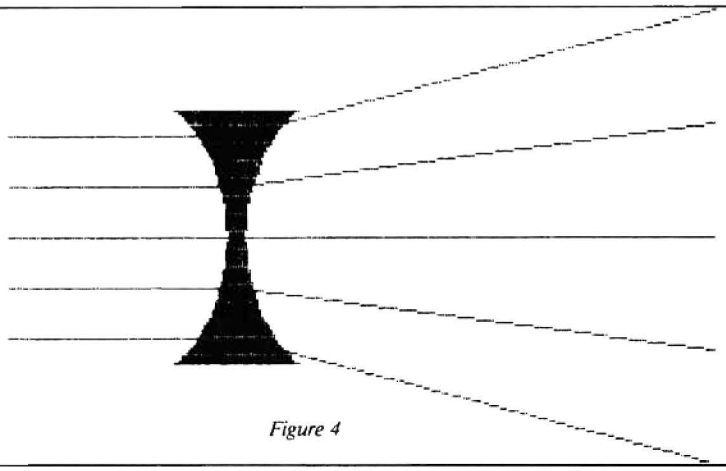

Figure 4

Program Listing next page

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Program Listing 1

```
10 REM JAMES W. WOOD, 424 N.     MISSOURI,ATWOOD,IL,61913,JUNE
1981
20 CLS:PRINT:PRINTTAB(10)"ADDING COLORS"
30 A$(1)="TO ADD COLORS IN THE PHYSICS LAB TWO OR THREE PROJECTO
RS ARE     USED. EACH ONE IS PRODUCING A     DIFFERENT COLOR OF LIG
HT. IF THE BEAMS ARE OVERLAPPED ON A       SCREEN YOU CAN SEE WHA
T COLOR    RESULTS.
40 A$(2)="YOUR PROJECTORS CAN PROVIDE FAR MORE COLOR COMBINATION
S THAN THE TRS-80 IS CAPABLE OF AT THIS    TIME."
50 A$(3)="WHEN THE COMPUTERS CAN HANDLE    MORE COLORS AND SHADES
 MAYBE     SOMEONE WILL MATHEMATICALLY     PREDICT WHAT COLOR RES
ULTS FROM THE ADDING OF TWO OTHERS AND     HAVE THE COMPUTER SHOW
 THE       RESULT."
60 A$(4)="A SCIENTIST NAMED OERSTED HAS    DONE MUCH WORK ON THIS
 TOPIC."
70 A$(5)="BUT FOR NOW LETS LOOK AT THE     CLASSIC ADDING OF THRE
E BEAMS OF LIGHT. THE BEAMS USED WILL BE   RED, BLUE, AND GREEN."
80 FORW=1TO5:L=LEN(A$(W)):FORE=1TOL:PRINTMID$(A$(W),E,1);:FORT=1
TO30:NEXTT:NEXTE:PRINT:NEXTW
90 FORT=1TO400:NEXTT
100 CLS0:PRINT@32,"ADJUST COLORS";:PRINT@64,"RED BLUE GREEN MAGE
NTA";:PRINT@96,STRING$(3,191)+CHR$(128)+STRING$(4,175)+CHR$(128)
+STRING$(5,143)+CHR$(128)+STRING$(7,239);
110 PRINT@160,"CYAN YELLOW WHITE";:PRINT@192,STRING$(4,223)+CHR$
(128)+STRING$(6,159)+CHR$(128)+STRING$(5,207);
120 PRINT@384,"PRESS ANY KEY TO CONTINUE";
130 A$=INKEY$:IFA$=""THEN130
140 GOSUB160
150 GOTO330
160 CLS0:PRINT@39,CHR$(177)+CHR$(179)+STRING$(6,191)+CHR$(179)+C
HR$(163)+CHR$(167)+STRING$(5,175)+CHR$(163)+CHR$(162);
170 PRINT@69,CHR$(177)+CHR$(183)+STRING$(7,191)+STRING$(4,239)+S
TRING$(8,175)+CHR$(162);
180 PRINT@100,CHR$(177)+STRING$(8,191)+STRING$(6,239)+STRING$(8,
175)+CHR$(162);
190 PRINT@132,CHR$(183)+STRING$(7,191)+STRING$(8,239)+STRING$(8,
175);
200 PRINT@163,CHR$(181)+STRING$(8,191)+STRING$(8,239)+STRING$(8,
175)+CHR$(170);
210 PRINT@196,STRING$(8,191)+STRING$(8,207)+STRING$(8,175);
220 PRINT@228,CHR$(180)+STRING$(5,191)+STRING$(3,159)+STRING$(6,
207)+STRING$(3,223)+STRING$(5,175)+CHR$(170);
230 PRINT@261,CHR$(180)+STRING$(3,191)+STRING$(5,159)+STRING$(4,
207)+STRING$(5,223)+STRING$(3,175)+CHR$(174);
240 PRINT@295,CHR$(188)+STRING$(7,159)+STRING$(2,207)+STRING$(7,
223)+CHR$(174)+CHR$(168);
250 PRINT@328,STRING$(16,143);
260 PRINT@360,STRING$(16,143);
270 PRINT@392,CHR$(133)+STRING$(14,143)+CHR$(138);
280 PRINT@425,CHR$(140)+STRING$(12,143)+CHR$(142);
290 PRINT@458,CHR$(132)+CHR$(140)+STRING$(8,143)+CHR$(140)+CHR$(
136);
300 PRINT@494,STRING$(4,140);
310 PRINT@480,"PRESS ANY KEY TO CONTINUE";
320 A$=INKEY$:IFA$=""THEN320ELSECLS:RETURN
330 B$(1)="RED PLUS BLUE"
340 B$(2)="RED PLUS GREEN"
350 B$(3)="BLUE PLUS GREEN"
360 B$(4)="MAGENTA PLUS GREEN"
370 B$(5)="YELLOW PLUS BLUE"
380 B$(6)="RED PLUS CYAN"
390 C$(1)="MAGENTA":C$(2)="YELLOW":C$(3)="CYAN":C$(4)="WHITE":C$
(5)="WHITE":C$(6)="WHITE"
400 CLS
410 FORX=1TO5
420 N=RND(6):IFM(N)=1THEN420ELSEM(N)=1:PRINT"WHAT IS ";B$(N):INP
UTD$
430 IFD$<>C$(N)THENPRINT"SORRY, IT IS ";C$(N):FORT=1TO800:NEXTT:
GOSUB160:NEXTX:GOTO450
440 PRINT"CORRECT":CC=CC+1:NEXTX
450 PRINT"YOU GOT ";CC;" OUT OF 5 CORRECT"
460 FORT=1TO1000:NEXTT
470 CLS:PRINT:PRINT:PRINTTAB(5)"SUBTRACTION OF LIGHT"
480 PRINT:PRINT"LAB RESULTS MAY BE DIFFERENT    BECAUSE FILTERS
ARE NOT PERFECT":PRINT
490 FORT=1TO700:NEXTT
500 A$(1)="IT IS NOW TIME TO STUDY THE     RESULT OF PASSING LIG
HT THROUGH A COLORED FILTER."
510 A$(2)="A FILTER PASSES COLORS WHICH    MAKE UP THE COLOR OF
THE FILTER."
520 A$(3)="FOR EXAMPLE"
530 A$(4)="A RED FILTER PASSES RED LIGHT."
540 A$(5)="A YELLOW FILTER WILL PASS RED   AND GREEN LIGHT BECAU
SE YELLOW  IS THE COMBINATION OF RED AND   GREEN."
550 A$(6)="LETS LOOK AT LIGHT AND FILTERS."
560 FORW=1TO6:L=LEN(A$(W)):FORE=1TOL:PRINTMID$(A$(W),E,1);:FORT=
1TO30:NEXTT:NEXTE:PRINT:NEXTW
570 FORT=1TO1000:NEXTT
580 CLS0:PRINT@75,"RED FILTER";
590 P=4:M=63:N=29:O=29:GOSUB640
600 CLS0:PRINT@75,"GREEN FILTER";:P=1:M=29:N=29:O=63:GOSUB640
610 CLS0:PRINT@75,"BLUE FILTER";:P=3:M=29:N=63:O=29:GOSUB640
620 CLS0:PRINT@75,"YELLOW FILTER";:P=2:M=63:N=29:O=63:GOSUB640
630 GOTO690
640 FORY=6TO12:SET(31,Y,P):SET(30,Y,P):NEXTY
650 FORX=0TO29:SET(X,7,4):FORT=1TO20:NEXTT,X:IFM=63THENFORX=32TO
63:SET(X,7,4):FORT=1TO20:NEXTT,X
660 FORX=0TO29:SET(X,9,3):FORT=1TO20:NEXTT,X:IFN=63THENFORX=32TO
63:SET(X,9,3):FORT=1TO20:NEXTT,X
670 FORX=0TO29:SET(X,11,1):FORT=1TO20:NEXTT,X:IFO=63THENFORX=32T
O63:SET(X,11,1):FORT=1TO20:NEXTT,X
680 FORT=1TO1000:NEXTT:RETURN
690 CLS:B$(1)="MAGENTA LIGHT AND YELLOW FILTER"
700 B$(2)="RED LIGHT AND RED FILTER"
710 B$(3)="WHITE LIGHT AND BLUE FILTER"
720 B$(4)="CYAN LIGHT AND RED FILTER"
730 B$(5)="BLUE LIGHT AND MAGENTA FILTER"
740 B$(6)="BLUE LIGHT AND RED FILTER"
750 E$(1)="RED":C$(1)="      MAGENTA IS RED AND BLUE.    THE YELLO
W FILTER PASSES RED AND GREEN. RED IS THE ONLY COLOR    PRESENT W
HICH WILL BE          TRANSMITTED BY THE FILTER."
760 E$(2)="RED":C$(2)="     (DIFFICULT)"
770 E$(3)="BLUE":C$(3)="       WHITE IS RED,BLUE, AND     GREEN. R
ED AND GREEN ARE NOT    TRANSMITTED."
780 E$(4)="NONE":C$(4)="       CYAN IS BLUE AND GREEN.    THEREFOR
E RED IS NOT TRANSMITTED BY THE FILTER"
790 E$(5)="BLUE":C$(5)="       MAGENTA PASSES BLUE AND    RED. THE
RE IS NO RED."
800 E$(6)="NONE":C$(6)="       A RED FILTER DOES NOT PASS BLUE LI
GHT"
810 FORX=1TO5
820 PRINT
830 N=RND(6):IFD(N)=1THEN830ELSED(N)=1:PRINT"WHAT COLOR RESULTS
IF YOU USE A":PRINTB$(N):INPUTD$
840 IFD$<>E$(N)THENPRINT"SORRY":PRINTE$(N):PRINTC$(N):FORT=1TO13
00:NEXTT:NEXTX:GOTO860
850 PRINT"CORRECT":CC=CC+1:NEXTX
860 PRINT"YOU NOW HAVE ";CC;" OUT OF 10 CORRECT"
870 FORT=1TO1200:NEXTT:CLS:PRINT@194,"WASN'T THIS EN'LIGHT'ENING
?"
```

Program Listing 2

```
  10 REMJAMES W. WOOD,424N.MISSOURI, ATWOOD,ILL,61913,JUNE 1981
20 CLS:PRINT:PRINTTAB(13)"LENSES":PRINT
30 DIMA$(15):PRINT"A CALCULATOR, PENCIL AND PAPER  WILL COME IN
HANDY":PRINT
40 INPUT"YOUR NAME";NA$
50 PRINT"TYPE 1 FOR ALL OF PROGRAM,      TYPE 2 TO GO TO PROBLEM
S";
60 AA$=INKEY$:IFAA$=""THEN60
70 IFAA$="1"THEN80ELSEIFAA$="2"THEN330ELSE60
80 CLS:A$(1)="LENSES ARE OPTICAL DEVICES WHICH CAUSE LIGHT RAYS
TO CONVERGE OR DIVERGE. A CONVEX LENS IS      THICKER IN THE MID
DLE THAN AT   THE EDGES. IT WILL CONVERGE RAYS OF LIGHT.":N=1:GO
SUB690
90 PRINT:A$(2)="AS A CONVEX LENS BECOMES FLATTER ITS FOCAL LENGT
H BECOMES LONGER. OBSERVE!":N=2:GOSUB690:FORT=1TO500:NEXTT:GOSUB
610
100 CLS:A$(3)="A CONCAVE LENS CAUSES LIGHT RAYS TO DIVERGE (SPRE
AD OUT)":N=3:GOSUB690:FORT=1TO500:NEXTT:GOSUB700
110 CLS:A$(4)="A MORE CONCAVE LENS WILL BEND   THE LIGHT OUT AT
GREATER ANGLES.":N=4:GOSUB690:FORT=1TO500:NEXTT:GOSUB790
120 CLS:A$(5)="THE FOCAL LENGTH OF A LENS      DEPENDS ON ITS IN
DEx OF         REFRACTION AND ITS SHAPE.":N=5:GOSUB690
130 PRINT:A$(6)="A LENS IS USED TO PROJECT IMAGES. IT MIGHT BE U
SED IN A MOVIE   PROJECTOR, A TELESCOPE, OR IN A SPOTLIGHT":N=6:
GOSUB690
140 PRINT:A$(7)="THERE ARE TWO WAYS TO PREDICT   WHERE AN IMAGE
WILL BE FORMED.  RAY DIAGRAMS AND MATHEMATICALLY. THERE ARE THRE
E RAYS WHICH ARE EASY TO DRAW.":N=7:GOSUB690
150 PRINT:A$(8)="A RAY IN PARALLEL TO THE OPTICAL AXIS WILL GO T
HROUGH THE FOCAL POINT.":N=8:GOSUB690
160 PRINT:A$(9)="A RAY WHICH PASSES THROUGH THE  OPTICAL CENTER
OF A LENS WILL   PASS UNBENT.":N=9:GOSUB690
170 PRINT:A$(10)="A RAY IN THROUGH THE FOCAL POINT WILL BECOME P
ARALLEL TO THE    OPTICAL AXIS. WATCH!":N=10:GOSUB690
180 PRINT:A$(11)="THE OBJECT WILL BE AT THE LINES POINT OF INTER
SECTION.":N=11:GOSUB690
190 FORT=1TO1000:NEXTT
200 PMODE4,1:PCLS:SCREEN1,1
210 LINE(0,100)-(255,100),PSET
220 LINE(30,100)-(30,85),PSET:LINE-(34,89),PSET:LINE(30,85)-(26,
89),PSET
230 PSET(55,99):PSET(56,99):PSET(55,101):PSET(56,101):PSET(145,9
9):PSET(146,99):PSET(145,101):PSET(146,101)
240 LINE(53,115)-(53,104),PSET:LINE-(58,104),PSET:LINE(53,110)-(
58,110),PSET:LINE(145,95)-(145,84),PSET:LINE-(150,84),PSET:LINE(
145,90)-(150,90),PSET
250 CIRCLE(70,100),40,1,2,0,.12
260 CIRCLE(70,100),40,1,2,.9,0
270 CIRCLE(130,100),40,1,2,.4,.61:PAINT(100,90),1:PAINT(100,110)
,1
280 FORT=1TO300:NEXTT:LINE(30,85)-(100,85),PSET:LINE-(255,137),P
SET
290 FORT=1TO300:NEXTT:LINE(30,85)-(255,133),PSET
300 FORT=1TO300:NEXTT:LINE(30,85)-(100,127),PSET:LINE-(255,127),
PSET
310 FORT=1TO300:NEXTT:LINE(227,100)-(227,128),PSET:LINE-(232,123
),PSET:LINE(227,128)-(222,123),PSET
320 FORT=1TO1500:NEXTT
330 CLS:A$(12)="MATHEMATICALLY THE RELATIONSHIP BETWEEN THE OBJE
CT DISTANCE,    FOCAL LENGTH, AND IMAGE DISTANCE IS":N=12:GOSUB6
90
340 PRINT:PRINT"     1/FL=1/OD+1/ID"
350 PRINT:PRINT"FL=FOCAL LENGTH":PRINT"OD=OBJECT DISTANCE":PRINT
"ID=IMAGE DISTANCE":PRINT:PRINT"WRITE THE FORMULA DOWN!"
360 PRINT:PRINT"PRESS ANY KEY FOR PROBLEMS"
370 P$=INKEY$:IFP$=""THEN370
380 FORPP=1TO5
390 ONRND(3)GOSUB420,490,560
400 NEXTPP:PRINTCC;"OUT OF 5 CORRECT"
410 PRINT:PRINT:PRINT"END OF PROGRAM.":PRINT"GOODBYE ";NA$:END
420 FL=RND(15)*5:IFRND(10)=10THENFL=-FL
430 OD=RND(30)*5
440 IF FL=OD THEN 430
450 PRINT"FOCAL LENGTH = ";FL:PRINT"OBJECT DISTANCE = ";OD:INPUT
"WHAT IS THE IMAGE DISTANCE";X
460 ID=FL*OD/(OD-FL)
470 IF ABS(X-ID)<.5 THENPRINT"CORRECT":CC=CC+1:RETURN
480 PRINT"SORRY, IT IS ";INT(100*ID)/100:RETURN
490 FL=RND(15)*5:IFRND(10)=10THENFL=-FL
500 ID=RND(30)*5
510 IF FL=ID THEN 500
520 PRINT"FOCAL LENGTH = ";FL:PRINT"IMAGE DISTANCE = ";ID:INPUT"
WHAT IS THE OBJECT DISTANCE";X
530 OD=FL*ID/(ID-FL)
540 IFABS(X-OD)<.5 THENPRINT"CORRECT":CC=CC+1:RETURN
550 PRINT"SORRY, IT IS ";INT(100*OD)/100:RETURN
560 OD=RND(30)*5:ID=RND(30)*5
570 PRINT"OBJECT DISTANCE = ";OD:PRINT"IMAGE DISTANCE = ";ID:INP
UT"WHAT IS THE FOCAL LENGTH";X
580 FL=ID*OD/(OD+ID)
590 IFABS(X-OD)<.5THENPRINT"CORRECT":CC=CC+1:RETURN
600 PRINT"SORRY, IT IS ";INT(100*FL)/100:RETURN
610 PMODE4,1:PCLS:SCREEN1,1
620 FORE=90TO250STEP10
630 CIRCLE(40,100),60-(E/50+1)*7.5,5,(E/50+1)/2
640 PAINT(50,100),1
650 FORW=60TO140STEP10:LINE(1,W)-(30,W),PSET:NEXTW
660 FORW=60TO140STEP10:LINE(30,W)-(E,100),PSET:NEXTW
670 FORT=1TO400:NEXTT:PCLS
680 NEXTE:RETURN
690 L=LEN(A$(N)):FORA=1TOL:PRINTMID$(A$(N),A,1);:FORT=1TO30:NEXT
T,A:RETURN
700 PMODE4,1:PCLS:SCREEN1,1
710 LINE(60,50)-(90,50),PSET:LINE(60,150)-(90,150),PSET
720 CIRCLE(30,100),40,1,2,0,.12
730 CIRCLE(30,100),40,1,2,.90,0
740 CIRCLE(120,100),40,1,2,.4,.61
750 PAINT(62,52),1
760 FORE=60TO140STEP20:LINE(1,E)-(75,E),PSET:LINE(75,E)-(255,(3*
E-100)/2),PSET:NEXTE
770 FORT=1TO2000:NEXTT
780 RETURN
790 PMODE4,1:PCLS:SCREEN1,1
800 LINE(60,50)-(105,50),PSET:LINE(60,150)-(105,150),PSET
810 CIRCLE(40,100),40,1,1.5,0,.17
820 CIRCLE(40,100),40,1,1.5,.85,0
830 CIRCLE(125,100),40,1,1.5,.35,.66
840 PAINT(70,52),1
850 FORE=60TO140STEP20:LINE(1,E)-(82,E),PSET:LINE(82,E)-(255,(9*
E-500)/4),PSET:NEXTE
860 FORT=1TO2000:NEXTT:RETURN
```

BY DELMAR SEARLS

3-D GRAPHICS

Graphics advertisements frequently show three-dimensional views of mathematically generated surfaces. While these graphics are appealing and impressive, there is little information available to allow home-computer owners to produce their own graphics.

The Color Computer program listings in this article can easily be adapted to any system that uses Basic, and that can set individual pixels, or dots, on the video screen.

Of the three types of displays, two of them consist of an image formed by a set of parallel lines as they rise and fall over the contours of the shape. The first of these two has these lines perpendicular to the line of sight, and the second consists of lines at about 75 degrees to the line of sight. The third display is formed by a rectangular grid of lines that follow the contours in two directions.

On the Color Computer, points are located on the video screen by a coordinate system with its origin at the upper left corner. That is, the upper leftmost point has coordinates (0,0). The first coordinate refers to the horizontal position (or column), and the second refers to the vertical position (or row). The column coordinates increase as you move right, while the row coordinates increase as you move down. This latter is, of course, just the opposite of the way the vertical coordinate changes in mathematics.

In a rectangular coordinate system the vertical coordinate increases in an upward direction. In preparing our displays it is somewhat convenient to think of plotting points on a rectangular coordinate system centered on the video screen.

For the Color Computer, with its 256 columns and 192 rows (in its highest-resolution mode), the center point is taken to be (128,96). This is to be the origin of your coordinate system. In order to plot a point (X,Y) on this coordinate system, you must convert (X,Y) into appropriate screen coordinates. This is done by using screen coordinates (128 + X,96 – Y). The negative sign in the second coordinate is a result of the different interpretation of increasing values mentioned earlier.

System Requirements

16K RAM
Extended Color Basic
Printer Optional

If you are interested in contour graphics, here are some algorithms for use on dot-matrix printers.

Display 1

Imagine that the surface you wish to graph is part of a landscape viewed at noon from above. The absence of shadows would make changes in elevation difficult to see and the terrain would appear to be flat. Next, impose a rectangular coordinate system over the surface in order to establish points of reference (see Fig. 1).

On top of this coordinate system, superimpose a set of lines parallel to the X-axis. If you further imagine that these lines are ropes, you will realize that they would rise and fall as they follow the contours of the terrain below. Only from your vantage point directly overhead would they appear to be straight. Your goal is to move your vantage point down the Y-axis (south on your "map") and look at these ropes from an angle. To improve the image, you must further imagine that the ropes are on top of opaque cross-sections of terrain and that foreground cross-sections of sufficient height would block your view of background cross-sections.

To accomplish this you must first determine the location of each point on each rope within the three-dimensional coordinate system (using Z to measure elevation). Then you must convert this three-dimensional point into a two-dimensional point on the video screen. Finally, you must prevent hidden background points from being displayed.

Your basic approach (see Fig. 2) is to process the image from left to right, along lines of sight, running parallel to the Y-axis. As you view the ropes your lines of sight will intersect them at evenly spaced intervals. These points of intersection will be processed from front to back to facilitate the identification of hidden points. Figure 3 outlines this process in more detail.

The variable MAX is used to keep track of the highest point plotted along the current line of sight. MAX is initially set to a large negative value to guarantee that the first point on each line of sight will always be plotted. It cannot be a hidden point.

Finding the X and Y coordinates at the intersections of the lines of sight and the ropes is relatively easy in this case since X increases by a fixed amount as you move left to right, and Y also in-

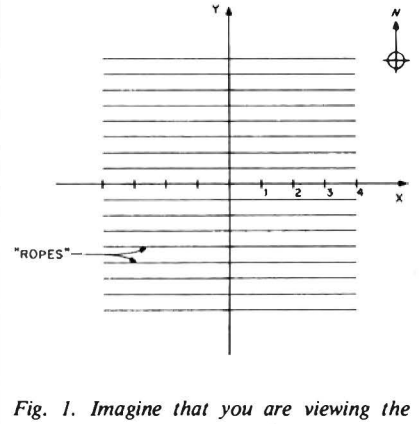

Fig. 1. Imagine that you are viewing the three-dimensional terrain from above at noon. The absence of shadows causes the terrain to appear flat. Impose a rectangular coordinate system upon the terrain to provide points of reference. Superimpose a set of horizontal lines that can be thought of as ropes that rise and fall over the terrain below. Our goal is to view these ropes from an angle, that is, from a vantage point farther to the south.

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creases by a fixed amount as you move up a line of sight from bottom (south) to top (north). As you move up each line of sight, you find the altitude of the terrain (Z) as a function of X and Y.

This altitude must be converted into a Y-value on a two-dimensional screen image. This screen height is found using the following formula:

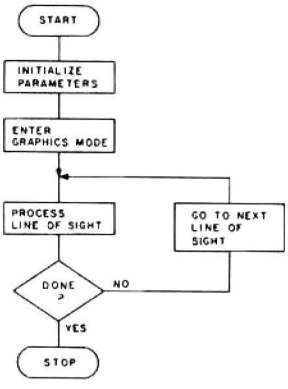

Fig. 2. Simple flowchart outlining the basic steps involved in processing an image. The lines of sight are parallel to the Y-axis and are processed from left to right.

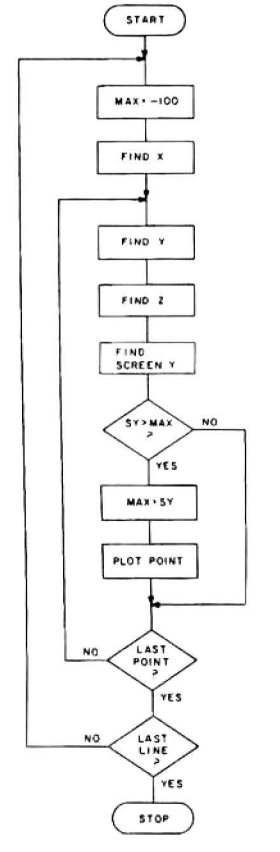

Fig. 3. Each line of sight is processed from bottom to top. This makes it easier to find hidden points.

Screen Y = Y•COS(A) + Z•SIN(A)

where A is the viewing angle as measured from the vertical. If the calculated value for the screen Y exceeds that for previously plotted points, then the new point is plotted and MAX is updated. Otherwise, the new point is not plotted; it is hidden. When the last point on a given line of sight is processed, you move on to the next line. When the last line of sight has been processed, the image is complete.

Listing 1 is a short program based on the flowcharts in Figs. 2 and 3. The program is well documented with remarks. Note that the outer loop in the flowchart (Fig. 3) is processed with a For... Next loop using I (the line-of-sight number) as the counter, while the inner loop uses K (the rope number) as the counter.

Lines 20 and 95 set the screen display for the two-color, high-resolution mode (256 by 192 pixels). In line 45, the line density (number of ropes per unit distance) is set at two, while in line 55 the dot density is set at 16.

The dot density can be interpreted as the number of lines of sight per unit distance, or as the number of dots per unit distance on each rope. If the dot density is high, then the ropes will appear as solid lines. If dot density is low, then the plotted ropes will appear as dotted lines, especially where they rise and fall as they follow the terrain. However, lower dot densities will reduce processing time.

The viewing angle is set at 75 degrees in line 80. The altitude calculation is done in a subroutine starting at line 1000, while the plotting subroutine starts at line 2000. Notice that the plotting subroutine scales the Y-value to fit the screen (the X-value is scaled in line 117 before the inner loop is begun) and plots the points on the imaginary (X,Y) coordinate system centered at the middle of the screen. Change the expression in line 1010 to experiment with a variety of altitude functions.

While separate subroutines for calculating the screen Y-value and for plotting the corresponding point are not necessary in this simple program, they are useful in the listings that follow. When you enter this program, you can omit all remarks except for line 1000.

The program will produce a display that resembles a hill or mound. You'll find, however, that the program is quite slow.

Saving Time

Most of the time used in processing a display is lost in the calculation of the three-dimensional coordinates, especially the elevation. Fortunately, with one minor adjustment you can divide the number of such calculations by almost four. This adjustment involves making the elevation a function of distance from the origin, rather than a function of the X and Y coordinates of

```
20 M=4 : 'PMODE 4
45 LD=2 : '2 ROPES/UNIT DISTANCE
55 DD=16 : '16 LINES OF SIGHT/UNIT DISTANCE
80 A=75 : 'VIEWING ANGLE IS 75 DEGREES FROM VERTICAL
85 A=A*3.14159/180:C=COS(A):S=SIN(A) : 'SINE AND COSINE OF ANGLE
95 PMODE M,1:PCLS:SCREEN1,1 : 'ENTER GRAPHICS MODE
110 FOR I=-64 TO 64 : 'PROCESS LINES OF SIGHT FROM LEFT TO RIGHT
115 MAX=-100 : 'MAXIMUM HEIGHT IS SET TO -100 TO MAKE SURE FIRST
 POINT IS SET
116 X=I/DD : 'X-VALUE RANGES FROM -4 TO 4 BY SIXTEENTHS
117 X1=INT(30*X+.5) : 'CONVERT X-VALUE TO SCREEN CO-ORDINATE
120 NL=8 : 'NO. OF ROPES BELOW AND ABOVE X-AXIS
125 FOR K=-NL TO NL : 'CROSS ALL 17 ROPES FROM BOTTOM TO TOP
130 Y=K/LD : 'Y-VALUE GOES FROM -4 TO 4 BY HALVES
135 GOSUB 1000
145 GOSUB 2000
150 NEXT K
160 NEXT I
195 GOTO 195
1000 'CALCULATE ALTITUDE
1010 Z=3*EXP(-(X*X+Y*Y)/4)-1 : 'CALCULATE ALTITUDE
1020 RETURN
2000 Y=INT(30*(C*Y+S*Z)+.5) : 'TRANSFORM ALTITUDE INTO SCREEN HE
IGHT
2060 IF Y>MAX THEN MAX=Y ELSE 2090 : 'IF POINT IS HIGHER THAN PR
EVIOUSLY PLOTTED                                    POINTS, P
LOT IT ALSO, ELSE DON'T
2080 PSET(128+X1,96-Y) : 'PLOT THE POINT
2090 RETURN
```

Program Listing 1. A simple, straightforward program based on the flowcharts in Figs. 2 and 3. Running the program will result in a display resembling a mound or a hill. The program is quite slow. All remarks (indicated by an apostrophe) can be deleted except for line 1000.

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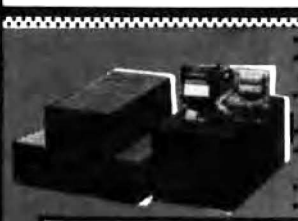

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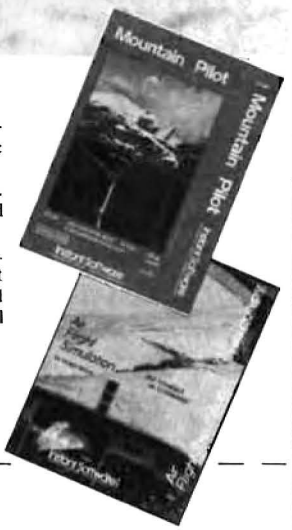

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a point. This distance is denoted R and is given by R = SQR(X*X + Y*Y) (see Fig. 4). The elevation Z will be expressed in terms of R.

How will this reduce processing time? The answer has to do with symmetry; a shape is symmetrical about a line if its two halves are the same on both sides of the line. If the shape is drawn on paper, and the paper folded along the line of symmetry, then the two halves of the shape will match perfectly (see Fig. 5).

If elevation is a function of R, then the left and right halves of the image are identical. Anytime a point is plotted on the left half, the corresponding point can be plotted on the right half without requiring additional calculations. This cuts processing time by about two. Your display will be created on the video screen from the left and right edges simultaneously, meeting in the middle.

If the elevation is a function of R, then the top and bottom halves of the terrain are also identical. However, on the screen image of the terrain, the top and bottom halves will not be identical. Recall that the majority of processing time is in calculating elevations, not in plotting them. Consequently, as you calculate elevations for points in the bottom half of the terrain, you will store the results in an array for later use in processing the top half. Thus the number of elevation calculations is divided by about four.

Program execution time is not divided by four, however, because you must add code to process the data stored in the array. Even so, the time to complete a given image is greatly reduced by this adjustment. These changes can be made by altering some of the lines in your program and by adding some new ones (see Table 1). After making the necessary changes and additions, rerun the program and see how much faster the display is created.

Line 0 dimensions the array that will store the calculated terrain heights. It is dimensioned to contain 33 elements (0–32) in order to accommodate a larger number of ropes in the expanded program that follows.

Line 110 is the line-of-sight counter that starts at X = −4 and goes to X = 0 at 16 lines of sight-per-unit distance.

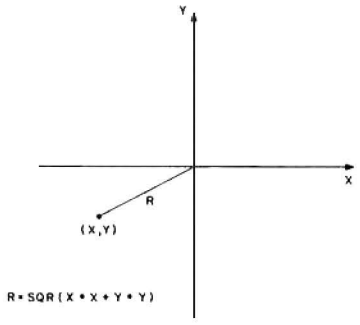

*Fig. 4. The distance R from any point (X, Y) to the origin (0,0) is given by R = SQR (X*X + Y*Y). If the altitude Z is a function of R, processing time can be greatly reduced because of the symmetry of the terrain.*

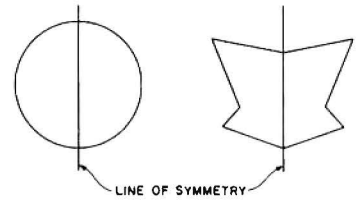

Fig. 5. A two-dimensional figure is symmetrical about a line if the line divides the figure into two parts that are mirror images of each other. The circle would be symmetrical about any of its diameters. The polygon has only one line of symmetry. If the altitude Z is a function of R, the displayed image will have symmetry about the Y-axis.

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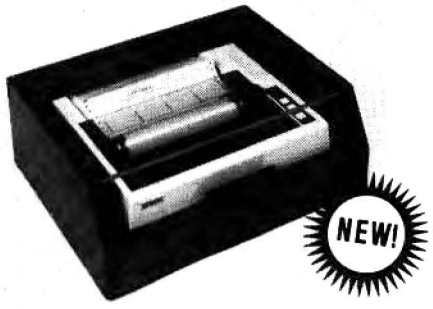

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Notice that for each point on each line of sight, line 2080 plots the corresponding point on the right half of the image.

Line 125 is the rope counter starting at the bottom and counting up to the X-axis. The altitudes calculated for these points are stored in an array in line 140. The subroutine at line 3000 uses these stored values to process the upper half of the image.

Lines 1000 and 1010 reflect the changes in how the altitude is calculated. The distance R is calculated in line 1000; the altitude function in line 1010 is written in terms of R.

Bells and Whistles

The program, with the modifications, is still short and efficient. It is not, however, very flexible. By adding some lines you can insert several nice features into your program.

You can let user input determine the line density and the dot density. Remember that each dot is the intersection of a line of sight and a rope. A low line density (two ropes per unit distance), and a low dot density (eight) will greatly reduce the time required to complete the display. On the other hand, the contours will be relatively far apart and will be dotted rather than solid. Low densities are useful for drawing rough sketches to determine if you are willing to wait for a better version.

Listing 2 is a complete version of this more versatile program. The For... Next loops have been rewritten to accommodate user input, and screen prompts have been added where data is requested. In addition, subroutines have been included to let the user save a screen image to tape, and to load a previously stored image from tape.

Another major change found in Listing 2 is the addition of the PMODE 3 (four-color, medium-resolution) option. For some functions, a significant portion of the image falls below the first rope and cannot be seen in the two-color version. The four-color option plots these points in a different color, allowing the viewer to see the top and bottom portions of the image. One can imagine the screen image representing a rubber sheet having differently colored grids on its top and bottom sides.

The plotting subroutine at line 2000 now plots all points that are higher than those previously plotted as before, and those that are lower than any previously plotted points are plotted in a second color.

A peculiarity of the Color Computer lets the user create an even more impressive four-color display by following these steps: When the display is com-

```
ADD:
0 DIM A(32)

CHANGE:
110 FOR I = -64 TO 0
125 FOR K = -NL TO 0

1000 R = SQR(X*X + Y*Y)
1010 Z = 3*EXP(-R*R/4) - 1

ADD:
140 A(-K) = Z
155 GOSUB 3000

2080 PSET(128 - X1,96 - Y)

3000 FOR K = 0 TO NL
3010 Z = A(K)
3020 Y = K/LD
3040 GOSUB 2000
3050 NEXT K
3060 RETURN
```

Table 1. These changes and additions to Listing 1 will result in a program that runs much more quickly. The savings in time are a result of having taken advantage of the symmetry of the terrain.

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plete (a beeping signal will sound), press the break key.

Type
PMODE 4,1:SCREEN 1,1:GOTO 190
and press enter.

PMODE 4 is normally a two-color mode. However, when a screen image is processed in PMODE 3 and then displayed in PMODE 4, something interesting happens. The image is still a four-color image with medium resolution, but it appears in a color set that is not normally available. In this instance, the background will be black (not possible in normal PMODE 3) with the top of the grid white and the bottom red. The contrasting colors make a very attractive display.

```
0 DIM A(32)
10 CLS:PRINT"DO YOU WANT TO LOAD A PREVIOUSLYSAVED DISPLAY ";:IN
PUT "(Y OR N)";A$
15 IF A$="Y" THEN 4000
20 CLS:PRINT"GRAPHICS PMODE"
25 PRINT:PRINT"(3) MEDIUM RESOLUTION, 4 COLORS"
30 PRINT"(4) HIGH RESOLUTION, 2 COLORS"
35 PRINT:INPUT"PMODE (3 OR 4)";M
40 PRINT
45 INPUT"LINE DENSITY (MAX=8)";LD
50 PRINT
55 INPUT "DOT DENSITY";DD
60 PRINT
65 CLS:PRINT"SELECT VIEWING ANGLE"
70 PRINT"   0 DEGREES IS FROM OVERHEAD"
75 PRINT"  90 DEGREES IS FROM THE SIDE"
80 PRINT:INPUT"ANGLE IN DEGREES";A
90 A=A*3.14159/180:S=SIN(A):C=COS(A)
95 PMODE M,1:PCLS:SCREEN1,1
105 POKE 65495,0
110 FOR I=-4*DD TO 0
115 MAX=-100:MIN=100:X=I/DD:X1=INT(30*X+.5)
120 NL=INT(SQR(16-X*X)*LD)
125 FOR K=-NL TO 0
130 Y=K/LD
135 GOSUB 1000
140 A(-K)=Z
145 GOSUB 2000
150 NEXT K
155 GOSUB 3000
160 NEXT I
165 POKE 65494,0
175 SOUND 100,2
180 FOR I=1 TO 20:NEXT I
185 IF INKEY$="" THEN 175
190 IF INKEY$="" THEN 190
195 CLS:PRINT"DO  YOU WISH TO SAVE SCREEN ON"
200 INPUT "TAPE (Y OR N)";A$
205 IF A$="Y" THEN GOSUB 5000 ELSE RUN
210 CLS:PRINT"DONE"
215 PRINT"PRESS ANY KEY TO CONTINUE"
220 IF INKEY$="" THEN 220 ELSE RUN
1000 R=SQR(X*X+Y*Y)
1010 Z=COS(4*R)/(R/2+2)-3*R/8+1
1020 RETURN
2000 Y=INT(30*(C*Y+S*Z)+.5)
2005 IF M=4 THEN 2050
2010 IF Y<MIN THEN MIN=Y ELSE 2050
2030 PSET(128+X1,96-Y,3)
2040 PSET(128-X1,96-Y,3)
2050 IF Y>MAX THEN MAX=Y ELSE 2090
2070 PSET(128+X1,96-Y)
2080 PSET(128-X1,96-Y)
2090 RETURN
3000 FOR K=0 TO NL
3010 Z=A(K)
3020 Y=K/LD
3040 GOSUB 2000
3050 NEXT K
3060 RETURN
4000 CLS:PRINT"PREPARE TAPE RECORDER AND PRESS ANY KEY."
4010 IF INKEY$="" THEN 4010
4020 PMODE 4,1:PCLS: SCREEN 1,1
4030 CLOADM
4040 GOTO 165
5000 CLS:PRINT"PREPARE TAPE RECORDER"
5010 PRINT "PRESS ANY KEY WHEN READY"
5020 IF INKEY$="" THEN 5020
5030 CSAVEM"SCREEN",1536,7679,0
5040 RETURN
```

Program Listing 2. A highly modified version of the simple program in Listing 1. It produces images like those in Figs. 8-11A. This version allows for user input, the ability to save a display on tape, and the ability to load a previously saved display from tape. Taking advantage of symmetry lets this program run much faster.

Lines 10, 15, and 4000–4040 provide the option of loading a previously saved display.

Lines 20–80 allow user input related to the graphics mode, line density, dot density, and the viewing angle. Line 90 converts this viewing angle from degree measure to radian measure and then calculates the sine and cosine of the angle. These values are used in line 2000 where the terrain height is converted into a screen height.

Line 95 selects which graphics memory will be used, clears it, and puts the video display into the graphics mode.

Line 105 speeds up program execution by making use of a dual clock rate. As I understand it, memory operations in ROM (especially the ROM chips containing the Basic interpreter) are executed at twice the normal speed, while operations in user memory occur at the normal rate. The net effect is to speed up program execution.

Some Color Computers will not operate properly under these conditions. If such is the case in your situation, simply delete lines 105 and 165. Line 165 returns the computer to its normal clock rate. This is required before attempting any input/output operations with either a printer or a cassette recorder, neither of which will work properly when the computer is running with a dual clock rate.

If, for any reason, program execution is halted prior to line 165, press the reset button on the rear of the computer. Or, if you prefer, type POKE 65494,0 and enter.

Line 110 counts the lines of sight I, from $X = -4$ to $X = 0$. Line 115 sets the initial values of MAX and MIN, calculates X, and scales it to the correct screen value. Terrain X starts at -4. By multiplying X by 30, the screen X values start at -120 and go to $+120$.

Line 120 determines how many ropes will be crossed. As listed, the number of ropes crossed is variable and depends on X and Y. A display will be formed using a circular base rather than the square base illustrated in Fig. 1. This is frequently desirable due to the symmetry of the terrain. If a square base is desired, line 120 should read NL=4*LD.

Line 125 sets up the rope counter. The Y value is calculated in line 130. The altitude Z is calculated in line 135 and stored for future use in line 140. This altitude is transformed, scaled, and plotted by the subroutine called at line 145. The program then advances to the next rope.

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When all the ropes up to and including the X-axis have been processed, the subroutine at line 155 uses the stored altitudes to process the upper half of the display. When finished, the program moves on to the next line of sight in line 160.

Lines 175–185 provide for a beeping tone to signal completion of the display. When large line and dot densities are used, the display takes a few minutes to complete.

Lines 195–205 and 5000–5040 let you save a particularly pleasing display on tape. These displays can be loaded from tape at the beginning of the program.

For displays 2 and 3, the major changes to Listing 2 will be in lines 110–160, as these form the heart of the program. This part of the program finds the points of intersection where the lines of sight cross the ropes.

At this time, enter the program and experiment a little. Vary the line density, the dot density, and the viewing angle. You should even vary the altitude formula in line 1010. If you do decide to enter the program and play with it, then skip ahead to the section entitled "Additional Comments."

```
0 DIM Y(64),Z(64)
10 CLS:PRINT"DO YOU WANT TO LOAD A PREVIOUSLYSAVED DISPLAY ";:IN
PUT "(Y OR N)";A$
15 IF A$="Y" THEN 4000
20 CLS:PRINT"GRAPHICS PMODE"
25 PRINT:PRINT"(3) MEDIUM RESOLUTION, 4 COLORS"
30 PRINT"(4) HIGH RESOLUTION, 2 COLORS"
35 PRINT:INPUT"PMODE (3 OR 4)";M
40 PRINT
45 INPUT"LINE DENSITY (MAX=8)";LD
50 PRINT
55 INPUT "DOT DENSITY";DD
60 PRINT
65 CLS:PRINT"SELECT VIEWING ANGLE"
70 PRINT"   0 DEGREES IS FROM OVERHEAD"
75 PRINT"  90 DEGREES IS FROM THE SIDE"
80 PRINT:INPUT"ANGLE IN DEGREES";A
90 A=A*3.14159/180:S=SIN(A):C=COS(A)
95 PMODE M,1:PCLS:SCREEN1,1
105 POKE 65495,0
110 FOR I=0 TO 5*DD
115 MAX=-100:MIN=100:X1=INT(25*(-5+I/DD)+.5):X2=-4+I/DD
120 IF I<=2*DD THEN NL=INT(I/DD*4*LD) ELSE NL=8*LD
125 FOR J=0 TO NL
130 X=X2-J/4/LD:Y=-4+J/LD
135 GOSUB 1000:Y(J)=Y:Z(J)=Z
140 GOSUB 2000:NEXT J
145 MAX=-100:MIN=100:X1=-X1
150 FOR J=NL TO 0 STEP -1
155 Y=-Y(J):Z=Z(J)
160 GOSUB 2000:NEXTJ:NEXTI
165 POKE 65494,0
175 SOUND 100,2
180 FOR I=1 TO 20:NEXT I
185 IF INKEY$="" THEN 175
190 IF INKEY$="" THEN 190
195 CLS:PRINT"DO  YOU WISH TO SAVE SCREEN ON"
200 INPUT "TAPE (Y OR N)";A$
205 IF A$="Y" THEN GOSUB 5000 ELSE RUN
210 CLS:PRINT"DONE"
215 PRINT"PRESS ANY KEY TO CONTINUE"
220 IF INKEY$="" THEN 220 ELSE RUN
1000 R=SQR(X*X+Y*Y)
1010 Z=COS(4*R)/(R/2+2)-3*R/8+1
1020 RETURN
2000 Y=INT(30*(C*Y+S*Z)+.5)
2005 IF M=4 THEN 2050
2010 IF Y<MIN THEN MIN=Y ELSE 2050
2030 PSET(128+X1,96-Y,3)
2050 IF Y>MAX THEN MAX=Y ELSE 2090
2070 PSET(128+X1,96-Y)
2090 RETURN
4000 CLS:PRINT"PREPARE TAPE RECORDER AND PRESS ANY KEY."
4010 IF INKEY$="" THEN 4010
4020 PMODE 4,1:PCLS: SCREEN 1,1
4030 CLOADM
4040 GOTO 165
5000 CLS:PRINT"PREPARE TAPE RECORDER"
5010 PRINT "PRESS ANY KEY WHEN READY"
5020 IF INKEY$="" THEN 5020
5030 CSAVEM"SCREEN",1536,7679,0
5040 RETURN
```

Program Listing 3. By making the above changes in Listing 2, the program will generate displays representing terrain as viewed from the southeast. See Figs. 11B and 12. This program runs slower than Listing 2 because of some loss in symmetry due to using slanted lines of sight.

Display 2

Program Listing 2 has one shortcoming that you may have noticed. Most graphs that you see advertised are images viewed not from due south, but rather from a little to one side of south.

Referring to Fig. 6, note that the lines of sight are no longer parallel to the Y-axis. This causes several complications. First, the X-value on the terrain is no longer the same for each point on a given line of sight. Second, the screen X-value is not the same as the terrain X-value (although the screen X-value does remain the same for any given line of sight). Third, while the Y-values will still increase at a regular rate, the number of ropes crossed by a line of sight varies as you move left to right. Finally, you lose some of the benefits of symmetry.

In Fig. 6, I have selected lines of sight that have a slope of -4 relative to the terrain coordinate system. That is, as you move up a line of sight, the Y-value increases four times faster than the X-value decreases. Consequently, as a line of sight crosses successive ropes, the value of X will decrease by an amount equal to one-fourth of the distance between ropes.

The variable LD is the line density (ropes per unit distance), so the distance between ropes is 1/LD. One-fourth of this distance is 1/4/LD (written in Basic). Thus the terrain X decreases by 1/4/LD for each rope crossed by a line of sight, while the terrain Y increases by 1/LD for each rope crossed (see line 130 in Listing 3).

The screen X-values (Fig. 6) will start at -5 and go to 0. Note that for each line of sight, the terrain X-values always start at a number one larger than the corresponding screen X-value.

The number of ropes crossed by a line of sight increases as the line of sight moves from left to right, until the terrain X-value is -2, beyond which all the ropes will be crossed. A new rope will be crossed each time the initial terrain X-value increases by 1/4/LD.

The number of ropes crossed (after the first rope) can be determined by finding how far over the initial terrain X-value is (compared to -4) and dividing by 1/4/LD.

The increase in the X-value is found by dividing the current line-of-sight number (I) by the number of lines of sight per unit distance (DD): Increase = I/DD. Thus the number of ropes (after the first) is given by INT((I/DD)/(1/4/LD)), which is equivalent to INT(I/DD*4*LD). (See line 120 of Listing 3.)

Beyond an initial terrain X-value of -2, all the ropes are crossed, and the above formula can be ignored since it would continue to add more and more ropes.

While some of the advantages of symmetry are lost, the left-right symmetry is still retained, although the processing is no longer quite as direct due to the slanted lines of sight.

Listing 3 contains the changes necessary to alter Listing 2 to produce display 2. The display is, perhaps, more impressive, but at the cost of considerably more processing time.

Line 0 in Listing 3 provides for storing Y and Z in arrays. These stored values are used in processing the right half of the image. The size of the arrays has been doubled because you must cross all the ropes from $Y=-4$ to $Y=4$. In Listing 2 I stopped at the X-axis ($Y=0$) and used symmetry to do the upper half.

In line 110 the variable I is again used to count lines of sight. They must now be counted from terrain $X=-4$ to $X=1$ because they are slanted. In line 115 MAX and MIN are initialized, and the screen X-value is calculated. Recall from above that the screen X-value remains constant along any given line of sight, while the terrain X-values decrease.

In line 120, the number of ropes crossed (after the first) is determined. When $X=-2$ (i.e., when $I=2*DD+1$), all the ropes (8*LD ropes after the first) are crossed.

J in line 125 is the rope counter. X and Y are calculated in line 130, Z is calculated in line 135, and Y and Z are stored. Line 140 sends the data to the

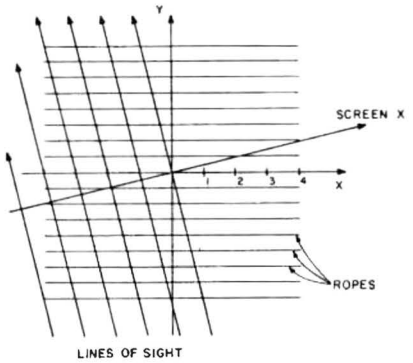

Fig. 6. Here the lines of sight cross the ropes at an angle. For any point, the value of X on the terrain coordinate system differs from the value of X on the screen coordinate system. Notice that as the lines of sight go from $X=-4$ to $X=1$ (bottom-most rope) on the terrain X-scale, the corresponding screen values go from $X=-5$ to 0.

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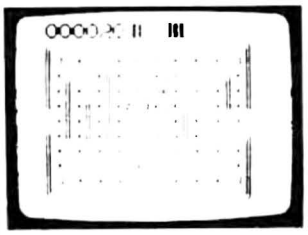

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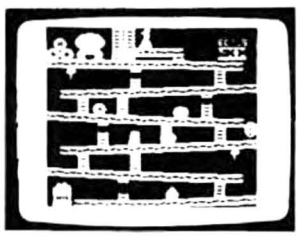

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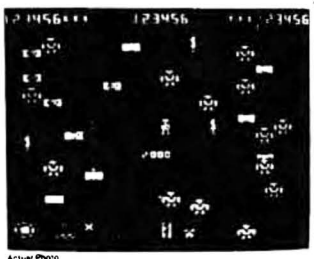

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plotting subroutine and then moves to the next rope. Lines 145–160 process the right half of the image using the values stored earlier.

Lines 2040 and 2080 must be deleted because the left and right halves of the display are no longer symmetrical. The subroutine at 3000 is not used. It should be deleted, although no harm will come if you do not.

```
0 DIM Y(16),Z(16)
10 CLS:PRINT"DO YOU WANT TO LOAD A PREVIOUSLYSAVED DISPLAY ";:IN
PUT "(Y OR N)";A$
15 IF A$="Y" THEN 4000
20 CLS:PRINT"GRAPHICS PMODE"
25 PRINT:PRINT"(3) MEDIUM RESOLUTION, 4 COLORS"
30 PRINT"(4) HIGH RESOLUTION, 2 COLORS"
35 PRINT:INPUT"PMODE (3 OR 4)";M
40 PRINT
55 INPUT"DOT DENSITY";DD:DD=DD/2:DX=1/4/DD
60 PRINT
65 CLS:PRINT"SELECT VIEWING ANGLE"
70 PRINT"   0 DEGREES IS FROM OVERHEAD"
75 PRINT"  90 DEGREES IS FROM THE SIDE"
80 PRINT:INPUT"ANGLE IN DEGREES";A
90 A=A*3.14159/180:S=SIN(A):C=COS(A)
95 PMODE M,1:PCLS:SCREEN1,1
105 POKE 65495,0
110 FOR I=0 TO 7
111 FOR K=0 TO 1
112 FOR J=0 TO DD-1
115 MAX=-100:MIN=100:X=-4+I/2+K/4+J*DX:X1=INT(30*X+.5):CC=16
116 FOR L=0 TO 7
117 FOR N=1 TO 2
118 IF K=0 THEN F=(-1)^N*(DD-J)*DX ELSE F=(-1)^N*J*DX
120 Y=-3.75+L/2+F
125 GOSUB 1000
128 Y(CC)=Y:Z(CC)=Z:CC=CC-1
130 GOSUB 2000
135 NEXT N,L
140 GOSUB 3000
142 NEXT J,K,I
145 X1=0:MAX=-100:MIN=100
150 FOR I=-4 TO 4 STEP .5
152 Y=I
155 GOSUB 1000:GOSUB 2000
160 NEXT I
165 POKE 65494,0
175 SOUND 100,2
180 FOR I=1 TO 20:NEXT I
185 IF INKEY$="" THEN 175
190 IF INKEY$="" THEN 190
195 CLS:PRINT"DO  YOU WISH TO SAVE SCREEN ON"
200 INPUT "TAPE (Y OR N)";A$
205 IF A$="Y" THEN GOSUB 5000 ELSE RUN
210 CLS:PRINT"DONE"
215 PRINT"PRESS ANY KEY TO CONTINUE"
220 IF INKEY$="" THEN 220 ELSE RUN
1000 R=SQR(X*X+Y*Y)
1010 Z=COS(4*R)/(R/2+2)-3*R/8+1
1020 RETURN
2000 Y=INT(30*(C*Y+S*Z)+.5)
2005 IF M=4 THEN 2050
2010 IF Y<MIN THEN MIN=Y ELSE 2050
2030 PSET(128+X1,96-Y,3)
2040 PSET(128-X1,96-Y,3)
2050 IF Y>MAX THEN MAX=Y ELSE 2090
2070 PSET(128+X1,96-Y)
2080 PSET(128-X1,96-Y)
2090 RETURN
3000 FOR II=CC+1 TO 16
3010 Z=Z(II)
3020 Y=-Y(II)
3040 GOSUB 2000
3050 NEXT II
3060 RETURN
4000 CLS:PRINT"PREPARE TAPE RECORDER AND PRESS ANY KEY."
4010 IF INKEY$="" THEN 4010
4020 PMODE 4,1:PCLS: SCREEN 1,1
4030 CLOADM
4040 GOTO 165
5000 CLS:PRINT"PREPARE TAPE RECORDER"
5010 PRINT "PRESS ANY KEY WHEN READY"
5020 IF INKEY$="" THEN 5020
5030 CSAVEM"SCREEN",1536,7679,0
5040 RETURN
```

Program Listing 4. By making these changes in Listing 2, a display is produced using a rectangular grid rather than a series of parallel ropes. See Figs. 13–15. This program also runs a little slower than Listing 2.

Display 3

The third, and final, display is derived by superimposing a rectangular grid on the terrain map as shown in Fig. 7A. As with display 2, the changes required in the original program (Listing 2) involve the lines dealing with finding the X and Y coordinates of the intersections of the lines of sight and the rectangular grid. The altitude calculation and the plotting routines remain the same.

Listing 4 details the necessary changes. Using lines of sight parallel to the Y-axis lets you take full advantage of symmetry. This is important due to the increase in processing time resulting from the large number of points that must be processed.

The processing of lines of sight is complicated by the fact that these lines cross the grid pattern at different Y-values. The key is to find a repeating pattern.

So far, any line of sight has been handled in the same manner as all the others. Now you must handle groups of lines as indicated in Fig. 7B. Each value of I denotes a separate group of lines of sight. Furthermore, each group is divided into segments, with each segment being processed in the same manner. As before, processing will proceed from left to right and from bottom to top. Notice in Fig. 7C that a line of sight crosses the grid at points equally spaced below and above the middle of each block, and that as the line of sight moves from left to right, this spacing first decreases and then increases. The magnitude of this change is constant as the line of sight moves, and is dependent on the dot density. (In this program I decided to leave the line density fixed because I found that increasing or decreasing the line density degraded the result.)

To process a point first below and then above the middle, I used a loop (FOR N = 1 TO 2) and included a factor of $(-1)\uparrow N$ in one term of the calculation of Y (line 118 of Listing 4). When N = 1 then $(-1)\uparrow N$ is negative, yielding the point below the middle. On the other hand, when N = 2 then $(-1)\uparrow N$ is positive, giving us the Y-value above the middle.

Since the spacing first decreases and then increases, I used a second loop (FOR K = 0 TO 1) to keep track of the difference. When K = 0 (again see line 118), the spacing decreases as the line of sight moves left to right. When K = 1 the spacing increases.

In line 55, the variable DX is the distance between adjacent lines of sight. Looking at Fig. 7C, notice that from

one line of sight to the next, the Y coordinate changes by this same amount since the grid is composed of lines at an angle of 45 degrees. Thus the X and the

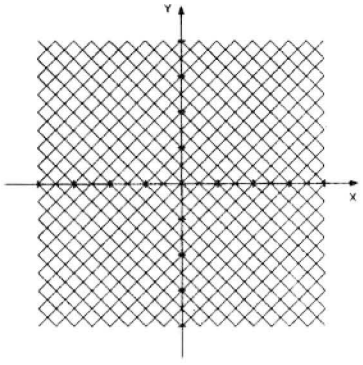

Fig. 7A. The terrain is now covered with a rectangular grid of lines that will let you view the changing contours in two directions.

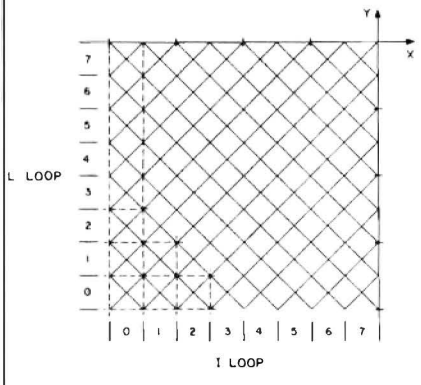

Fig. 7B. Making full use of symmetry lets you concentrate on the lower left portion of Fig. 7A. The lines of sight run vertically, and are grouped to include a column of X's. The variable I is the group counter. Each line of sight is processed by segments that are counted by the variable L.

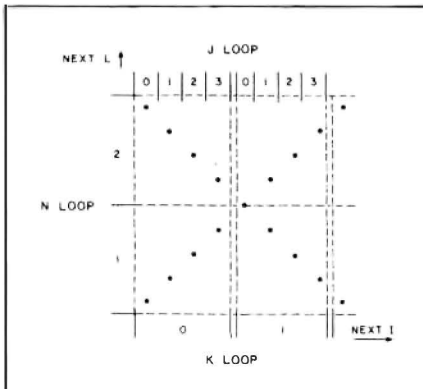

Fig. 7C. One small block (containing one of the X's) is seen to consist of individual dots. The spacing (and hence J) is dependent on the selected dot density.

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Y calculations (lines 115, and 118–120) use this incremental distance.

In Listing 4 the hardest parts to explain are the nested loops in lines 110–142. Refer to Fig. 7 as you read.

The I loop, begun in line 110, counts groups of vertical lines of sight from left to right (Fig. 7B). The variable K in line 111 is set at 0 for the left half of each group (Fig. 7C). In line 112, J selects the particular line of sight that is processed in segments counted by L in line 116 (Figs. 7B and 7C).

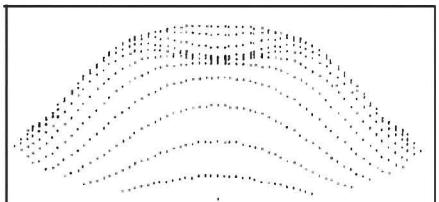
Within each segment, N (line 117) is set to select first the point below the middle and then the point above. This is the innermost loop. Then the next segment up is processed (line 135).

When each segment, up to the X-axis, has been processed, the subroutine call in line 140 processes the upper half of the display for that line of sight. The program then moves to the next line of sight (NEXT J) until it has finished the left half of a group. The program then processes the right half (NEXT K) in a similar fashion. Finally, when the right half of a group is done, the program moves on to the next group (NEXT I) and so on until all eight groups are processed. The NEXT J, NEXT K, and NEXT I statements are lumped into a NEXT J,K,I command at line 142.

Lines 145–160 process the Y-axis separately, as it is not included in any of the groups.

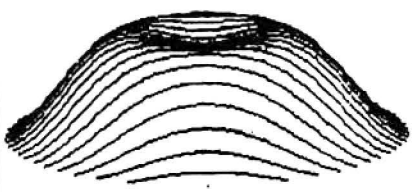
```
20 PMODE4,1:COLOR0,1:PCLS:SCREEN1,1
30 LINE(0,96)-(255,96),PSET
40 LINE(128,0)-(128,191),PSET
50 FOR I=-4 TO 4
60 A=128+30*I:B=94
70 DRAW"BM"+STR$(A)+","+STR$(B)+"D5"
80 NEXTI
90 FOR I=-3 TO 3
100 A=126:B=96-30*I
110 DRAW "BM"+STR$(A)+","+STR$(B)+"R5"
120 NEXTI
130 FOR I=-120 TO 0
140 GOSUB 1000
150 Y=INT(30*Z+.5)
160 PSET(128+I,96-Y):PSET(128-I,96-Y)
170 NEXTI
180 GOTO 180
1000 R=-I/30
1010 Z=3*EXP(-R*R/4)-1
1020 RETURN
```

Program Listing 5. A short program that will plot a cross-section of the function used in line 1010. You can eliminate many possibilities by simply viewing this cross-section. Make note of those functions that look promising and try them out in one of the display programs.



1000 R = .75*SQR(X*X + Y*Y)
1010 Z = 1 + COS(R) – COS(2*R)/2
LINE DENSITY = 2
DOT DENSITY = 8
ANGLE = 75 DEGREES

Fig. 8A. Notice that a low line density and a low dot density result in ropes that are spaced rather far apart, and that appear as dotted lines. Even so, the general shape of the display is apparent. Low densities require only a short processing time.



1000 R = .75*SQR(X*X + Y*Y)
1010 Z = 1 + COS(R) – COS(2*R)/2
LINE DENSITY = 3
DOT DENSITY = 32
ANGLE = 75 DEGREES

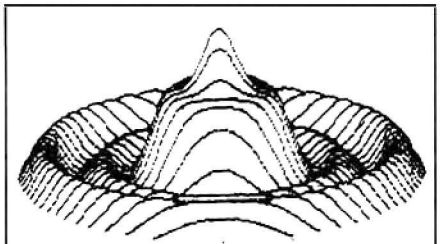
Fig. 8B. An increase in line and dot densities results in a better display. Note in line 1000 that the formula for R is multiplied by .75. This scaling lets you show more or less of the breadth of the terrain as desired.

Additional Comments

In each program, the altitude function is in a subroutine starting at line 1000. Unless a person has some knowledge of mathematics, it can be difficult to know which expressions to use in line 1010. Probably the most frequently used functions are trigonometric and exponential functions.

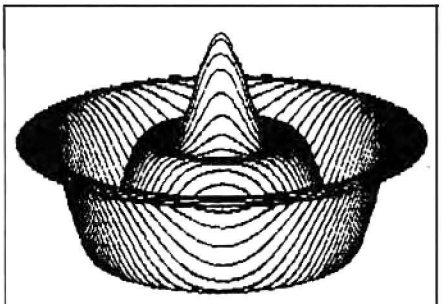
In Basic the exponential function is written EXP( ), where some expression involving R is placed inside the parentheses. This expression is the exponent of the number "e" (about 2.718). It would be equally suitable, from a graphing standpoint, to use some other base such as 2 or 3. The function would then be written 2↑( ) or 3↑( ), where again an expression involving R goes in the parentheses.

If the base is a number greater than one, then the expression inside the parentheses (the exponent) should be negative or zero. If the exponent is positive, the altitude will quickly become too large to plot. Z = EXP (– R), Z = 1.5*2↑(– R*R), and Z = 2*3 ↑(– R*R/4) – 1 are all examples where



1000 R = .9*SQR(X*X + Y*Y)
1010 Z = COS(R) + COS(2*R)/2 + COS(6*R)/4:Z = 1.25*Z
LINE DENSITY = 4
DOT DENSITY = 32
ANGLE = 70 DEGREES

Fig. 9. Note that again R is scaled in line 1000. At the end of line 1010 the altitude is multiplied by 1.25 to increase the height of the display.



1000 R = 1.25*SQR(X*X + Y*Y)
1010 Z = 1.75*(COS(R) + .4*COS(3*R)) + .25
DELETE LINE 2005
2030 PSET(128 + X1,96 – Y)
2040 PSET(128 – X1,96 – Y)
LINE DENSITY = 8
DOT DENSITY = 64
ANGLE = 70 DEGREES

Fig. 10. Program Listing 2 has been modified to show points on the top and the bottom sides of the grid. Both sides are plotted in the same color in PMODE 4. This display took a fair amount of time to complete because of the high densities used.

the exponent is negative or zero. Remember that R is a distance and is always positive. The negative sign in each of the exponents makes the exponent negative, or zero at most. Each of these would produce a display resembling a mound.

The height of the mound is determined by the multiplier (if any) in front. The first would have a height of 1, the second a height of 1.5, and the third a height of 2. In addition, the display for the third Z function would be lower on the screen because a 1 was subtracted from the height calculation.

The trigonometric functions (sine and cosine) produce the graphs that resemble ripples in a pond. In Basic these functions are written SIN( ) and COS( ), where, once more, an expression involving R goes inside the parentheses. The values will range from −1 to 1, with the sine function equal to zero at the origin, and the cosine function equal to one at the origin. The range can be adjusted by multiplying the trig function by some number or by some other function (such as an exponential).

Most of the displays commonly seen are combinations of trigonometric functions or of trigonometric and exponential functions. This is where the trial and error process enters in; you enter a function in line 1010 and see what you get. If you don't like it, you try again.

Program Listing 5 contains a short program that will let you view a cross-section of the graph that would result from using a specific expression in line 1010. Frequently you can dismiss an expression just by looking at this cross-section, and with far less wasted time.

Use this program to test several expressions, making note of those that look promising. Then, test the good ones in a display program using a low dot density and (for displays 1 and 2) a low line density. You may want to vary the viewing angle. Different expressions are also likely to look better on one display than on another.

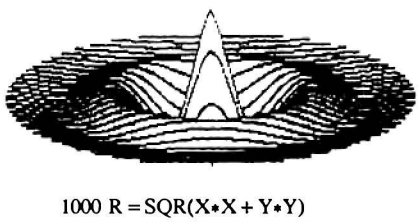
You can alter the height of a display by multiplying or dividing the altitude function by some number based on trial and error. The total width of the screen display is constant, but you can scale the function horizontally by multiplying the right side in line 1000 by a number. Again, trial and error will determine the best choice.

Figures 8–15 are examples of images produced by the programs listed in this article. Each figure includes the altitude function, the dot density, the line density (where applicable), and the viewing angle. Additional comments are included where appropriate. These figures may give you some ideas for further experimentation.

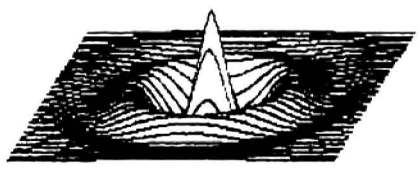
The figures were printed on a Radio Shack Line Printer VII using a screen-print program from the August 1982 issue of *80 Micro*, p. 202. The printed display has a smaller height-to-width ratio than the screen display; thus, each of the displays shown will appear taller on the screen.

I welcome comments from readers, and am willing to answer questions if I can. But please include a self-addressed, stamped envelope. ■

Delmar E. Searls lives at 1825 S. Johnstone, Bartlesville, OK 74003.

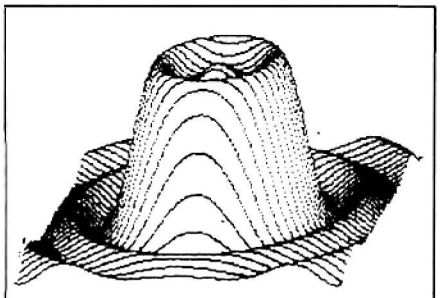


1000 R = SQR(X*X + Y*Y)
1010 Z = 2*EXP(−R)*COS(3*R)
LINE DENSITY = 4
DOT DENSITY = 64
ANGLE = 75 DEGREES



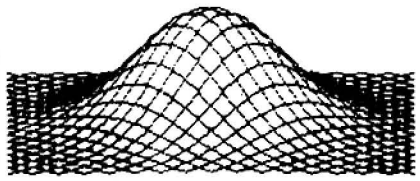
1000 R = SQR(X*X + Y*Y)
1010 Z = 2*EXP(−R)*COS(3*R)
LINE DENSITY = 4
DOT DENSITY = 64
ANGLE = 75 DEGREES

*Fig. 11. The same function plotted using Program Listing 2 (Fig. 11A) and Listing 3 (Fig. 11B). Figure 11A could have been produced with a square base by changing line 120 in Listing 2 to read NL = 4*LD.*



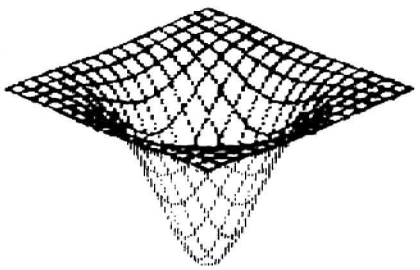
1000 R = .75*SQR(X*X + Y*Y)
1010 Z = 2*(COS(R) − COS(3*R)/3 + COS(5*R)/5) + .25
LINE DENSITY = 5
DOT DENSITY = 32
ANGLE = 70 DEGREES

Fig. 12. A second example of a function plotted using Listing 3 (display 2). The cosine terms are the first three terms in the infinite series representation of a square wave.



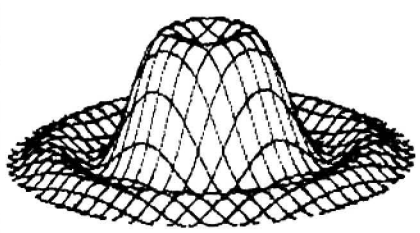
1000 R = SQR(X*X + Y*Y)
1010 Z = 2.5*EXP(−R*R/4)
DOT DENSITY = 16
ANGLE = 75 DEGREES

Fig. 13. A Simple Example of Display 3 (Listing 4).



1000 R = SQR(X*X + Y*Y)
1010 Z = 1.5 − 3*EXP(−R*R/2)
DOT DENSITY = 16
ANGLE = 65 DEGREES

Fig. 14. A PMODE 3 example illustrating the use of two colors for the top and bottom of the grid. The diamond-shaped base is obtained by inserting the following line into Listing 4: 122 IF Y< −(X+4) THEN 135.



1000 R = SQR(X*X + Y*Y)
1010 Z = 1.5*(COS(R) − COS(3*R)/3) + .5
DOT DENSITY = 32
ANGLE = 70 DEGREES

*Fig. 15. The circular base is obtained by adding this line to Listing 4: 122 IF Y< −SQR(16−X*X) THEN 135.*

BY RUSTY LE BLANG

DEMYSTIFYING SYSTEM RAM

Playing POKE and PEEK with your Color Computer could lead you to some startling discoveries.

One of the few mysteries of the Color Computer is what is in that area of RAM that the *Going Ahead with Extended Color Basic* book calls "system RAM." The *Getting Started with Color Basic* book defines only some of the addresses.

With computer in hand, I systematically went through the area, POKEing, PEEKing, and EXECing at each address from 0 to 1023. After that, with the help of the EDTASM+ package from Radio Shack, I compiled the listing in Table 1. I included the addresses that were in the Color Basic book so that programmers won't have to use several books to find a needed address.

As with the memory map in both Basic books, the list of addresses in the Color Basic book is not complete. Many of the addresses there are to be used with a Basic program, and altering their contents crashes the computer.

The addresses I did find can add all sorts of new features to the Color Computer. The most important address is 359, which usually contains the value 126. If you POKE 255 into it, the cursor will appear back on the screen, flashing as usual. But if you try to type anything, it will not be printed on the screen.

At first I thought the computer had crashed and wasn't accepting keyboard input. When I typed SCREEN 1 and enter, however, the computer displayed the graphics screen and stayed there. I tried using graphics commands such as Circle and Line and to my amazement, I saw them work right there in the command mode. Usually, when the computer prints something to the text screen, it automatically returns to the text screen. After you change contents of 359, however, the computer will not

System Requirements

16K RAM
Extended Color Basic
Disk Color Basic

Address	Function
23-24	top of RAM
25-26	start address of Basic program
31-32	end address of Basic program
55-56	name of last variable used
111	DEVNUM—device number for CHROUT
124	cassette block type
125	cassette block length
126-127	cassette buffer address
135	last key pressed in program
136-137	cursor address
148	cursor timer
149-150	line printer baud rate
151-152	line printer delay
153	line printer comma field width
154	line printer last comma field
155	line printer line width
156	line printer current position
157-158	EXEC address of machine-language program
175	trace flag 0 = off, 79 = on
182	present PMODE number
234	drive operation (0-3)
235	drive number (0-3)
236	track number (0-34)
237	sector number (1-18)
238-239	buffer address
240	disk I/O error codes
274-275	timer value
282	upper/lowercase flag 0 = on, 255 = off
283-284	keyboard delay constant
338-345	keyboard rollover table
346-349	joystick pot values
359	disable Print 126 = on, 128 = graphics, 255 = off
474-481	cassette file name
485-486	EXEC address of cassette-loaded machine-language program
487-488	load address of cassette-loaded machine-language program
512-730	free RAM usable by machine-language programs
733-981	keyboard input buffer (noncompressed format)
1024-1535	text screen memory

Table 1. Memory Map of System RAM

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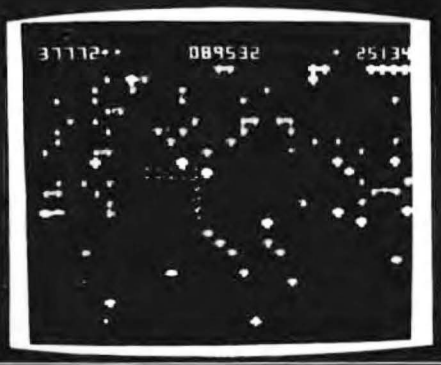

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```
10 VERIFY ON
20 CLS:CLEAR2048
30 PRINT@224,"STANDBY FOR COLOR DIRECTORY 1.0"
40 FORX=512TO541
50 READA$
60 POKEX,VAL("&H"+A$)
70 NEXT
80 DEFUSR0=512
90 Z=PEEK(235)
100 F=FREE(Z)
110 DIMA$(68):Y=1:P1=1:PO=4:T=247
120 FORX=3TO11
130 DISKI$ Z,17,X,A$,B$:C$=A$+LEFT$(B$,128)
140 FORN=0TO7
150 A$(Y)=MID$(C$,N*32+1,8)+" "+MID$(C$,N*32+9,3)+" "
160 R=ASC(A$(Y)):IFR=255 THEN A$(Y)="":GOTO220
170 A$(Y)=A$(Y)+CHR$(PEEK(1547+N*32)+48)+" "
180 IF PEEK(1548+N*32)=0 THEN A$(Y)=A$(Y)+"B" ELSE A$(Y)=A$(Y)+"
A"
190 IFR=0 THEN A$(Y)="":GOTO210
200 Y=Y+1
210 NEXTN,X
220 P2=INT((Y-1)/10):IFP2<(Y-1)/10 THEN P2=P2+1
230 CLS
240 PRINTTAB(4)"COLOR DISK DIRECTORY 1.0"
250 PRINTTAB(10)"DISK DRIVE";Z
260 PRINT@65," USED";68-F;"FREE";F;" PAGE"P1"OF"P2:PRINT
270 H=(P1-1)*10+1
280 FORX=H TO H+9
290 IFA$(X)="" THEN PRINT:GOTO310
300 PRINTTAB(8)A$(X)
310 NEXT
320 K=PO*32+8:POKE529,&H80:A=USR0(K):POKE529,&H8B
330 E=(P1-1)*10+PO-3
340 IFPEEK(341)=T AND PO=4 AND P1>1 THEN P1=P1-1:PO=13:A=USR0(K)
:GOTO260 ELSE IF PEEK(341)=T AND PO>4 THEN A=USR0(K):PO=PO-1:GOT
O320
350 IFPEEK(342)=T AND PO<13 AND E<Y-1 THEN A=USR0(K):PO=PO+1:GOT
O320 ELSE IF PEEK(342)=T AND P1<P2 AND PO=13 THEN P1=P1+1:PO=4:A
=USR0(K):GOTO260
360 IFPEEK(340)=251 THEN 380
370 GOTO340
380 MID$(A$(E),9,1)=".":T$=LEFT$(A$(E),12)
390 IF INSTR(A$(E),"BIN") THEN LOADM T$:EXEC
400 IF INSTR(A$(E),"BAS") THEN LOAD T$,R
410 GOTO340
420 DATA BD,B3,ED,C3,4,0,1F,1,C3,0,10,ED,8D,0,D,A6,84,8B,40,A7,8
0,AC,8D,0,3,26,F4,39,0,0
```

Program Listing 1

print anything to the text screen and will stay in the graphics screen if it is used.

This opens up a whole new feature of the Color Computer, something I have seen only on Apple and Atari computers. All graphics commands will work, as will all the other Color Basic and Extended Color Basic commands, except the Print function. The feature has one more hidden extra. If you POKE the value 128 into 359 and are viewing the text screen, you will see that any key pressed (except the clear key, which will still clear the screen) will print a graphics character on the screen.

ROMPAK use machine-language subroutines, so type them in carefully and save them before running them. A on the screen, along with some graphics characters that are equivalent to the OK prompt. To return to normal use of the computer, POKE 126 into 359.

With the disk system installed, disabling the Print function will work, but you won't be able to get the graphics characters from the keyboard due to changes that the disk system makes in that area.

The set of addresses from 338 to 345 is the keyboard rollover table. The addresses tell what keys are being pressed at any one time. Unlike the INKEY$ function, PEEKing the address that corresponds to the desired key allows you to read whether a key is being pressed. This allows you to use repeated keys, something that can't be done with the INKEY$ function. Table 2 shows the values that the addresses will have if any key is held down.

To test this, type in this small routine:

```
10 PRINT@0,;: FOR X=338 TO 345:
PRINT PEEK(X): NEXT: GOTO 10
```

After typing it in and running it, press any key and the corresponding address will change according to Table 2. When you release the key, the address will return to 255.

This feature can be used in arcade-type games that need repetitive key-pressing. By PEEKing these addresses, you need not constantly press a key—just hold it down as long as needed and then release it.

I have also included four programs. Three of them require Color Disk Basic, and all require Extended Color Basic. The programs use some of the addresses that I didn't explain, but their functions in the programs are described in remark statements that I included. DIR and

This reverses alphanumerics and graphics. If you type "PRINT CHR$ (191)" and enter, an "A" will appear

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mistake can crash the computer.

DIR

DIR is a disk-directory program that reads the entries of the directory track into array A and allows them to be viewed. DIR includes the name, extension, file type, and ASCII flag. DIR is designed so that it will work on the drive from which it was loaded or the last drive used.

The program prints the entries in pages, with 10 entries per page and up to seven pages. After the initialization, which takes about eight seconds, the title will appear on top of the screen, along with the drive number being used, the number of used and free granules, the page number, and the total number of pages.

The entries will scroll down the screen and the first entry will be highlighted in inverted text (green on black). DIR uses a machine-language routine to highlight each entry for speed and convenience. Use the up and down arrow keys to move the black bar from entry to entry. If the bar reaches the top of the screen and there is a previous page, it will scroll that page onto the screen and the black bar will be on the bottom entry.

If you reach the bottom of a page, the

```
10 CLS:DEFUSR0=&HD66C ' POINTS TO DSKCON
20 PRINTTAB(8)"COLOR DISK DRIVE":PRINTTAB(6)"HEAD CLEANING DRIVE
R"
30 PRINT@102,"REMOVE PROGRAM DISKS"
40 PRINT@129,"INSERT CLEANING DISK IN DRIVES"
50 PRINT@224,;:INPUT"DRIVE NUMBER (0-3) OR <ENTER>   TO QUIT";DR
$
60 IFDR$="" THEN CLS:END ELSE DR=VAL(DR$):IFDR<0 OR DR>3 THEN 50
70 PRINT@288,"HEAD IN POSITION"
80 A=0:B=34:C=1:GOSUB110
90 A=34:B=0:C=-1:GOSUB110
100 POKE&HFF40,0:RUN
110 FORX=A TO B STEP C
120 POKE234,1 ' SETS DISK TO NO OPERATION
130 POKE235,DR ' SETS DRIVE NUMBER
140 POKE236,X ' SETS TRACK NUMBER
150 PRINT@304,X;
160 FORY=1TO70:A=USR0(0):NEXTY,X
170 RETURN
```

Program Listing 2

```
10 CLS:PRINT"MACHINE LANGUAGE TRANSFER DRIVER      FROM CASSETTE
 TO DISK":PRINT"PROGRAM: "
20 FORX=474TO481:NA$=NA$+CHR$(PEEK(X)):NEXT:PRINT@73,NA$
30 ST=PEEK(487)*256+PEEK(488):EN=PEEK(126)*256+PEEK(127):EX=PEEK
(157)*256+PEEK(158):ST=ST+EX-PEEK(485)*256-PEEK(486)
40 PRINT"START ADDRESS"ST:PRINT"ENDING ADDRESS"EN:PRINT"EXECUTIN
G ADDRESS"EX
50 INPUT"HOW MANY COPIES";NO:IFNO<=0 THEN END
60 FORX=1TO NO:PRINT@224,"INSERT DISK IN DRIVE":PRINT"KEY <ENTER
> TO COPY";:LINEINPUTA$:!MNA$,ST,EN,EX:NEXT:END
```

Program Listing 3

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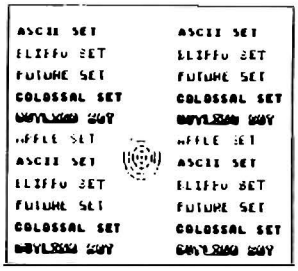

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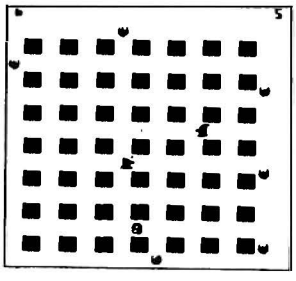

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next page will scroll down the screen and the top entry will be highlighted. To go quickly from entry to entry, just hold down the up or down arrow. The program polls the keyboard rollover table for input, so you have repeated-key ability.

When you have selected the program you want, either in Basic or machine language, press R and the program will load and run. This is the only way to exit DIR, except to press the break key.

```
10 PMODE0,1:PCLEAR1:CLEAR10,8192
20 CLS
30 PRINTTAB(7)"PROGRAM PAK COPIER"
40 PRINT
50 FORX=511TO530
60 READA$
70 POKEX,VAL("&H"+A$)
80 NEXT
90 DEFUSR0=511
100 PRINT@64,;:INPUT"ENTER MEMORY SIZE (16 OR 32)";ME
110 IF ME<>16 AND ME<>32 THEN 100
120 IFME=32 THEN ST=24576 ELSE ST=8192
130 POKE65315,54    'DISABLE CARTRIDGE INTERRUPT
140 LINEINPUT"INSERT PROGRAM PAK IN CARTRIDGE SLOT AND KEY <ENTE
R>";A$
150 A=USR0(ST)
160 PRINT"PROGRAM PAK DUMPED"
170 INPUT"HOW MANY COPIES";C
180 IFC=0 THEN 240
190 FORX=1 TO C
200 PRINT@256,"POSITION TAPE---PRESS PLAY AND RECORD"
210 LINEINPUT"KEY <ENTER>";A$
220 CSAVEM"ROMPAK",ST,ST+8192,ST
230 NEXT
240 END
250 REM MACHINE LANGUAGE SUBROUTINE
260 DATA BD,B3,ED,1F,1,10,8E,C0,00,A6,A0,A7,80,10,8C,E0,00,26,F6
,39,0,0
```

Program Listing 4

DSKCLEAN

DSKCLEAN is a head-cleaning driver program. When you purchase Radio Shack's cleaning disks, the suggested method for using them is to type DIR, escape the command with an I/O error, and continue the same procedure until the disks have spun for 30 seconds.

This not only wastes time, but also uses only a small area of the cleaning disk, the area that corresponds to track 17. DSKCLEAN solves both problems. The program will spin the disks for 30 seconds and move the head from 0 to 34, then back to 0.

The program will tell you to remove all program disks and insert the cleaning disk into the drive you want cleaned. Answer the prompt with either the number of the disk or with the enter key to end the program. Comments in the program tell what address is doing what. The loop in line 160 is required because the drive is set to no operation, and the computer will execute one pass through the loop in a split second, so a loop of 70 is enough to get 30 seconds of spinning time.

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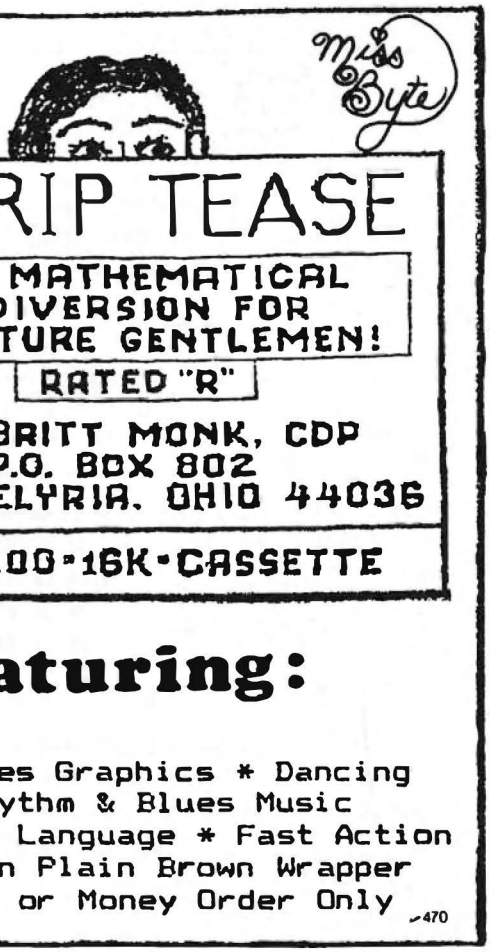

✓470

338	@	H	P	X	0	8	enter
339	A	I	Q	Y	1	9	clear
340	B	J	R	Z	2	:	break
341	C	K	S	up arrow	3	;	
342	D	L	T	down arrow	4	,	
343	E	M	U	left arrow	5	-	
344	F	N	V	right arrow	6	.	
345	G	O	W	space	7	/	
VALUE:	254	253	251	247	239	223	191

NO KEY SEEN=255

Table 2. Keyboard Rollover Table Values.

language program from tape to disk. After loading the machine-language program, run MLCOPY. MLCOPY will print the program name and start, end, and EXEC addresses. It will then prompt you on how many copies you want made. If you answer 0, the program will end. Otherwise, it will tell you to insert the disk and press enter.

It will then save a copy of the machine-language program. If you want more than one copy, it will tell you to insert another disk and press enter. The program will continue doing this until it has made all the copies you requested. Program Listing 3 is slightly cramped so that it won't interfere with a machine-language program that loads low in memory.

If you run MLCOPY without loading a machine-language program first, the EXEC address will be from the last machine-language program you loaded. The default address for the EXEC command, 46152, will cause an FC error if you EXEC without having loaded a program or specifying an address.

ROMPAK

ROMPAK will copy the contents of any program pak from ROM to high RAM. It will also copy a program pak to cassette on a 16K or 32K system. ROMPAK uses a short machine-language routine to copy the program pak contents because the same routine in Basic would take about five minutes to dump the program. ROMPAK takes only a few seconds.

ROMPAK prompts you when to insert the program pak, and after you press enter, it will dump the program to RAM. ROMPAK prevents the program pak from autostart by masking the cartridge-interrupt input, which is the first bit of address 65315.

Once the program is in RAM, it can be disassembled or modified to the user's requirements. A good understanding of machine-language programming is required if you want to do this. Also, the program will not run in RAM because it was not designed to run in any area of memory other than 49152 to 65279. Once the program is copied, it will have to be rewritten to run in the new area of RAM. The machine-language program starts at 8192 for a 16K computer and at 24576 for a 32K computer.

ROMPAK copies only 8K of any program pak because most Radio Shack program paks use only 8K of the possible 16K for the program. ■

Write Rusty Le Blang at 2605 Sedgwick Ave., Bronx, NY 10468.

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BY ROBERT P. BUSSELL

MERGE MANEUVERS MADE EASY

At last CoCo owners can simplify the troublesome task of merging their Basic program libraries.

Articles explaining how you can merge Basic programs by using PEEK and POKE instructions are standard magazine fare. These techniques require that you write down memory contents at every step. You must calculate new addresses by hand and follow special procedures if the least-significant byte of an address is 0 or 1. You must also make sure that the line numbers of the program to be merged are greater than the original program.

After seeing a number of these programs, it seemed to me that there must be a better way to merge Basic programs.

A Better Way

The merge utility in Program Listing 1 simplifies the task of merging Basic programs from a library of routines stored on cassette tape. This routine should also work on disk systems by using the disk LOAD command in place of the CLOAD command.

The merge utility has been written in position-independent code and can be relocated elsewhere in memory. It is loaded into memory using the CLOADM command. This version of the merge utility was assembled at address $7D00 for a 32K computer.

Once you load this utility, you can begin the program-merge function. Load the first Basic program using the CLOAD command. When you receive the OK prompt, enter the EXEC &H7D00 command. This routine will compute and save the first and last line number for this segment of the merge.

You will then be given instructions for continuing or terminating the merge function. If you want to merge additional Basic programs, enter the EXEC &H7D3B command. Doing so will display the *** CLOAD Next Program *** prompt. Load each additional program, continuing the above procedure until you have loaded all the programs into memory.

At this time you should enter the EXEC &H7D5D command. This routine will restore the Basic pointer to the first line of the first program loaded and combine all the programs into one program. If you execute the LIST or LLIST command, you will see the entire program. The program automatically resolves all line numbers, allowing you to load Basic programs in any order without regard to the current line numbers.

Program Listing 1 contains the Assembly-language source statements used to generate this merge utility. If you have a 16K computer, change line number 200 to ORG $3D00. You should also

System Requirements

Extended Color Basic
16K RAM
Assembler Optional

Program Listing 1. Basic Program Merge Utility

```
00100 *        A BASIC PROGRAM MERGE UTILITY
00102 *
00104 *        COPYRIGHT DECEMBER 1982
00106 *                BY
00108 *        ROBERT P. BUSSELL
00110 *
00120 CLS      EQU $A928 CLEAR SCREEN
00130 RENUM    EQU $8A3A ENTRY TO RENUM WITH ALL INPUTS SET
00140 SCREEN   EQU $A30A DISPLAY ADDRESS
00200          ORG $7D00
00210 INIT     LBSR INST DISPLAY INSTRUCTIONS
00280 RNUM     LEAX NUMTAB,PCR LOAD MERGE TABLE
00290          LDD #10 GET CONSTANT
00300          STD $CF SET UP INCREMENT
00310          ADDD ,X GET LAST LINE USED
00320          STD $D5 SET UP FIRST LINE
00330 * COMPUTE LAST LINE TO SAVE
00340 *
00350          CLRA
00360          CLRB CLEAR D
00370          STD $D1 CLEAR START LINE
00380          LDY $19 BEGIN ADDRESS OF PROGRAM
00390          LDD ,X NEW LINE VALUE
00400 LNUM     ADDD #10 INCREMENT
00405          LDY ,Y GET NEXT LINE
00410          CMPY #0 AT END ?
00420          BGT LNUM NO, GET MORE
00430          STD ,X SAVE FOR NEXT MERGE
00440          JMP RENUM LEAVE ROUTINE AND RENUMBER
00500 INST     JSR CLS CLEAR SCREEN
00510          LEAX TEXT,PCR GET MESSAGE
00520 ILOOP    LDA ,X+ GET CHARACTER
00530          BEQ ILOOP1 NO MORE DATA
00540          JSR SCREEN DISPLAY IT
00550          BRA ILOOP MORE TO GET
00560 ILOOP1   RTS RETURN
00600 MRG      LEAX FLINE,PCR
00610          LDD ,X GET FIRST LINE
00620          CMPD #0 1ST PASS?
00630          BNE MRG1 NO,CONTINUE
```

Listing continued

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change lines 2000–2020 of the prompt messages to 3D00, 3D3B, and 3D5D instead of 7D00, 7D3B, and 7D5D.

This program uses three routines contained in the Basic ROMs. The first call is to $A928, which clears the display screen and sets the screen pointer to the upper left corner. The next call is to the Extended Basic renumbering function. This routine is called at a point after the increment (address $CF), first line number (address $D5), and new line number (address $D1) have been set.

The initialization executed at address $7D00 performs three functions. First, it initializes the line-number increment and starting line number and displays operator instructions. Next, the loop at label LNUM computes the value of the last line number to be used in this segment of the merge. Finally, control is transferred to the Basic renumber routine, where all lines are renumbered and all references to GOTO and GOSUB are adjusted.

Execution of the subroutine at label MRG (address $7D3B) resets the Basic pointers at addresses $19–$1C (25–28 decimal) to the next available location for loading the next program to be merged. The first time this subroutine is executed, the value of working storage at label FLINE is tested. If this value is zero, the Basic program start address is saved in FLINE. Execution of the subroutine at the label RESTR (address $7D5D) retrieves the Basic program start address of the first program to be merged and uses it to restore the line pointer to the beginning of the program.

If You Have No Assembler...

I wrote Program Listing 2 for users without an assembler. If you want to use this program with a 16K computer, make the following changes:

```
20    FOR A = &H3D00 TO &H3E5C
70    IF CHKSUM < > 26283 THEN.....
110   .....CSAVEM"MERGE",
&H3D00, &H3D3B, &H3D00:END
360   (Change value 37 to 33)
460   (Change value 37 to 33)
540   (Change value 37 to 33)
```

The routine in line 70 of Listing 2 is a quick check to verify that you have entered the data statements correctly. Lines 90–110 save the loaded utility program to tape so that you can run it without rerunning the Basic program. ■

For more information write to Mr. Bussell at 104 Barley Court, Lexington Park, MD 20653.

Listing continued

```
00640           LDD $19 GET ORIGINAL BASIC POINTER
00650           STD ,X SAVE IN WORKING STORAGE
00660 MRG1      LDD $1B NEXT AVAILABLE LOCATION
00670           SUBD #2 COMPUTE NEW POINTER
00680           STD $19 NEW BASIC POINTER
00690           JSR CLS CLEAR SCREEN
00700           LEAX LOAD,PCR GET MESSAGE
00710           LBSR ILOOP DISPLAY IT
00720           RTS DONE
00730 RESTR     LEAX FLINE,PCR
00740           LDD ,X GET FIRST LINE
00750           STD $19 RESTORE BASIC POINTER
00760           CLRA
00770           CLRB CLEAR D
00780           STD ,X RESET POINTER
00790           STD -2,X RESET NEW LINE          Page No. 01
00800           RTS DONE
01800 LOAD      FCC /*** CLOAD NEXT PROGRAM ***/
01810           FDB $0D00 MSG TERMINATOR
01900 NUMTAB    FDB 0 HOLDS CONSTANTS FOR MERGE
01910 FLINE     FDB 0 HOLDS BASIC POINTER
02000 TEXT      FCC /YOU MAY MERGE ANOTHER PROGRAM   BY EXECUTING EXEC &H7D3B. WHE
N  YOU RECEIVE THE CLOAD PROMPT YOUCAN LOAD THE NEXT /
02010           FCC /PROGRAM. THEN EXECUTE &H7D00. /
02020           FCC /WHEN YOU ARE     THROUGH MERGING YOU SHOULD         EXEC &H7D5D
. /
02030
02040 ZEND      FDB $0D00 MSG TERMINATOR
03000           END INIT
```

```
10 CHKSUM=0
20 FOR A=&H7D00 TO &H7E5C
30 READA$:N=VAL("&H"+A$)
40 POKE A,N
50 CHKSUM=CHKSUM+N
60 NEXT A
70 IF CHKSUM <>26295 THEN CLS:PRINT@32,"BAD DATA VALUE. CHECK &
REENTER":END
80 CLS:PRINT@32,"GOOD DATA LOAD"
90 PRINT"DO YOU WANT AN OBJECT TAPE"
100 Q$=INKEY$:IFQ$="N"THEN END ELSE IF Q$<>"Y"THEN 100
110 PRINT"PUT TAPE IN RECORD MODE PRESS   ENTER WHEN READY":INPU
T Q$:CSAVEM"MERGE",&H7D00,&H7E5C,&H7D00:END
120 DATA 17,0,27,30,8D,0,81,CC
130 DATA 0,0A,DD,CF,E3,84,DD,D5
140 DATA 4F,5F,DD,D1,10,9E,19,EC
150 DATA 84,C3,0,0A,10,AE,A4,10
160 DATA 8C,0,0,2E,F4,ED,84,7E
170 DATA 8A,3A,BD,A9,28,30,8D,0
180 DATA 5B,A6,80,27,05,BD,A3,0A
190 DATA 20,F7,39,30,8D,0,4B,EC
200 DATA 84,10,83,0,0,26,04,DC
210 DATA 19,ED,84,DC,1B,83,0,02
220 DATA DD,19,BD,A9,28,30,8D,0
230 DATA 13,17,FF,D5,39,30,8D,0
240 DATA 29,EC,84,DD,19,4F,5F,ED
250 DATA 84,ED,1E,39,2A,2A,2A,20
260 DATA 43,4C,4F,41,44,20,4E,45
270 DATA 58,54,20,50,52,4F,47,52
280 DATA 41,4D,20,2A,2A,2A,0D,0
290 DATA 0,0,0,0,59,4F,55,20
300 DATA 4D,41,59,20,4D,45,52,47
310 DATA 45,20,41,4E,4F,54,48,45
320 DATA 52,20,50,52,4F,47,52,41
330 DATA 4D,20,20,20,42,59,20,45
340 DATA 58,45,43,55,54,49,4E,47
350 DATA 20,45,58,45,43,20,26,48
360 DATA 37,44,33,42,2E,20,57,48
370 DATA 45,4E,20,20,59,4F,55,20
380 DATA 52,45,43,45,49,56,45,20
390 DATA 54,48,45,20,43,4C,4F,41
400 DATA 44,20,50,52,4F,4D,50,54
410 DATA 20,59,4F,55,43,41,4E,20
420 DATA 4C,4F,41,44,20,54,48,45
430 DATA 20,4E,45,58,54,20,50,52
440 DATA 4F,47,52,41,4D,2E,20,54
450 DATA 48,45,4E,20,45,58,45,43
460 DATA 55,54,45,20,26,48,37,44
470 DATA 30,30,2E,20,57,48,45,4E
480 DATA 20,59,4F,55,20,41,52,45
490 DATA 20,20,20,20,54,48,52,4F
500 DATA 55,47,48,20,4D,45,52,47
510 DATA 49,4E,47,20,59,4F,55,20
520 DATA 53,48,4F,55,4C,44,20,20
530 DATA 20,20,20,20,20,20,45,58
540 DATA 45,43,20,26,48,37,44,35
550 DATA 44,2E,20,0D,0
```

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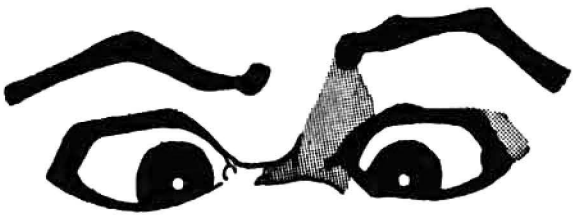

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BY LEIGH H. FRENCH

MICROLINE 82A MEETS COCO

Buying a Microline 82A for your CoCo? Here's how to build a cheap interface cable for it.

I recently purchased a Microline 82A, and when I asked about interface cables I was quoted a price of $39 for a made-to-order cable. I went to Radio Shack and looked into the serial-to-RS-232C interface for the Color Computer at $19.95, but the Radio Shack version of the RS-232C interface is different from Microline's. Consequently, I decided to build a cable myself.

If you have the tools in Table 1 and about an hour or less, and if you have worked with cables before, you can make the cable for less than $10. You'll learn a bit about your computer, too.

Check the parts list (Table 2) for those things you will need to buy from Radio Shack. There is an optional cover for the submini plug, but it is not required for the operation of the printer.

All the following information is available in the CoCo technical reference manual and the user's manual for the 82A printer.

Remove one end of the CoCo printer cable either by desoldering the socket from the cable or by cutting the socket off with wire cutters. Strip off about 1½ inches of the gray cable insulation to expose the four colored wires inside. Remove ¼ inch of insulation from the end of each colored wire. I will not refer to colors on the wires because they are not always the same.

If you look at the DIN plug on the other end of the cable, you will see numbers from one to four near the pin connections. Using the ohmmeter, determine which of the colored wires connects to which pin.

First set the meter to one of its resistance scales. Place one of the test probes on pin 1 of the DIN plug. Touch the other probe to each of the bared ends of the colored wires until a low resistance reading is found. You will get a low resistance reading on the wire that is attached to pin 1. Do this with each pin on the DIN plug and use pieces of tape to mark each colored wire with its corresponding pin number. (See Fig. 1.)

Once you have identified the wires, you can snip the wire to pin 1 down to the insulation, since it will not be used. Save the wire that you cut off. Then following Fig. 2, solder the wires to the submini-25 plug. Pay particular attention to the pin numbers, since there is a possibility of voltages that are not compatible with the CoCo if you solder a wire to the wrong pin. Finally, solder a jumper between pins 6 and 20 (use the

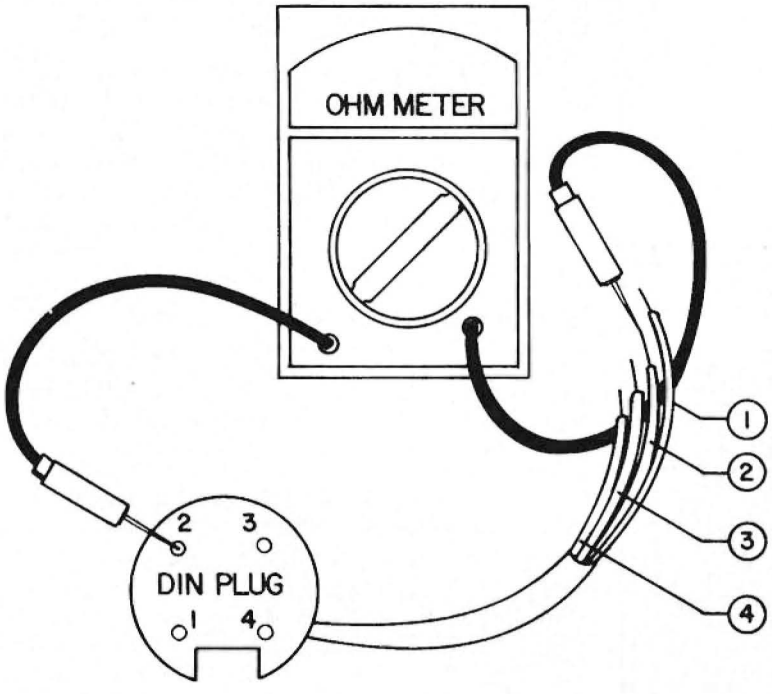

Fig. 1. Use an ohmmeter to test the DIN plug connections.

System Requirements

4K RAM
Microline 82A Printer

soldering iron
needle-nose pliers
small screwdriver
wire strippers/cutters
solder
flux (rosin)
ohm/voltmeter (optional)

Table 1. List of Needed Tools

Color Computer		82A printer
pin 1— no connection		
pin 2— data in	———	pin 11 superv data out
pin 3— gnd	———	pin 7 gnd
pin 4— data out	———	pin 3 data received
	: ——	pin 6 dsr
jumper between	:	
	: ——	pin 20 dtr

Fig. 2. Soldering Instructions

Part #	Description	Price
PN 26-3020	Color Computer serial printer cable	$4.95
PN 276-1547	D-Submini 25 (male) plug	$2.99
PN 276-1549	Hood (optional)	$2.19

Table 2. Parts List from Radio Shack

piece you cut off of wire 1 of the CoCo printer cable). Now you are ready to connect your printer.

At this point you will want to consult the printer manual to learn how to set up the switches in the printer. Since I have Extended Color Basic Version 1.1, I configured the printer for 8-bit serial input at 600 baud and automatic line feed. I switch-selected the TRS-80 language set (you can select 10 different language character sets). I then turned on the printer and sent it a few lines. It worked well.

So the total cost to you if you are willing to spend some time to build the cable yourself is $7.94, plus tax. I think that's quite a saving to you, and you will learn a good deal about your printer and your CoCo. ■

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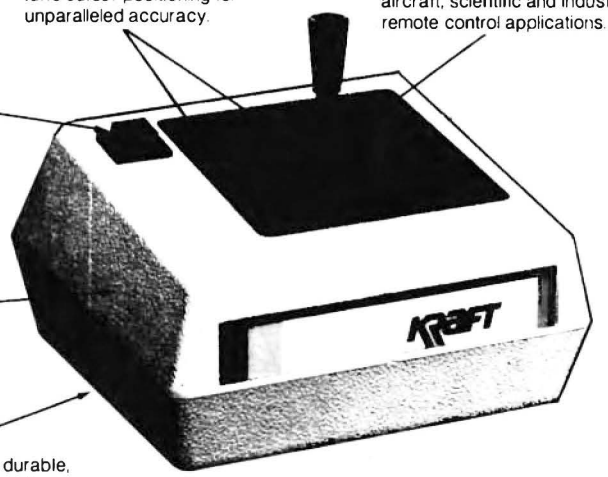

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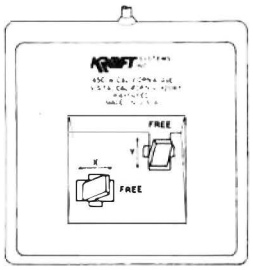

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BY JOHN P. KOCH

COLOR BACKGAMMON FOR TWO

I enjoy playing backgammon, so I wrote this program that lets me play it with another person on my Color Computer.

Line 10 establishes four arrays. The BR numeric array stores the location of pieces in play or on the bar. Column 1 is for blue's pieces and column 2 for red's. Arrays CB, CR, and CY store graphics displays for use with the PUT command, which allows you to place pieces on the board or remove them. Lines 20 and 30 set values in the BR array for the initial placement of pieces on the board.

The program uses PMODE 3 rather than PMODE 4, which might produce rounder circles, to provide a set of four colors. A yellow game board is drawn against a green background; lines 70 and 80 draw horizontal lines across the bottom and middle of the board; GOSUB 1440 draws the vertical lines separating the points.

If you like a little color in your backgammon game, try playing this version with a friend.

Line 90 draws a circle on the board and paints it blue; line 100 uses the GET command to store a rectangle containing the blue circle in the array CB and then paints the circle red. Line 110 stores the red circle in the array CR and then paints the circle yellow. Line 85 stores a yellow rectangle in the array CY for use in blanking out pieces when they are moved. Lines 131 to 154 draw the numbers on the points.

The subroutine beginning at line 1300 uses a PUT command to display the pieces on the board. Line 1330 checks the BR array for point P and if neither column has a value greater than zero, jumps to 1400 to put a yellow rectangle on the board. Lines 1350–1380 put blue or red circles on the point; line 1400 puts a yellow rectangle at one position higher than the last blue or red circle to cover up any circles that might have appeared there but were moved.

There is room on each point to display only six pieces. Any more are invisible, but the BR array keeps track of them.

The program uses the random-number generator to determine whether blue or red moves first and to simulate the roll of two dice. Something the Color Computer instruction manual does not make clear is that those numbers are not really random.

I ran a few tests by making the computer print a series of random numbers and found it gave me the same series every time, provided I turned the computer off between each test instead of just pushing the reset button.

My solution was to require the player to enter a number at the beginning of each game. Line 50 uses this number in a FOR...NEXT loop, exercising the random-number generator so that the game program will start picking the "random" numbers from some place other than the beginning of the series. The higher the number, the longer it takes to begin the game, so line 40 won't accept a number greater than 499.

In the game of backgammon the players attempt to move their pieces, in accordance with their dice rolls, around the board from their initial placement to any of the last six points and then off the board. The first player to remove all

Program Listing

```
10 CLEAR200:PCLEAR4:CLS:DIM BR(30,2),CB(12,12),CR(12,12),CY(12,1
2)
20 BR(6,2)=5:BR(8,2)=3:BR(13,2)=5:BR(24,2)=2
30 BR(1,1)=2:BR(12,1)=5:BR(17,1)=3:BR(19,1)=5
40 INPUT"INPUT A NUMBER SMALLER THAN 500";X:IFX>499THEN40
50 FOR XX=1TOX:N=RND(6):NEXT XX
60 PMODE3,1:SCREEN1,0:COLOR3,2:PCLS
```

Listing continued

System Requirements

16K RAM
Extended Color Basic

his pieces from the board wins the game, but a player cannot remove any pieces if any of his pieces is farther than the fifth point from his exit point.

The players move in opposite directions. If a player rolls doubles, he uses each die twice.

"If a point has only one piece on it, called a 'blot,' the opposing player may 'hit' it by moving one of his pieces there."

Only one player's pieces may be placed on a given point. If a point has more than one piece on it, it is said to be "covered," and the opposing player cannot move there. If a point has only one piece on it, called a "blot," the opposing player may "hit" it by moving one of his pieces there. The blot is then removed and placed "on the bar."

The owner of the removed piece may

Listing continued

```
 70 LINE(0,180)-(240,180),PSET:GOSUB1440
 80 LINE(0,90)-(240,90),PSET:PAINT(243,90),1,3
 85 GET(3,1)-(15,13),CY
 90 CIRCLE(9,7),6,3:PAINT(9,7),3,3
100 GET (3,1)-(15,13),CB:PAINT(9,7),4,2
110 GET(3,1)-(15,13),CR
131 O$="E1;D6;L1;R2":DRAW"BM7,82;XO$;"
132 TWO$="D1;E1;R2;F1;D1;G4;R4":DRAW"BM27,81;XTWO$;"
133 THREE$="D1;E1;R2;F1;D1;G1;L1;R1;F1;D2;G1;L2;H1":DRAW"BM48,81
;XTHREE$;"
134 FOUR$="D3;R6;L2;U3;D6":DRAW"BM65,82;XFOUR$;"
135 FIVE$="L4;D3;R4;F1;D2;G1;L3;H1":DRAW"BM90,81;XFIVE$;"
136 SIX$="D1;D3;E1;R3;F1;D2;G1;L3;H1;U5;E1;R3;F1":DRAW"BM106,81;
XSIX$;"
137 SEVEN$="R4;D6":DRAW"BM126,82;XSEVEN$;"
138 EIGHT$="R1;R3;F1;D1;G1;L3;G1;D2;F1;R3;E1;U2;H1;L3;H1":DRAW"B
M147,81;XEIGHT$;"
139 NINE$="L3;U2;R4;D6":DRAW"BM169,84;XNINE$;"
140 ZERO$="U6;R4;D6;L4":DRAW"BM185,83;XO$;B;R4;XZERO$;"
141 DRAW"BM205,83;XO$;B;U5;B;R4;XO$;"
142 DRAW"BM225,83;XO$;B;R4;B;U6;XTWO$;"
143 DRAW"BM225,93;XO$;B;R3;B;U6;XTHREE$;"
144 DRAW"BM205,93;XO$;B;R3;B;U6;XFOUR$;"
145 DRAW"BM185,93;XO$;B;R9;B;U6;XFIVE$;"
146 DRAW"BM165,93;XO$;B;R3;B;U6;XSIX$;"
147 DRAW"BM145,93;XO$;BR3;BU6;XSEVEN$;"
148 DRAW"BM125,93;XO$;BR4;BU6;XEIGHT$;"
149 DRAW"BM105,93;XO$;BR6;BU4;XNINE$;"
150 DRAW"BM85,93;XTWO$;BR4;XZERO$;"
151 DRAW"BM65,93;XTWO$;BR4;BU5;XO$;"
152 DRAW"BM45,93;XTWO$;BR4;BU6;XTWO$;"
153 DRAW"BM25,93;XTWO$;BR4;BU6;XTHREE$;"
154 DRAW"BM5,93;XTWO$;BR4;BU6;XFOUR$;"
200 'SET UP
210 FOR P=1 TO 24:GOSUB1300:NEXTP:GOSUB1440:T=RND(2)
220 'ROLL DICE
230 D4=0:D1=RND(6):D2=RND(6):IF D1=D2 THEN D4=D1
240 D3=D4:TT=3-T
310 Y=184:IF D1=0 THEN360
320 FOR X=0 TO D1*12-12 STEP12
330 LINE(X,Y)-(X+6,Y+6),PSET,BF:IF T=2 THEN PAINT(X+3,Y+3),4,1
```

Listing continued


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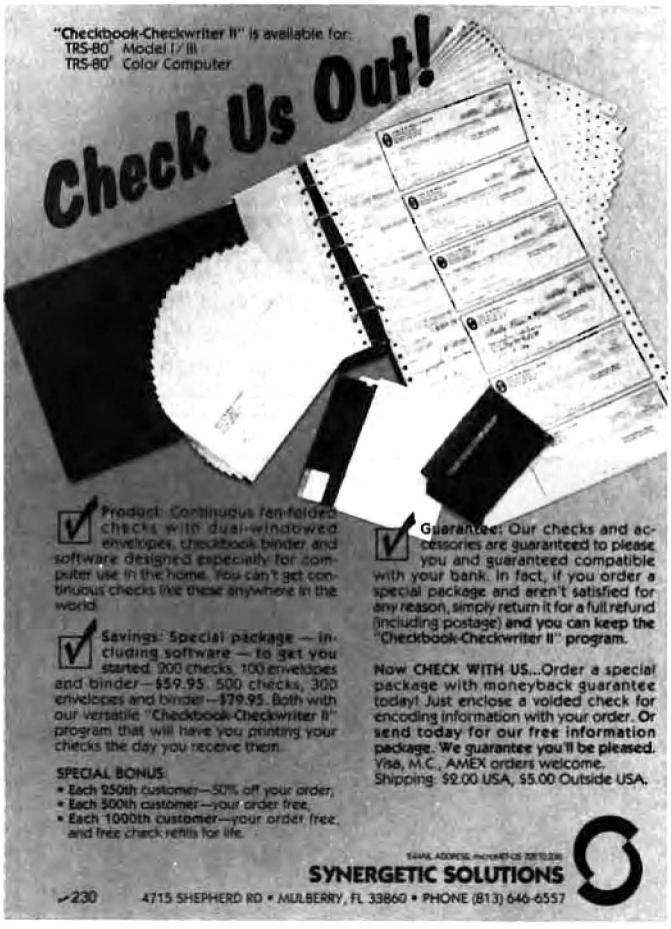

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Listing continued

```
340 SOUND50,2:NEXT X
350 IF D2=0 THEN 400ELSEFORX=1TO50:NEXT
360 FOR X=90 TO D2*12-12+90 STEP 12
370 LINE(X,Y)-(X+6,Y+6),PSET,BF:IF T=2 THEN PAINT(X+3,Y+3),4,1
380 SOUND25,2:NEXT X
400 'DRAW "FROM?"
410 PAINT(188,200),1,1
420 DRAW"BM164,184;R4;L4;D3;R4;L4;D4"
430 DRAW"BM+8,-0;U7;R4;D3;L4;F6"
440 DRAW"BM+4,-0;U7;R5;D7;L5;R5"
450 DRAW"BM+4,-0;U7;F4;E4;D7"
460 DRAW"BM+5,-6;U2;R5;D4;L3;D4"
500 'PICK POINT
510 IF BR(0,T)>0 THEN P=0:GOTO650
520 P$=INKEY$:IF P$=""THEN520
530 IF P$="C"THEN1270 ELSE IF VAL(P$)>2 THEN590
540 IF ASC(P$)>57 OR ASC(P$)<48 THEN620
550 PP$=INKEY$:IF PP$=""THEN550
560 IF ASC(PP$)=13 THEN590
570 IF ASC(PP$)>57 OR ASC(PP$)<48 THEN620
580 P$=P$+PP$
590 P=VAL(P$):IF P>24 THEN620
600 'CHECK LEGALITY
610 IF BR(P,T)>0 THEN650
620 GOSUB1500:GOTO310
630 'PICK DIE
650 IF D1=0 THEN D=D2:GOTO830
660 IF D2=0 THEN D=D1:GOTO830
670 IF D1=D2 THEN D=D1:GOTO830
671 IF P<>0THEN710
672 IFT=2THEN690
674 IF BR(P+D1,TT)<2 AND BR(P+D2,TT)<2 THEN710
675 IF BR(P+D1,TT)>1 AND BR(P+D2,TT)<2 THEN D=D2:GOTO830
680 IF BR(P+D2,TT)>1 AND BR(P+D1,TT)<2 THEN D=D1:GOTO830
685 IFP=0 AND BR(D1,TT)>1 AND BR(D2,TT)>1 THENGOSUB1500:GOTO1270
690 IF BR(25-D1,TT)>1 AND BR(25-D2,TT)<2 THEN D=D2:GOTO830
695 IF BR(25-D2,TT)>1 AND BR(25-D1,TT)<2 THEN D=D1:GOTO830
698 IF P=0 AND BR(25-D1,TT)>1 AND BR(25-D2,TT)>1 THENGOSUB1500:G
OTO1270
700 'DRAW "DIE?"
710 LINE(164,182)-(222,192),PRESET,BF
720 DRAW"BM166,184;D8;R3;E2;U4;H2;L3"
730 DRAW"BM177,184;D7;B;R6;U7;R4;L4;D3;R3;L3;D4;R4"
740 DRAW"BM+5,-6;U2;R5;D4;L3;D4"
745 'PICK DIE
750 D$=INKEY$:IF D$="" THEN 750
760 IF D$="C" THEN GOSUB1500:GOTO1270
770 D=VAL(D$)
780 IF D<>D1 AND D<>D2 THEN GOSUB1500:GOTO310
800 'CHECK LEGALITY
810 'DP IS DESTINATION POINT
820 'CHECK DESTINATION POINT NOT COVERED
830 IF T=1 THEN DP=P+D ELSE DP=P-D
840 IF T=2 THEN IF  P=0 THEN DP=25-D
850 IF DP<1 THEN940
860 IF BR(DP,TT)>1 THEN980
870 IF DP>24 THEN 890 ELSE IF DP<1 THEN 940
880 GOTO1020
890 FOR Z=1 TO 18
900 IF BR(Z,1)>0 THEN1000
910 NEXT Z:IF DP=25 THEN 1030 ELSE FOR Z=19 TO P-1
920 IF BR(Z,1)>0 THEN1000
930 NEXT Z:GOTO1030
940 FOR Z=24 TO 7 STEP-1:IF BR(Z,2)>0 THEN1000
```

Listing continued

make no other move until he has reentered the piece at his end of the board. If the points on which his dice roll would permit him to enter are covered, he can't move and loses his turn. Occasionally, even if a player has no man on the bar, his dice roll and the placement of his opponent's pieces are such that there is no point to which he can move any of his pieces. In that case, he loses his turn.

The computer displays the dice roll in the mover's color at the bottom of the screen with the word "FROM?". The player then picks which point he will move from. Line 520 uses INKEY$ to check the keyboard for the number pressed. Only if the player wants to move from point one or two is it necessary to press the enter key. If no legal moves are available, the player presses C to forfeit the move (line 530). Line 580 combines the two numbers, which are in the form of strings, to form one string of two digits. Line 590 converts the string to a value and assigns it to the variable P, for the point moved from.

"Only if the player wants to move from point one or two is it necessary to press the enter key. If no legal moves are available, the player presses C to forfeit the move."

If the first number entered is higher than two, the program jumps from line 530 to line 590, as there won't be a second digit. Entry from the bar is required and therefore made automatic in line 510.

After the point has been selected, line 610 checks whether the player actually has a man on it. If not, the program goes back to request entry of another point.

If a valid move-from point has been selected, the computer then asks which die to use. If there is only one die to use, lines 650 to 670 pick it automatically. Line 750 uses INKEY$ to assign the player's choice of die to variable D.

During blue's turn, line 830 adds the value of the die to the move-from point to determine the destination point (DP); during red's turn, it subtracts the value to determine the DP. Line 860 checks

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the destination point to see if it is covered. If so, it sends the player back (via 980 and 1000) to select a different move-from point.

Once the program determines that the move is legal, line 1030 subtracts one from the number of pieces the BR array records on the move-from point, and line 1050 adds one to the number of pieces on the destination point. If the opponent has a blot on the destination point, line 1020 subtracts it from the destination point and adds it to row 0, where the array stores the men "on the bar."

Lines 1070–1090 cancel the die used, and lines 1110 and 1120 execute GOSUB 1300 first with the move-from point as P, then with the destination point as P, to update the display of the game board. Line 1140 checks to see if the game is over.

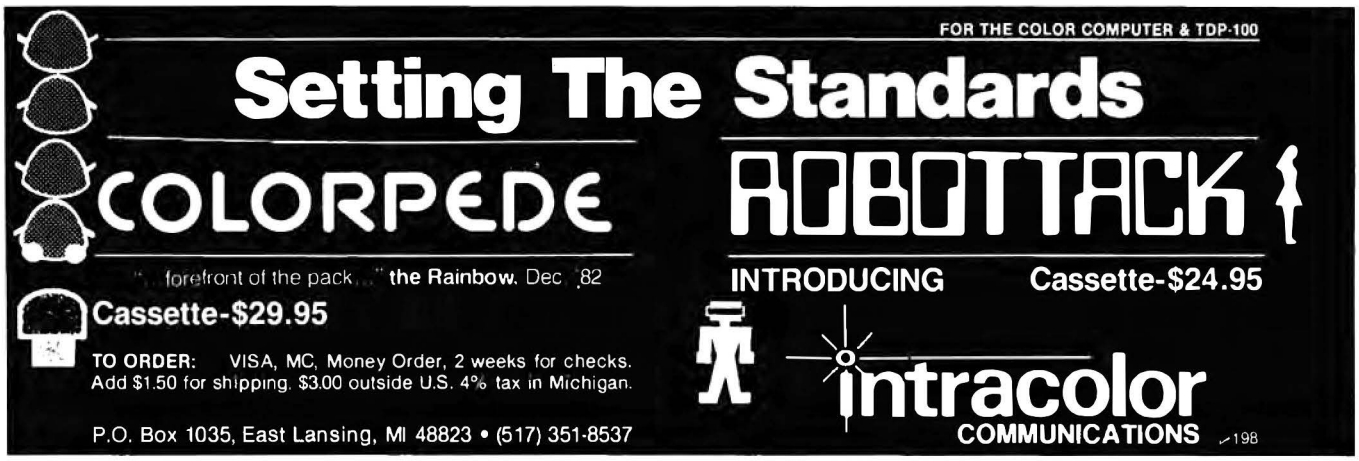
If every point in the moving player's column in the BR array has been reduced to zero, he has won the game. Line 1150 clears the screen to his color and prints the message "YOU WON!". If he still has pieces on the board, line 1250 checks to see if he has any dice remaining to use. If so, it sends him back to specify the next move-from point. If the player has used all his dice, line 1270 switches the values of T and TT, and 1280 goes back to line 230 for the other player's turn.

The SOUND command is used at various points in the game to add interest. When the dice are displayed, a tone sounds to help the player count his roll. Different notes signify entering a valid move, hitting a blot, removing a piece from the board, or winning the game. ■

Address correspondence to John Koch at 111 W. Washington St., Chicago, IL 60602.

Listing continued

```
950 NEXT Z:IF DP=0 THEN 1030 ELSE FOR Z=6 TO P+1 STEP-1
960 IF BR(Z,2)>0 THEN1000
970 NEXT Z:GOTO1020
980 IF BR(0,T)<1 THEN1000
990 IF D1=D2 OR D1=0 OR D2=0 THEN1270
1000 GOSUB1500:GOTO310
1010 'REMOVE BLOTS HIT
1020 IF DP>0 THEN IF BR(DP,TT)=1 THEN BR(DP,TT)=0:BR(0,TT)=BR(0,
TT)+1:FORX=1TO2:SOUND70,2:SOUND100,3:NEXT
1030 BR(P,T)=BR(P,T)-1:SOUND100,3:SOUND75,2
1040 IF DP>24 OR DP<1 THEN FOR X=1TO3:SOUND80,2:SOUND100,4:NEXTX
1050 IF DP<25 AND DP>0 THEN BR(DP,T)=BR(DP,T)+1:SOUND75,2:SOUND1
00,3
1060 'CANCEL USED DIE
1070 IF D4>0 THEN D4=0:GOTO1100
1080 IF D3>0 THEN D3=0:GOTO1100
1090 IF D=D2 THEN D2=0 ELSE D1=0
1100 'DISPLAY NEW BOARD POSITIONS
1110 IF P>0 THENGOSUB1300
1120 P=DP:IF DP>0 AND DP<25 THENGOSUB1300
1130 'CHECK IF GAME WON
1140 FOR P=0 TO 24:IF BR(P,T)>0 THEN1210 ELSE NEXT P
1150 SCREEN0,0:CLS(T+2):PRINT@500,"YOU WON!";:FORX=1TO3:SOUND100
,2:NEXTX:FORX=1TO2:SOUND115,4:NEXTX:SOUND140,5
1160 GOTO1160
1200 'INDICATE MEN ON BAR
1210 IF BR(0,1)>0 THEN LINE(244,76)-(252,84),PSET,BF:ELSE PAINT(
248,80),1,1
1220 IF BR(0,2)>0 THEN LINE(244,100)-(252,108),PRESET,BF:PAINT(2
46,104),4,1
1230 IF BR(0,2)=0 THEN PAINT(246,104),1,1
1240 'CHECK IF ALL DICE USED
1250 IF D1>0 OR D2>0 THENGOSUB1500:GOTO310
1260 'OTHER PLAYER'S TURN STARTS
1270 IF T=1 THEN T=2 ELSE T=1
1280 GOSUB1440:GOSUB1500:GOTO230
1290 END
1300 'DRAW COUNTERS ON POINTS
1310 IF P<13 THEN Y=0:X=(P*20)-16
1320 IF P>12 THEN X=((25-P)*20)-16:Y=167
1330 XX=BR(P,1):IF BR(P,1)=0 THEN XX=BR(P,2):IF XX=0 THEN 1400
1340 IF XX>6 THEN XX=6
1350 FOR Z=1 TO XX
1360 IF BR(P,1)>0 THEN PUT(X,Y)-(X+12,Y+12),CB ELSE PUT(X,Y)-(X+
12,Y+12),CR
1370 IF P<13 THEN Y=Y+13 ELSE Y=Y-13
1380 NEXT Z
1390 IF XX=6 THEN RETURN
1400 'COVER MOVED COUNTER
1410 PUT(X,Y)-(X+12,Y+12),CY
1420 RETURN
1430 'DRAW VERTICAL LINES
1440 FOR X=20 TO 240 STEP 20
1450 LINE(X,0)-(X,180),PSET
1460 NEXT X:RETURN
1500 'BLOCK OUT DICE
1510 LINE(0,182)-(160,200),PRESET,BF
1520 IF BR(0,T)>0 AND D1=0 THEN P$="C"
1530 IF BR(0,T)>0 AND D2=0 THEN P$="C"
1540 IF BR(0,T)>0 AND D1=D2 THEN P$="C"
1550 FOR X=1 TO 400:NEXT X:PAINT(100,191),1,1
1560 RETURN
```

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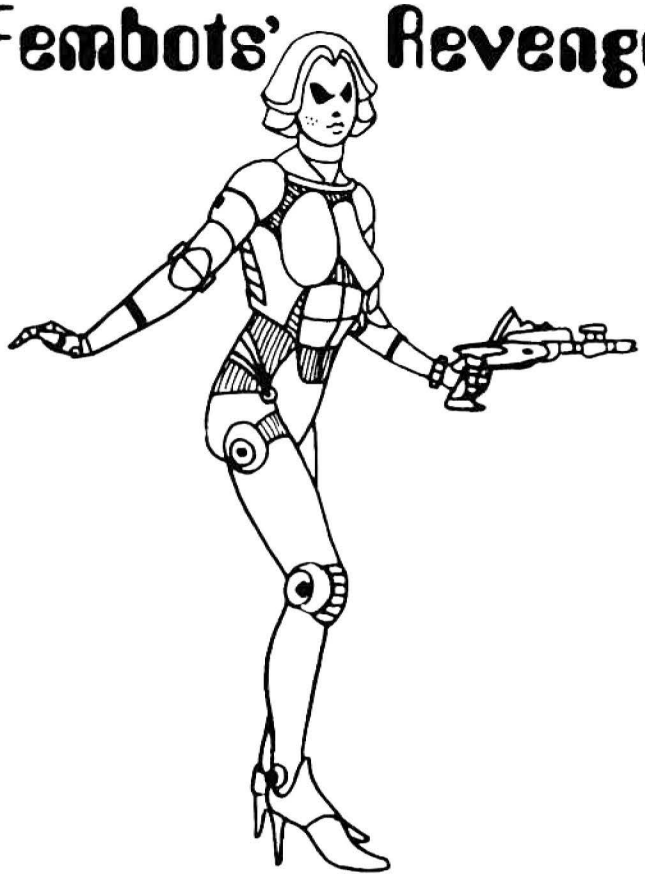

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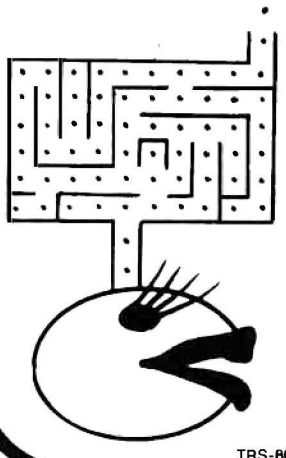

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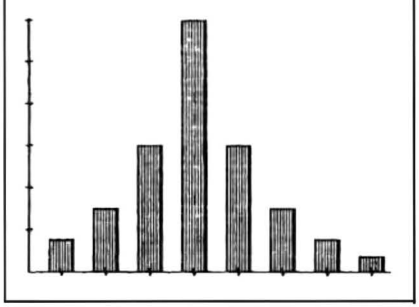
Graphically Speaking

PLOT FUNCTIONS ON THE SCREEN AND PRINTER

by Delmar Searls



In this column, I will be concentrating on Color Computer printer-graphics topics with business or mathematical/scientific applications. Some of these techniques can also be used to produce computer art. I will investigate graphics in two and three dimensions, including the removal of hidden lines in three-dimensional representations.

The theory will be accompanied by programs written in Extended Basic for at least 16K RAM. The programs make use of various subroutines to perform the necessary tasks. The subroutines related directly to drawing an image on the TV screen are intentionally written to simulate the operation of a graphics plotter, such as Radio Shack's Color Graphic Printer.

The application programs that I develop can be used with a plotter by changing those lines that call one of the graphics subroutines. This change will involve replacing the GOSUB command with the appropriate command for a plotter. Because you can adapt the program for use with a plotter, some of the graphics programs will not be very efficient when used with the TV screen. For example, the program to draw circles is much slower than the Circle command in Extended Basic.

This column assumes that you have a working knowledge of high-school geometry and algebra. Knowledge of trigonometry is helpful, but not necessary. I also assume that you are familiar with programming the Color Computer.

PLOT (X,Y,M)

Most plotters use commands that move the pen from its current position to a destination point (X,Y) that then becomes the new current position. The point (X,Y) refers to a point on the usual rectangular (sometimes called Cartesian) coordinate system. A move can be performed with the pen up (a blank move) or down. The latter, of course, results in a line segment being drawn on the paper.

The destination point can be designated using absolute coordinates (referenced to the origin of the coordinate system) or relative coordinates (referenced to the current position). The user also can reset the origin of the coordinate system if desired. Figures 1-3 illustrate some of these options.

The first task is to write a subroutine that will allow you to simulate a plotter on the TV screen. You must provide for each of the following capabilities:

- Blank lines (pen up)
- Drawn lines (pen down)
- Use of absolute coordinates
- Use of relative coordinates
- Change origin

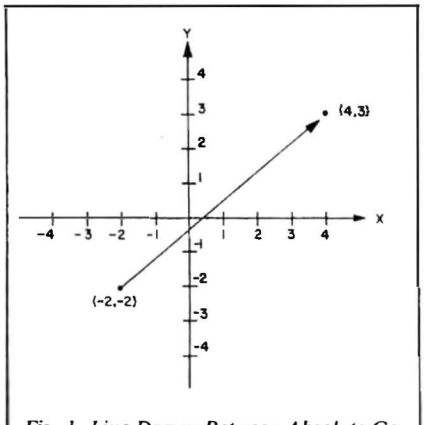


Fig. 1. Line Drawn Between Absolute Coordinates (-2,-2) and (4,3)

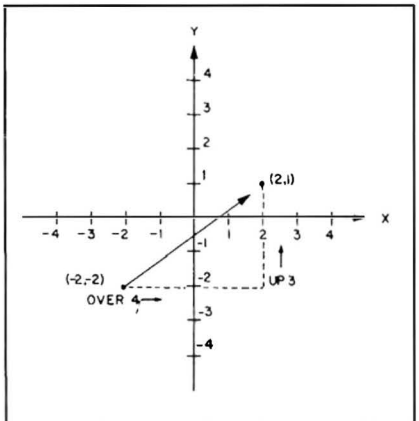


Fig. 2. Line Drawn from Current Position (-2,-2) to the Destination Point with Relative Coordinates (4,3). Notice that the Absolute destination point (2,1) is four units over and three units up from the starting point.

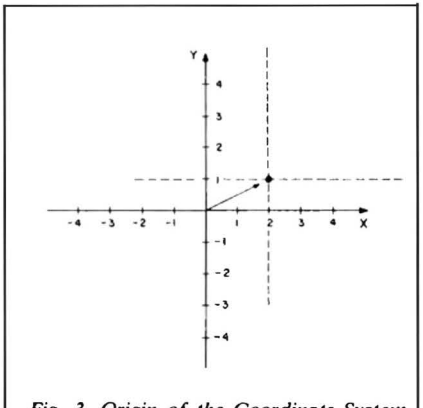


Fig. 3. Origin of the Coordinate System. Moved to the Point (2,1)

Graphically Speaking

Program Listing 1 is a well-documented subroutine that meets these requirements. Do not enter this listing into your computer. Its only purpose is to help you follow the logic. See Program Listing 2 (lines 10–16) for a much more compact version to type into your computer.

Start

There are a few minor tasks that prepare for plotting on the screen. You must set the high-resolution graphics mode and clear the graphics memory. While not necessary, it is desirable to set the origin of the coordinate system at the center of the screen.

By the way, the plot subroutine given above automatically adjusts for the way the Color Computer figures the vertical coordinate. Usually this is the Y-coordinate that increases upward. With the Color Computer, the Y-coordinate increases downward. The Start subroutine (lines 1 and 2 of Listing 2) places the origin at the center of the screen, and the coordinate system is oriented in the usual sense: positive X to the right and positive Y up.

The Start subroutine also provides for the input of a scale factor to be applied to the X-variable. You've probably noticed that circles drawn on the TV screen look like ellipses. If such a screen image is printed on the Radio Shack LP VII printer, it is more nearly circular but still slightly wider than it is high.

By selecting the appropriate scale factor, you can draw true circles on the screen, as well as true squares, true regular polygons, and so on. If a screen image is to be printed on a graphics printer, a different scale factor can be chosen so that the resulting figures will have true shapes.

The oblong circles are caused by the difference in the horizontal and vertical resolutions (dots per inch) on the TV screen and the printer. Thus, an increase in length from one dot to the next is different horizontally than it is vertically. A plotter has equal resolutions in both directions.

The correct scale factor is determined by dividing the horizontal resolution by the vertical. On the LP VII printer, the horizontal resolution is 60 dots per inch and the vertical resolution is 63 dots per inch. The appropriate scale factor is 60/63 or approximately 0.95.

The TV screen is a bit more complicated. You must measure, as accurately as possible, the height and width of the usable portion of the TV display (the green rectangle in text mode). The horizontal resolution is 256/width and the vertical resolution is 192/height. The scale factor is found with the following formula:

SF = (256/W)/(192/H) = (256*H)/(192*W)

For my system this is about 1.2; it may be somewhat different for yours.

X,Y is the destination point.
M = 1 indicates a drawn line using absolute coordinates.
M = -1 indicates a blank move using absolute coordinates.
M = 2 indicates a drawn line using relative coordinates.
M = -2 indicates a blank move using relative coordinates.
M = -3 indicates a blank move using absolute coordinates, and the destination point will become the new origin.

First, convert X and Y to integers (rounded off). SF is a scale factor which is discussed in the text.

```
10A XX = INT(SF*X + .5) : YY = INT(Y + .5)
```

If X and Y are relative coordinates (i.e. M = 2 or M = -2), use the current position as the reference point. SX and SY are the coordinates of the current position (screen coordinates).

```
10B IF ABS(M) = 2 THEN SX = SX + XX : SY = SY-YY : GOTO 12
```

Otherwise, X and Y are absolute coordinates and the origin (X0,Y0) is used as the reference point.

```
11 SX = X0 + XX : SY = Y0-YY
```

Make sure the screen coordinates are within bounds.

```
12 IF SX<0 THEN SX = 0 ELSE IF SX>255 THEN SX = 255
13 IF SY<0 THEN SY = 0 ELSE IF SY>191 THEN SY = 191
```

Form the string for the DRAW command.

```
14A P$ = STR$(SX) + "," + STR$(SY)
```

Perform the correct draw operation (blank move or draw line).

```
14B IF M>0 THEN DRAW "M" + P$ ELSE DRAW "BM" + P$
```

If necessary, reset the origin.

```
15 IF M = -3 THEN X0 = SX : Y0 = SY
16 RETURN
```

Program Listing 1. The PLOT (X,Y,M) Subroutine Simulates a Plotter Using the TV Screen.

```
 0 PI = 3.141592:GOSUB1:GOTO1000
 1 INPUT"SCALE FACTOR";SF:PMODE4,1:PCLS
 2 X0 = 128:Y0 = 96:X = 0:Y = 0:M = -1:GOSUB10:RETURN
10 XX = INT(SF*X + .5):YY = INT(Y + .5):IFABS(M) = 2THENSX = SX + XX:SY =
   SY-YY:GOTO12
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
```

Program Listing 2. Listing 1 and a Start Subroutine

You can enter the start subroutine at either line 1 or 2. Entry at line 2 resets the origin to the middle of the screen and performs a blank move to that point. Entry at line 1 asks for the scale factor, enters PMODE4,1, and clears the graphics memory as well as setting the origin.

Last, line 0 assigns the value of pi (ratio of the circumference of a circle to its diameter), runs the Start subroutine, and branches to line 1000, the first line of the main program.

Example 1

One approach to drawing a square is to first identify the four corners. Next, perform a blank move to the last corner and draw lines to all four corners in succession. Program Listing 3 uses this approach. While perfectly adequate, this program is very limited: In order to draw a different square, you would need to supply the coordinates of the new corners. This means changing up to eight different values, two for each corner.

A second approach is to draw the square using relative coordinates, as in Program Listing 4. This method allows you to place squares all over the screen by performing a blank move to the desired center and drawing the new square.

Exercise 1

Write a program that will allow you to input the length of one side of the square, and the point at the center of the square. The program will then draw the square. Write one version using absolute coordinates and one version using relative coordinates.

Exercise 2

Improve your program by allowing the user to draw any number of squares. That is, after each square is drawn, the user can view the result and add a square if desired. Do not clear the graphics memory between drawing squares. You can use the following line to allow the user to view the screen and resume program operation when he is ready:

```
Ln A$ = INKEY$:IF A$ = ""THEN Ln
(Ln is the line number)
```

While not very sophisticated, these examples and exercises will help you become more familiar with the concepts of absolute and relative coordinates. They will also give you practice in using the PLOT(X,Y,M) subroutine.

Example 2

It might be useful to develop a subroutine that draws rectangular boxes. There are several different sets of parameters that can be used to locate a box and determine its size. If the width and height of a box are known, it can be located by designating the point at the center of the box or by designating the lower left corner (any specific corner would do).

```
1000 DATA 40,40  ,  40,-40  ,  -40,-40  ,  -40,40
1001 :
1002 :  REM  READ COORDINATES OF CORNERS
1003 :
1010 FOR I=1 TO 4 : READ X(I) , Y(I) : NEXT I
1011 :
1012 :  REM  GOTO GRAPHICS SCREEN
1013 :
1020 SCREEN1,1
1021 :
1022 :  REM  EXECUTE BLANK MOVE TO FOURTH CORNER
1023 :
1030 X=X(4) : Y=Y(4) : M=-1 : GOSUB 10
1031 :
1032 :  REM  DRAW TO ALL FOUR CORNERS IN SUCCESSION
1033 :
1040 FOR I=1 TO 4
1050 X=X(I) : Y=Y(I) : M=1 : GOSUB 10
1060 NEXT I
1061 :
1070 GOTO 1070
```

Program Listing 3. Drawing a Square Using Absolute Coordinates

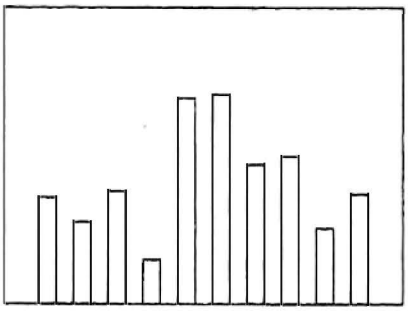


Fig. 4. Bar Chart

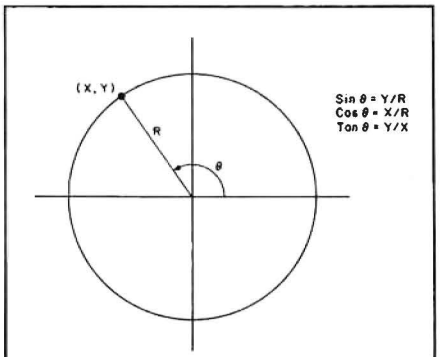


Fig. 5. Three Basic Trigonometric Functions

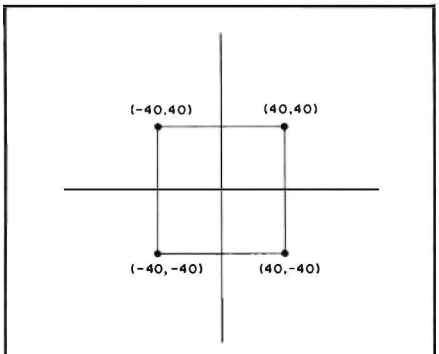


Fig. 6A. Square Drawn Using Rectangular Coordinates (X, Y)

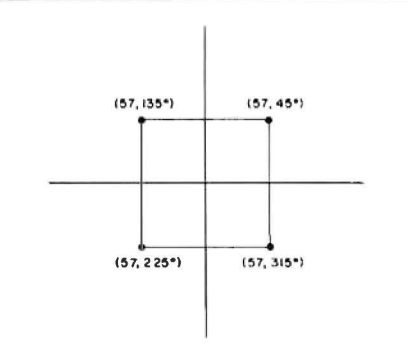


Fig. 6B. Square Drawn Using Polar Coordinates (R, θ)

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Alternately, one can determine location and size by specifying the coordinates of either pair of opposite corners (corners that lie at opposite ends of a diagonal). Regardless of the approach used, it requires four values to determine location and size. A Boxes subroutine is given in Program Listing 5. Notice that the subroutine can be entered at three different places (line 30, 31, or 32), corresponding to the three methods of determining location and size.

Exercise 3

Write a program that will draw a bar chart similar to Fig. 4. Make up your own data. Notice that the width of each bar (box) is the same, and that the lower left corner always has a Y-coordinate of zero (assuming that you move the origin to the lower left of the chart).

Trigonometry

Elements of trigonometry are used so frequently in computer graphics that you need to have some understanding of the basic concepts. The definitions of the trigonometric functions are based on the coordinates of a point lying on a circle of radius R centered at the origin. For this reason, they are sometimes referred to as circular functions.

Figure 5 illustrates the definitions of the three basic trigonometric functions. Notice that the location of a given point can be determined from X and Y (its rectangular coordinates) and also by R and Θ (its polar coordinates). Table 1 provides the relationship between polar coordinates and rectangular coordinates.

Converting Polar Coordinates to Rectangular Coordinates:

X = R*COSΘ , Y = R*SINΘ

Converting Rectangular Coordinates to Polar Coordinates:

R = SQR(X*X + Y*Y) , Θ = ATN(Y/X)

Note: ATN is the arctangent function. The arctangent of Y/X is the angle (Θ) whose tangent is Y/X (i.e., TANΘ = Y/X).

Table 1. Relationship Between Polar and Rectangular Coordinates

2π Radians is Equivalent to 360 Degrees

$$\text{Angle in Radians} = \frac{\text{Angle in Degrees} * \pi}{180}$$

$$\text{Angle in Degrees} = \frac{\text{Angle in Radians} * 180}{\pi}$$

Table 2. The Relationships Between Degree Measure and Radian Measure

The relationship between rectangular and polar coordinates is significant. Consider the square in Example 1. As you proceed from corner to corner, each coordinate changes at one time or another (see Fig. 6A). Furthermore, sometimes the change is positive (an increase) and sometimes the change is negative (a decrease).

Now consider Fig. 6B, where the corners are expressed in terms of polar coordinates. Notice that the value of R is constant and that the value of Θ varies at a uniform rate. Thinking in terms of polar coordinates can greatly simplify some of the difficulties in writing graphics programs. (Of course, for the plotter to recognize the data, the polar coordinates must be transformed into the appropriate rectangular coordinates, as in Table 1. But the computer can handle that.)

To better appreciate this point, try to write a program that will draw a regular hexagon (a six-sided figure with all sides and angles equal). Do it without using any trigonometry (no polar coordinates). The difficulty is in finding the vertices or corners of the hexagon.

One might successfully resort to trial and error, or use the familiar compass-and-straight-edge approach on a piece of graph paper. Someone quite familiar with geometry might recall the properties of a 30-60-90 triangle and apply these properties to the problem. It could be done, with some difficulty, without trigonometry. Now write a program that will draw a seven-sided regular polygon. Without trigonometry, your options are reduced to trial and error.

Consider the hexagon problem us-

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ing polar coordinates. For any regular polygon, the value of R is constant. The value of ∈ changes uniformly by an amount equal to 360/NS, where NS is the number of sides. Thus, for a regular hexagon the angle ∈ changes by 60 degrees from one vertex to the next.

```
1000 L=80 : REM  LENGTH OF ONE SIDE OF SQUARE
1001 :
1002 :  REM  GO TO GRAPHICS SCREEN
1003 :
1010 SCREEN 1,1
1011 :
1012 :  REM  BLANK MOVE TO FIRST CORNER (UPPER-RIGHT)
1013 :
1020 X=L/2 : Y=L/2 : M=-2 : GOSUB 10
1021 :
1022 :  REM  DRAW TO FOUR CORNERS IN SUCCESSION (USING RELATIVE
     COORDINATES)
1023 :
1030 X=-L : Y=0 : M=2 : GOSUB 10
1040 X=0 : Y=-L : GOSUB 10
1050 X=L : Y=0 : GOSUB 10
1060 X=0 : Y=L : GOSUB 10
1070 GOTO 1070
```

Program Listing 4. Drawing a Square Using Relative Coordinates

Entry at line 30 requires the coordinates of the center of the box (X,Y), the width of the box (W), and the height (H). The lower left corner (X1,Y1) is calculated.

```
30 X1=X-W/2 : Y1=Y-H/2
```

Entry at line 31 requires the coordinates of the lower left corner (X1, Y1), the width (W), and the height (H). The upper right corner (X2, Y2) is calculated.

```
31 X2=X1+W : Y2=Y1+H
```

Entry at line 32 requires either pair of opposite corners. A blank move is performed to the first corner (X1,Y1).

```
32 X=X1 : Y=Y1 : M=-1 : GOSUB 10
```

The directed distances (positive if up or to the right, negative if down or to the left) to the opposite corner are calculated.

```
33 DX=X2-X1 : DY=Y2-Y1
```

These directed distances are used as relative coordinates to draw lines to the opposite corner. The first line is horizontal and the second is vertical. The value of M is set in line 34 and stays the same for the next four lines.

```
34 X=DX : Y=0 : M=2 : GOSUB 10
35 X=0 : Y=DY : GOSUB 10
```

Finally, lines are drawn in the opposite directions to complete the box. Again, the first line is horizontal and the second is vertical.

```
36 X=-DX : Y=0 : GOSUB 10
37 X=0 : Y=-DY : GOSUB 10
38 RETURN
```

Program Listing 5. Boxes Subroutine

Example 3

You can use polar coordinates to write a program that will draw a regular hexagon. Since ∈ is not part of the alphabet, I will use A to refer to the angle. With R and the initial angle A fixed, Program Listing 6 performs a blank move to the first vertex. The angle is incremented and a line is drawn from the first vertex to the second. The angle is incremented again, and a line is drawn from the second vertex to the third.

This process is repeated six times until a line is drawn from the sixth vertex back to the first, thereby completing the hexagon. Notice (line 1040) that in Basic all angles are expected to be measured in radians, not degrees. Table 2 outlines the two systems of measure and lists the conversion formulas.

Enter Program Listing 6 and run it. Don't forget that the subroutines must also be in memory. Change the initial value of A to 30 degrees and run it again. Notice that two opposite sides are now vertical, whereas before two opposite sides were horizontal. Try varying R and the initial value of A. Try varying NS (the number of sides).

Exercise 4

Modify Program Listing 6 to allow you to input the value of R, the initial angle A, and the number of sides NS. The program will then draw the polygon, and allow you to view the result.

Exercise 5

Further modify the program to allow you to input the rectangular coordinates of the point at the center of the polygon.

Exercise 6

A circle can be approximated by a many-sided polygon. The larger the circle, the larger the number of sides required. On the TV screen, a good circle can be generated by drawing a 50-sided polygon. On a plotter, with its larger surface area, it might be better to use 100 sides. Write a subroutine that will draw a circle of given radius R centered at a given point (X,Y).

Example 4

For the last example, consider a computer version of a popular string-art project: Join each vertex of an n-sided polygon with every other vertex. Since you will be referring to each

```
1000 R=80 :                REM  SET R
1010 A=0 :                 REM  INITIAL ANGLE
1020 A=A*PI/180 :          REM  CONVERT TO RADIANS
1030 NS=6 :                REM  SET NUMBER OF SIDES
1040 DA=2*PI/NS :          REM  ANGLE INCREMENT
1050 SCREEN1,1
1051 :
1052 :  REM  BLANK MOVE TO FIRST VERTEX (OR CORNER)
1053 :
1060 X=R*COS(A) : Y=R*SIN(A) : M=-1 : GOSUB 10
1061 :
1062 :  REM  DRAW TO EACH VERTEX IN SUCCESSION
1063 :
1070 FOR I=1 TO NS
1080 A=A+DA :  REM  INCREMENT THE ANGLE
1090 X=R*COS(A) : Y=R*SIN(A) : M=1 : GOSUB 10
1100 NEXT I
1110 GOTO 1110
```

Program Listing 6. Drawing a Hexagon Using Polar Coordinates

Input data. NS is the number of vertices (which also corresponds to the number of sides of the polygon formed by connecting all of the verticals in succession). R is the radius.

```
1000 INPUT "NUMBER OF SIDES";NS
1010 INPUT "VALUE OF R";R
```

Go to the graphics screen.

```
1020 SCREEN 1,1
```

Set the initial angle to zero, and set the angle increment to 360/NS (converting to radian measure).

```
1030 A=0 : DA=2*PI/NS
```

Dimension the array to be used to store the coordinates of the vertices. Calculate the vertices and store the results, incrementing the angle after each calculation (in preparation for the next calculation).

```
1040 DIM X(NS) , Y(NS)
1050 FOR I=1 TO NS
1060 X(I)=R*COS(A) : Y(I)=R*SIN(A)
1070 A=A+DA
1080 NEXT I
```

Join each vertex to all of the vertices beyond it. Notice that a blank move is executed each time to get back to the initial vertex. Also notice that this process only continues up to the next to the last vertex (NS-1). This is because there are no additional vertices beyond the last.

```
1090 FOR I=1 TO NS-1
1100 FOR J=I+1 TO NS
1110 X=X(I) : Y=Y(I) : M=-1 : GOSUB 10
1120 X=X(J) : Y=Y(J) : M=1 : GOSUB 10
1130 NEXT J
1140 NEXT I
```

Allow the user to view the finished result.

```
1150 GOTO 1150
```

Program Listing 7. String Art

vertex several times, it is best to store the values of the coordinates in an array.

The calculations and array storage are performed by a loop at the beginning of the program (see Program Listing 7). A blank move is made to the first vertex, and lines are drawn from the first to each of the remaining vertices. Next a blank move is made to the second vertex, and lines are drawn from the second to each of the remaining vertices and so on.

Notice two things. First, after each line is drawn, a blank move is executed to return to the starting point for the next line. Second, it is necessary only to connect each vertex with the remaining vertices. For example, when you start using the second vertex as the initial endpoint, you have already connected it to the first vertex, and when you start using the third vertex as the initial point, it has already been connected to vertices 1 and 2.

Exercise 7

As noted above, Program Listing 7 requires a large number of blank moves. This is not too objectionable on the TV screen where blank moves and draws are executed quite rapidly. On a plotter, however, a blank-move operation takes as much time as a line draw and both are somewhat time-consuming, especially for a large figure.

Modify Program Listing 7 so that it requires a minimum number of blank moves. For a polygon whose number of sides is prime (such as 3, 5, 7, 11, 13, 17, 19) the blank move to the first vertex is the only one required.

Next Time

In the next column, I will consider a program that draws an ellipse. Such a program can also be used to draw a circle, which is merely a special kind of ellipse. I will show you my solution to Exercise 7, as well as present a few additional ideas in the study of computer graphics.

The next column will also feature a program I call SPIROGRF that operates just like the toy of a similar name. It includes a four-color option, and you won't want to miss it. In the meantime, don't forget to do your homework. ■

Write Delmar Searls c/o HOT CoCo, *Pine St., Peterborough, NH 03458.*

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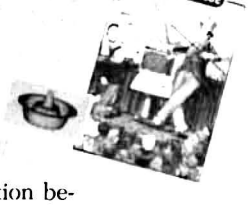

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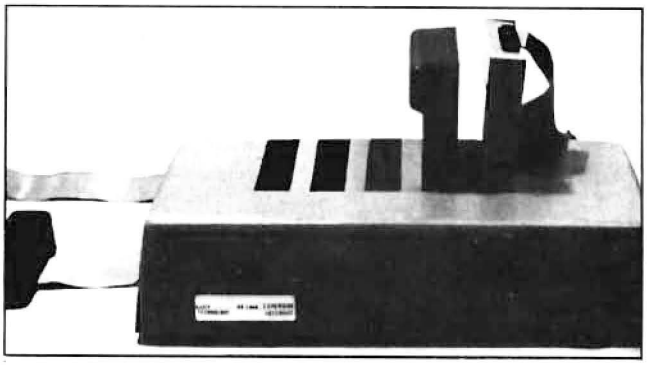
PRODUCT NEWS

Edited by Mark Reynolds



Basic Technology's BT-1000 Expansion Interface Unit.

Voice Recognition For the CoCo

Voice recognition is now available for the 16K TRS-80 Color Computer as ColorSoft Software Co. introduces Color Talk to Me, by Cary D. Perttunen.

Color Talk to Me can use your voice, via your cassette recorder's condenser microphone, as an alternate means of input for any of your existing Basic programs. With a little practice, you can attain from 80 to over 90 percent accuracy for most applications. Over 200 words can be stored in a 16K CoCo.

Included in the package are the Color Talk to Me machine-language subroutine, the Basic subroutine that can merge Color Talk to Me with your existing programs, and complete instructions on how to use and incorporate Color Talk to Me in Basic programs.

Two application programs, Screen Painter and Voice Calc, show how Color Talk to Me can be used. In Screen Painter, you say the name of one of the CoCo's nine colors, and the screen will be painted that color. In Voice Calc, you vocally enter arithmetic problems and Voice Calc will display the solution.

Color Talk to Me is great for professional programmers, since ColorSoft software will market original programs using Color Talk to Me. It is also ideal for making computer programs more accessible to disabled persons.

The Color Talk to Me software package is available on two cassettes for $49.95 (plus $2 shipping and handling) from ColorSoft Software Co., 11764 Raintree Court, Utica, MI 48087 (phone number unavailable). ■

Reader Service ✓550

An Expansion Interface Unit

The BT-1000 Expansion Interface Unit is a five-slot bus extender for the Radio Shack Color Computer. It allows the user to add serial ports, parallel ports, disk controller, and other compatible cartridges to the CoCo and operate with any Color Basic computer with any memory size.

The BT-1000 connects to the Color Computer through the cartridge slot by means of a 40-wire ribbon cable and a buffer cartridge. Additional features include a large internal power supply, internal memory decoding, gold edge connectors, socketed ICs, and four 24-pin RAM/ROM sockets. The sockets may be supplied with 8K of factory-installed static RAM.

The BT-1000 costs $270, or $300 with the installed 8K of static RAM. For further details, contact Basic Technology, P.O. Box 511, Dept. S, Ortonville, MI 48462, 313-627-2002. ■

Reader Service ✓553

Alphabet Soup

Alphabet Soup is a competitive spelling game for from one to five players, with provisions for nine skill levels. It is written for machines with 16K of memory and Extended Basic.

The game can be played by anyone old enough to spell a few simple words. The program generates a list of from 5 to 14 letters. The player then has 200 seconds or less to spell as many words as possible from the given letters. By choosing the appropriate skill level for each player, younger children can compete on an equal basis with adults.

The program includes an introduction, prompts, messages, and unique audio attention getters.

Alphabet Soup is currently available on cassette, and a disk version should be out soon. The game sells for $14.95, ppd. Colorspell, a program for a 16K machine without Extended Basic, is available for $10.95, ppd.

For more information, write Creative Technical Consultants, 16-8 Sangre de Cristo, P.O. Box 652, Cedar Crest, NM 87008 (phone number unavailable). ■

Reader Service ✓558

A Stock Market Analysis Program

Fundgraf is a program for stock market investment analysis that allows a graphic or numerical comparison for any stock or fund. It reports buy and sell signals back to you, based on the calculated moving average during a user-selected time period (up to 200 weeks). It allows an investor to compare the relative market performance of funds, stocks, or indices.

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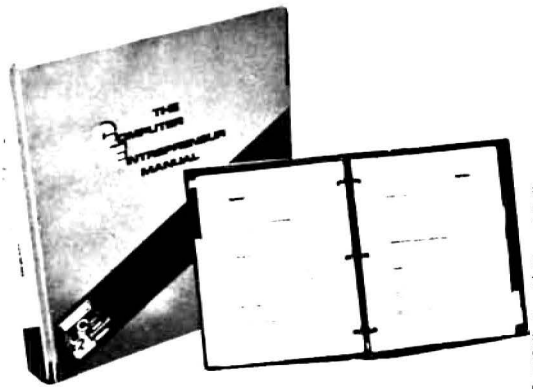

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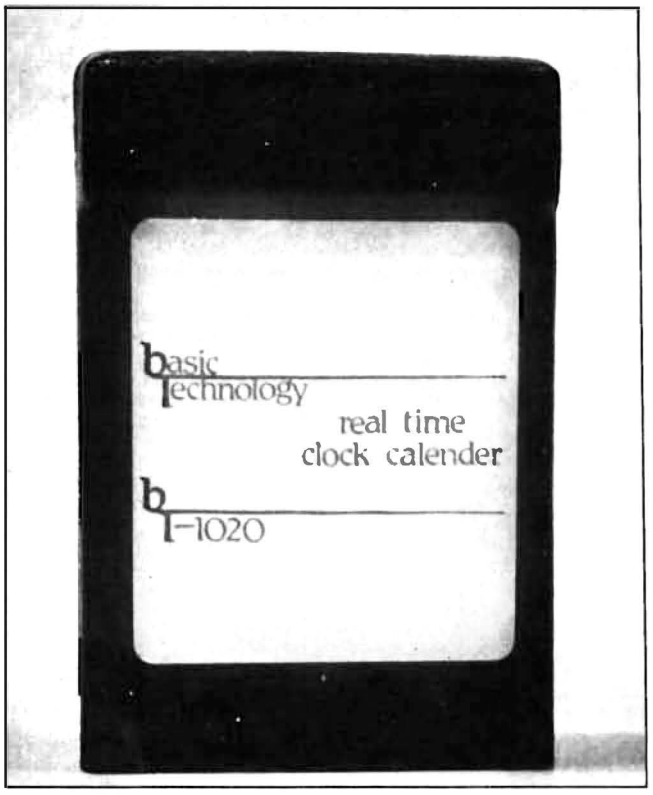

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tion of the percentage change in price (adjusted for dividends paid, if any) for any time period. You can compare funds by superimposing one graph over another.

Fundgraf will operate on the TRS-80 CoCo with Extended Color Basic and 16K for the high-resolution graphics.

A tape version of Fundgraf is furnished with documentation and a sample set of data for the Dow Industrial Average and six no-load mutual funds. This program can plot data for up to 70 weeks and can create data files for seven stocks or funds. It sells for $49.95, plus $2 postage and handling.

A disk version is furnished with documentation and a sample set of data for the Dow Industrial Average, Dow Transaction Average, and 30 no-load mutual funds. This version can plot data for up to 200 weeks and can create data files for 52 funds. It sells for $69.95, plus $2 postage and handling.

For more information, contact Parson's Software, 118 Woodshire Drive, Parkersburg, WV 26101, 304-424-5191. ■

Reader Service ✓557

3-D Ghostmania

Try to outwit pursuing ghosts in a three-dimensional maze of hallways. 3-D Ghostmania, a game of strategy, memory, and motor skill, is written for machines with 16K. It includes 30 skill levels, high-resolution graphics, and easy commands and instructions. No joysticks are required.

The price is $29.95 from Educational Arcade Systems, 5350 South 3600 W., Salt Lake City, UT 84118, 801-969-4139. ■

Reader Service ✓551

Electronic Spreadsheet

Transformation Technologies recently released the C.C. Calc electronic spreadsheet for the TDP and TRS-80 Color Computers with at least 32K. Arithmetic operators including exponentiation are supported along with summation, formula duplication, and repeating labels. Special features include hidden formulas, a screen printer, and an operator-specified decimal place.

C.C. Calc will print reports in regular or narrow print. Extra-wide reports can be printed in sections. A printer is recommended. Files can be shared with other programs through a standardized data exchange format.

C.C. Calc costs $25 for disk or cassette. Order from Trans Tek, 194 Lockwood, Bloomingdale, IL 60108, 312-351-1210. ■

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A Tape Editor/Assembler

The CORES-64 Tape Editor/Assembler supports the TRS-80 CoCo and TDP-100 systems that have at least 16K of memory. However, in a 16K system, only 3K of workspace is available to the programmer. In a 32K system, 19K is available, and in a 64K system, there is over 52K of workspace available. It does not require a disk system or FLEX.

This version of CORES adds a few enhancements to the versatile features of CER-COMP's Text Editor. It edits text files rapidly and is compatible with Basic ASCII-formatted tape files.

The Editor itself includes over 25 commands, such as string search and replace, and line- and automatic

line-edit modes. Automatic line editing allows you to skip forward and backward to review and edit. All screen editing immediately updates the screen so you know exactly what you are doing at all times. The Editor also has commands to copy or move single lines or blocks of text from one place to another.

The Assembler supports the full complement of 6809 instruction set with all addressing modes, and it will cross-assemble 6800 source code to produce 6809-compatible object code. It also supports the standard assembler directives. The listing includes line numbers for easy location of errors in the source file.

The tape includes a demonstration program listing and source file to help answer questions and allow the novice to work with a known program.

The CORES9 standard Editor/Assembler comes on tape for $29.95. The CORES9 upgrade to CORES-64, including a new manual, costs $14.95, and the CORES-64 64K enhanced Editor/Assembler (on tape) sells for $34.95. There is a $2.50 shipping and handling charge on all orders.

For more information, please contact CERCOMP, 5566 Ricochet Ave., Las Vegas, NV 89110, 702-452-0632. ■

Reader Service ✓555

Programmable Clock/Calendar

The BT-1020 Real-Time Clock/Calendar can add date and time to files, programs, and reports. This new programmable peripheral plugs directly into the cartridge slot of the TRS-80 Color Computer or into Basic Technology's BT-1000 Expansion Interface Unit.

It comes equipped with an internal nickel-cadmium battery, four jumper-selectable address ranges, and 50 bytes of battery-backed, general-purpose memory. The battery will maintain operation of the clock for a minimum of two weeks. It recharges when plugged into the computer cartridge slot.

The Clock/Calendar features a 100-year calendar, a 12/24-hour select, an automatic leap year, and daylight savings compensation. It costs $109, plus $2.50 for shipping. For further details contact Basic Technology, P.O. Box 511, Dept. S, Ortonville, MI 48462, 313-627-2002. ■

Reader Service ✓554

They Call Me Sister Honky-Tonk

Strip Tease (rated "R") is an adult math puzzle in which the player attempts to crack a nonrandom algorithm using three digits (one, two, or three).

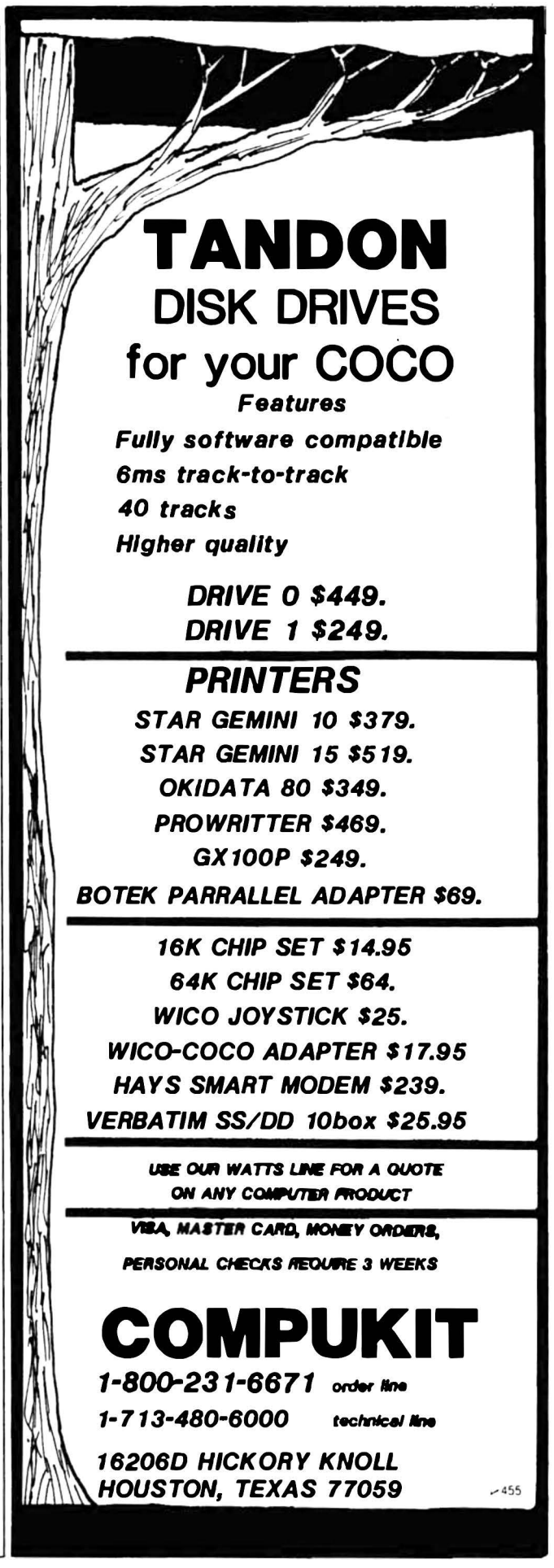
The beautiful—and au naturel—"Miss Byte" is hiding behind a billboard. If the player correctly guesses one of the three digits that the computer has chosen, a strip of the billboard disappears, revealing a strip of "Miss Byte."

When the last strip of billboard has disappeared, "Miss Byte" performs an undulating dance—in high-resolution graphics—accompanied by electronic rhythm and blues.

This game is sold on cassette and is for CoCos with 16K of memory. It is written in machine language, and does not require Extended Basic or joysticks.

This red-hot item sells for $14, ppd. (Does that include sin-tax?) from Britt Monk, CDP, P.O. Box 802, Elyria, OH 44036 (phone number unavailable). ■

Reader Service ✓556



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Re:FLEX

A Guide To The Four FLEX Systems

by David Wasler

There are those of you who have upgraded—or who may wish to upgrade—your CoCos to use a FLEX system. To date, there are four suppliers of such systems—Atomic City Electronics, Data Comp, Frank Hogg Laboratory, and Spectral Associates. Some of these products are similar in certain ways, and in some ways they are very different.

Over the next few months, I plan to look closely at each of these systems, to run as many programs as possible on them, and to report the results. I also intend to get into the heart of FLEX and its jump tables to learn what they do. As a result, I should have some helpful information for FLEX users on how the different versions of CoCo FLEX work, and how they vary.

The company that led the way for implementing FLEX on 6809-based computers was Technical Systems Consultants, or TSC (111 Providence Road, Chapel Hill, NC 27514). The TSC FLEX09 is not compatible with the Color Computer, but the four above-mentioned firms used the TSC FLEX09 as a basis for their versions.

What Is FLEX?

FLEX is a disk operating system that requires a minimum of 8K of free memory from $C000, and a minimum of 12K of free memory from $0000 up for system use. In the case of the Color Computer, you have free memory from $0000 to $F000 in memory map 1.

FLEX DOS is divided into three major parts: file-management system (FMS), disk operating system (DOS), and utility command set (UCS).

The file-management system is the link between the DOS and the disk drive. You are usually unaware of the fact that the FMS controls all the files that go to the disk. Nor do you know how many sectors it requires, or how it is written to the disk.

The FMS has a standard way of sending directory information to the disk. It is called the file-control block (FCB). The FCB sends 24 bytes to the disk directory about the file: 8 bytes for file name; 3 bytes for extension; 1 byte to read, write, delete and catalog-protect the disk; 2 bytes that contain the starting track and sector; 2 more bytes that contain the ending track and sector; 2 bytes for file size in sector; and 3 bytes for file starting date. I will cover FMS in a later article.

The FLEX DOS system must be able to communicate among the display, the keyboard, input and output (I/O) routines, and the FMS. The FLEX DOS doesn't have to be rewritten, but the communications routine must be, and that can take care of the keyboard, the display, and disk I/O.

In the case of the Color Computer, you must write a routine that uses the MC6883 and the MC6847 for the display, a printer routine that uses the 6821, and a boot-up routine that will load FLEX and execute it.

FLEX DOS is also easy to use. You only see the FLEX logo or the three pluses (+ + +) that tell you that the DOS is ready for the next command.

The utility command set consists of 25 utilities. All four sources of the Color Computer FLEX supply these utilities with their FLEX.

To invoke a FLEX utility, enter the command, the extension, and the drive number. The command can be any of the general FLEX commands. The extension can be one of three—CMD for command program, TXT for text, DATA for data. The drive numbers can be 0–3 for four disk drives and are normally placed after the command.

Here is the CATalog command, the first command most users learn: 1.CAT.CMD,1. The first number is the disk-drive number and isn't necessary if the command is on the system drive, which is normally zero. The three characters following the command are the extension. The comma separates the command from the drive number.

The following are the general FLEX disk-resident utilities:

- APPEND—merges two or more files into one. To invoke, type in the command APPEND, (first file name), (second file name).
- ASN—assigns the system drive and working drive.
- BUILD—lets you create a small text file for STARTUP or the EXEC command.
- CAT—displays all the file names on the disk.
- COPY—copies files on the disk to another disk.
- DATE—displays or changes the date register.
- DELETE—deletes a file from the disk by removing the file name from the directory.
- EXEC—executes a series of commands written as a text file.
- I—inputs characters from a disk file instead of the keyboard.
- JUMP—is like a GOTO. To invoke, type JUMP and a four-hex-number address; press the enter key and it will jump to the address.
- LINK—tells the boot loader where the FLEX system is on the disk.
- LIST—displays the control of a text file or Basic file to the terminal.

- NEWDISK—formats a new disk.
- O—routes the display output to name file on the disk.
- P—routes the display output to the printer.
- PROT—gives you the ability to protect a file from the delete or write command.
- RENAME—changes a file name.
- SAVE—saves a section of RAM to the disk.
- SAVE.LOW—is the same as SAVE, but loads the program into lower memory instead of the utilities area. This utility lets you save a program in the utilities area.
- STARTUP—lets you do something special during the after-boot load.
- TTYSET—sets the terminal control character and the formatting code.
- VERIFY—verifies every sector written to disk.
- VERSION—displays the version number of the command or utilities on the display.
- XOUT—deletes all commands with an extension of OUT.

The Disk

Obviously, the disk is an essential part of the DOS. FLEX disks are quite different from the Radio Shack disk. The FLEX disk must have track 0 single density, whereas Radio Shack has double density over the whole disk. And, FLEX puts the boot load on track 0, while sectors 1, 2, and 3 are for the system information record, which tells DOS where the free sectors are. Sectors 4–9 contain the disk catalog. Radio Shack puts the catalog on track 17.

FLEX writes a sector to the disk differently than Radio Shack does. I will get deeper into this area in the coming months.

All four versions of the CoCo FLEX support a NEWDISK command. Atomic City only offers a single-density disk at this time. Frank Hogg has NEWDISK or NEWDISKA.CMD, and he provides two NEWDISK commands because some drives cannot support 18 sectors per track on double-density disks.

Data Comp and Spectral Associates also have the NEWDISK.CMD, but Spectral, in the double-density mode, uses the FLEX BOOTLOADON command. When using the Data Comp system, you must use the MAKESYSTEM command after the NEWDISK command.

Atomic City Electronics

Atomic City FLEX09 conversion is the most unique of all Color Computers and the closest to the original FLEX09 system. In fact, it requires the TSC FLEX09. It has an EPROM in upper memory from $F000 to $FBB4. It uses an MC146818, a battery-powered CMOS clock with 50 bytes of RAM from $FF8E to $FFB8. It doesn't use the Radio Shack disk controller, although the other versions of Color Computer FLEX09 do.

On power-up, the program that puts the Color Computer into memory map 1 and then brings in FLEX resides in an EPROM. All the other versions of Color Computer FLEX must bring it in from disk to execute it. Atomic City's system has a real 80-by-24 display that uses an MC6845 chip and a parallel-printer interface port. Finally, you get a complete source listing from the EPROM. The EPROM is called the Wolfbug Monitor, and by using the following single-key entries you can call the accompanying routines from the monitor:

- A—is an ASCII dump of memory. You are prompted for the starting address and 15 rows of 16 characters; a total of 255 addresses is displayed.
- B—transfers Basic and Extended Basic into RAM with no return to FLEX.
- F—boots FLEX in while in the monitor.
- G—is a GOTO routine. You are prompted for a starting address.
- H—is the same as A command, but hex information is displayed.
- M—lets you examine and change memory.

The Atomic City disk-controller board (Photo 1) measures about 8-by-9 inches and fits on top of the RF shield. The heart of the disk controller is the 1793 chip, the same as that used in the Radio Shack disk controller. However, it is not compatible with any Radio Shack software, but it is fully FLEX09 compatible.

It also supports a real 80-by-24 display design around a MC6845 chip, which greatly expands the power of the Color Computer. And it has a real-time clock, which is battery powered and software controlled, with a parallel-printer port.

Installing the disk-controller board is easy—just open the Color Computer case (which voids the warranty) and place the board over the RF shield. Install the 40-pin ribbon connector into the cartridge port and follow the instructions provided.

The following are the disk-resident commands that Atomic City provides:

- RXBASIC.CMD—transfers Basic or Extended Basic from ROM to RAM and then executes it.
- CLOCK.CMD—displays the time and day of the system clock on the CRT display.
- CLOCKSET.CMD—prompts you for the month, day, and year. When you press the enter key you are prompted again, this time for the hour and minute. If the hour is past 12

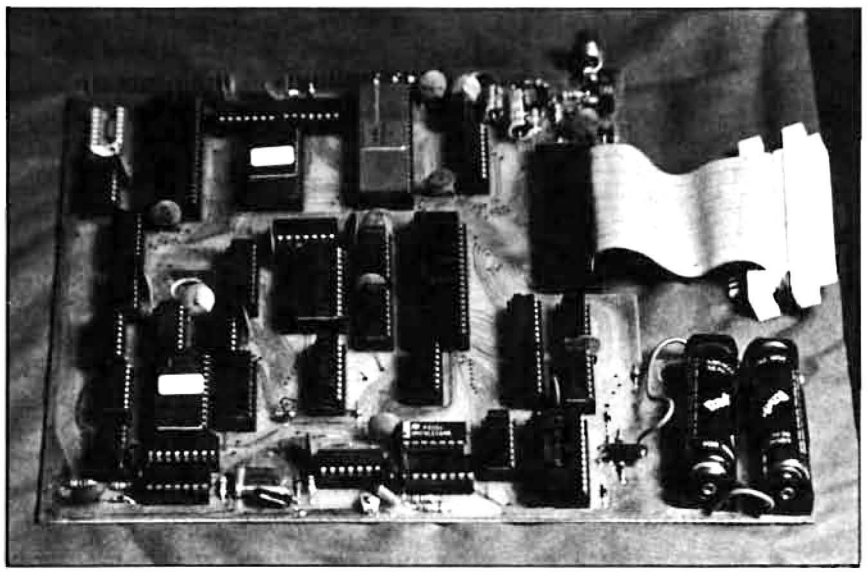

Photo 1. The Atomic City Disk-Controller Board

noon, you must add 128 to it. For example, 1 p.m. would be entered as 129 hours.

● DEMON.CMD—lets you examine and change disk information. After you enter DEMON.CMD, you are prompted for a drive number, track, and sector number. At this time you can examine or change the disk information.

Atomic City's version brings the Color Computer the closest to a real FLEX system, if there is such a system. It offers the user a 80-by-24 display, a real-time clock, and a parallel-printer port.

When Atomic City solves its double-density problem and achieves some compatibility with Radio Shack, it will be the most powerful Color Computer FLEX conversion.

Data Comp

Data Comp's version of FLEX is called F-MATE and is the most interesting Color Computer FLEX. It provides some unusual, powerful utilities. These utilities let you transfer a Radio Shack file to FLEX and a FLEX file to Radio Shack DOS.

You can also read the Radio Shack disk directory and repair a bad disk, using the DISKEX.CMD. Data Comp includes these utilities in their general package.

When you receive Data Comp's FLEX 9, you cannot run it. First, you must create a file called FLEX System from the general FLEX core.

Data Comp FLEX 9 comes with an installation disk, a utilities disk, and a general FLEX09.

The installation disk is the first one you will use. It contains the RSDISKO.BIN, RETERMIO.BIN, SDC.CMD, NEWDISK.CMD, and APPEND1.TXT files, which are needed to create the FLEX.SYSTEM disk.

The utilities disk contains 14 resident disk commands and nine text files. Later on I will explain more about the utilities.

The third disk contains the general FLEX CORE with the normal FLEX utilities.

To create a FLEX.SYSTEM disk under Data Comp's F-MATE, insert the installation disk into drive 0 and type RUN "FLEXLOADER". This is a boot-load program written in Basic, and it loads a machine-language program named RSLOADER/BIN. This is chained to another machine-language program on the disk and then to another Basic program that tells you what the system is doing.

The program prompts you for the general FLEX disk. At this time, insert this disk in drive 0 and hit enter. The system loads in the general FLEX and prompts you for the date. After entering the date, you will see the three pluses (+ + +), which tell you you are in FLEX.

Now, you want to make a FLEX.SYSTEM disk. Insert the installation disk in drive 0 and use the SDC.CMD (single-disk copy routine) to copy all the files to the general FLEX disk. After all the files have been copied, the FLEX prompts you with + + +, and you type EXEC APEND1.

APEND1 creates the system disk by appending the terminal keyboard and disk I/O routine to the FLEX.CORE and renaming it FLEX.SYSTEM. Data Comp tells you at this time to remove the disk from the drive and turn the computer off. Then turn the Color Computer back on and reinsert the new FLEX disk. Type RUN"FLEX".

In a few seconds, you will be prompted for the date. After entering this, the FLEX sign-on logo will appear (+ + +). You are now finished making the system disk.

Now make a back-up of the FLEX.SYSTEM disk. However, you must first make a new disk—type NEWDISK 0 and press enter. After a few seconds, you will be asked a series of questions about the new disk. Before answering the first question, remove the utilities disk.

After you have entered all the data, the specified drive will begin to format a new disk. When this is completed, remove the disk and reinsert the utilities disk. Use the SDC.CMD to copy the newly made FLEX.SYS disk to the new disk.

The following are disk-resident commands on the utilities disk:

● CCBASIC.CMD—moves Basic and Extended Basic from ROM to memory and provides patches for the remaining disk-resident commands.

● FLEX—returns you to FLEX DOS.

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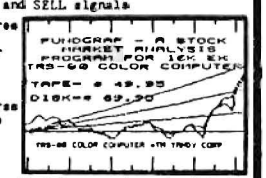

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● LOAD—loads a Basic program from FLEX disk.
● SAVEM—saves a machine-language program to FLEX disk.
● LOADM—loads a machine-language program from FLEX disk.
● DISKEX.CMD—is a powerful utility program. It lets you examine and modify the contents of the disk with one of the following single-key entry commands:

D—specifies the disk drive you wish to examine.

S—sets the display scroll value.

A—puts you in a new disk command.

C—modifies the contents of the disk data that was read into memory.

N—brings in the next disk sector.

P—brings back the previous disk sector.

F—lets you follow the chain of data from one sector to another. The program ends when it reaches the last sector.

R—is similar to the P command, but R rereads it off the disk.

W—writes back to the disk what you might have modified under the C command.

X—gets you back to FLEX.

● DISKRATE.CMD—lets you set the disk-drive number and the rate at which the disk drive will step at either 6ms, 12ms, or 30ms.
● MAKESYS.CMD—is used after the NEWDISK command to create a FLEX system disk.
● MEMEX.CDM—is used to modify and examine RAM memory with the following single-key entries:

S—sets the new scroll value.

A—displays hex addresses you set in.

C—lets you change the contents of memory.

X—gets you back to FLEX.

● NEWDISK.CMD—formats a new single- or double-density disk.
● P.CMD—directs the output to the printer.
● RSDIR.CMD—reads the Radio Shack directory.
● RSREAD.CMD—copies a Radio Shack Basic file to a FLEX disk by using a byte-by-byte method and no date conversion.
● RSBIN.CMD—copies a Radio Shack binary file to a FLEX disk using the same method as the RSREAD.CMD.
● RSWRITE.CMD—copies a FLEX disk to Radio Shack disk with no date conversion.
● SAVEROM.CMD—saves the ROM to disk.
● SDC.CMD—single-disk copy routine that lets you use one disk to copy a file.
● USERKEY.CMD—lets the user set the new control-key value.

Frank Hogg Laboratory

Frank Hogg Color FLEX has been on the market the longest and has the most software support. It is also the easiest to use. After you receive it, just put it in your drive and type RUN "FLEX".

Making a new system disk is done a little differently than it is with the other systems. After you have made a new disk and the formatting is complete, you must use the PUTBOOT. LDR utility. This puts the Color Computer FLEX boot on the disk. This utility is copy-protected, so you must use your master disk every time you make a system disk.

Here are the disk-resident utilities for the Frank Hogg system:

● CBASIC.CMD—lets you jump to Basic with no provisions to use the disk.
● EXT.CMD—is the external terminal utility that lets you use a serial terminal. This is an extremely powerful routine.
● HELP.CMC—is another powerful program that helps you by providing an outline of the utility.
● INT.CMD—returns to Color Computer from the EXT mode.
● LINK.CMD—informs the boot loader where the FLEX operating system resides on the disk.
● MOVEROM.CMD—transfers Basic and Extended Basic from ROM to memory.
● NEWDISK.CMD—formats a new single- or double-density disk.
● P.CMD—is the system printer routine.
● PUTBOOT.LDR—makes a newly made disk bootable for FLEX.
● SDC.CMD—is a single-disk copy program.
● SETUP.CMD—lets you set the system up according to your preference.
● XSCREENS.CMD—is the high-resolution screen routine.

Spectral Associates

Spectral Associates' FLEX09 conversion, FLEX+, is quite different from the other approaches. First, you must use their Supercharger (see Photo 2). According to Spectral Associates, this design allows access to the full 64K of RAM used in the series E board without modifying the Color Computer and voiding the warranty.

My Color Computer was the D-board version, so I upgraded it to an E board. To date, I haven't encountered any problems with FLEX+. The Supercharger must be inserted between the Radio Shack disk controller and the Color Computer.

To bring Spectral Associates' FLEX+ up, just enter RUN "FLEX+" and press enter. After a couple of seconds, the screen displays the Spectral Associates sign-on message with the version number, 1.25. At this time, you are prompted for the month, day, and year. After entering these, FLEX+ prompts you with the normal logo, +++. Now you are in Spectral Associates' FLEX+ world.

The FLEX+ world is somewhat

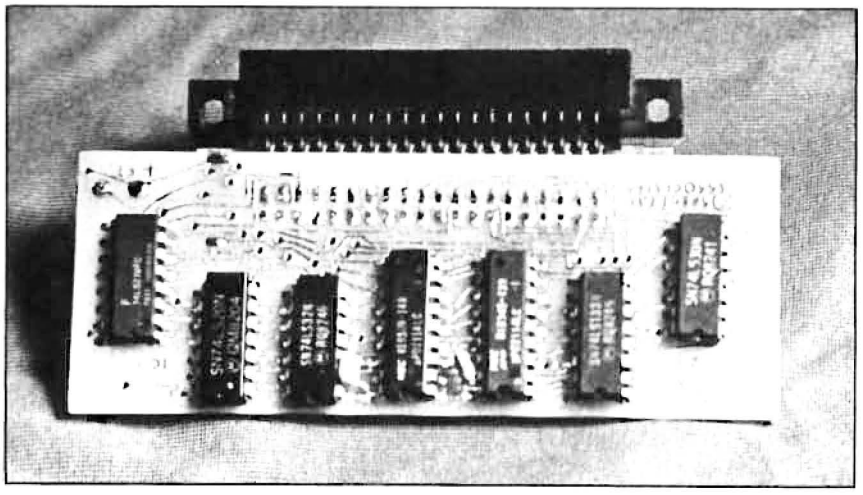

Photo 2. Spectral Associates' Supercharger

different from the others. FLEX+ recognizes only one disk driver after power-up. You must use the DRIVES command to tell the system you have more than one drive. After entering DRIVES.CMD, the screen displays the following message:

```
ANY DOUBLE SIDED DRIVES?
HOW MANY DRIVES (1-3)?
PROPER DISK IN DRIVE 0?
```

The HIRES command is a resident of the FLEX+ system. (It is not on the disk, but is attached to FLEX+, so on boot-up it is loaded into memory.) When you type LORES, the HIRES causes 51 columns by 24 lines of display to return to 16 columns by 32 lines. Direct cursor addressing, clear, end-of-line, end-of-screen, home, and cancel line are some of the important features of the HIRES display.

The keyboard software can generate every ASCII code from the Color Computer keyboard. Generate the control code in the usual manner by holding down the shift and up-arrow keys and hitting the desired single character.

The NEWDISK command, in the double-density mode, writes a bootload for the Color Computer, eliminating the MAKESYSTEM command.

FLEX+ has a powerful and compact monitor that can be relocated. To invoke the monitor, type MON and press enter.

The monitor supports the following single-key entry commands:

- A—stores the ASCII value of each key; you must enter them in consecutive addresses. To terminate this command, press the enter key. To invoke this command, type in A (ADDR1—the starting address in hex) and press the keys.
- D—displays the contents of memory from (ADDR1) to (ADDR2—the ending address) in hex.
- F—fills memory with a set value. Invoke this command by entering F (ADDR1), (ADDR2), and the value.
- G—(GOTO), is a powerful command. In addition to a GOTO command, you can also set break points.
- H—displays the differences of ADDR1 and ADDR2 in hex.
- M—moves a block of memory starting with ADDR1 through ADDR2 to ADDR3.
- P—lets you move the Monitor program to a block of memory. To invoke it, type P(ADDR1) and press enter.
- S—examines and modifies. To invoke, enter ADDR1.
- T—displays the contents of ADDR1 through ADDR2 in ASCII. Non-ASCII characters are displayed as periods.
- V—is a byte-for-byte comparison starting at ADDR1 through ADDR2 with ADDR3, and so on.
- X—displays the contents of the A, B, D, X, Y, U, P, C registers and can modify them.
- Y—searches all 64K for a string of data up to 256 bytes long. You invoke this command by entering Y(byte1, byte2,... byteXX).

The following disk-resident utilities are Spectral Associates commands:

- DBASIC.CMD—transfers Basic, Extended Basic, and Disk Basic to RAM. There is no return to FLEX.
- DRIVES.CMD—lets you tell the system if the drives are double or single sided, and how many of them there are.

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● DUPO.CMD—is a single-disk copy routine. It prompts you for all files on the disk; otherwise, you must enter each file name individually.

● NEWDISK.CMD—NEWDISK lets you format a new single- or double-density disk. When making a double-density disk, only the NEWDISK utilities put the FLEX boot-up program on the disk, eliminating the MAKESYSTEM command.

● P.CMD—is the print command.

● PBASIC.CMD—transfers Basic and Extended Basic to RAM. Entering EXEC&HCD00 and hitting enter returns you to FLEX.

● PLAY.CMD—is used when a binary file needs Basic. To invoke PLAY.CMD, type PLAY. (binary file name) and press enter. PLAY will load Basic and Extended Basic and modify them to run in RAM. Then it brings in the binary file and executes it.

Conclusion

All four FLEX suppliers have done an excellent job of bringing FLEX to the Color Computer. After comparing the different versions, it is difficult to be objective. I have not been able to test much software to see what runs and what doesn't.

Atomic City and Spectral Associates use the FLEX interrupts, which can only be tested out by running software that requires interrupts.

Data Comp and Frank Hogg require the Radio Shack disk controller and the 64K upgrades, plus their versions of FLEX.

Spectral Associates requires an E-level board with the Radio Shack disk controller, their Supercharger, and FLEX+.

Atomic City requires their disk-controller board and TSC general FLEX. All four companies use the same general FLEX utilities from TSC. You can find differences in the extra utilities they all provide.

Data Comp and Frank Hogg provide you with utilities to read and write a FLEX file to Radio Shack and back. Atomic City and Spectral Associates have no FLEX conversion to Radio Shack or from Radio Shack to FLEX.

Data Comp, Frank Hogg, and Spectral Associates can handle single- or double-density disks. Atomic City is only single density at this time—a big drawback.

Frank Hogg supports a serial terminal through the utilities program called EXT, which uses the RS-232 port. Atomic City comes standard with an 80-by-24 display. By setting a switch, you can use normal video output. Atomic City is the only system with a real-time clock.

In the coming months, I plan on running Fortran, Forth, Pascal, and C languages; word-processor and business programs; and as many utility programs as possible. I also hope to provide jump-table information on all four sources of Color Computer FLEX. ■

Atomic City Electronics' address is 3195 Arizona Ave., Los Alamos, NM 87544. The address for Frank Hogg Labs is 770 James St., Syracuse, NY 13203. The address for Data Comp is P.O. Box 794, Hixson, TN 37343. The address for Spectral Associates is 139 Harvard Ave., Tacoma, WA 98466.

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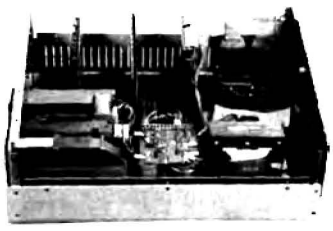

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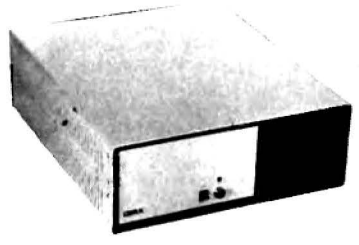

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