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Contour Graphics—See p. 94
Don't Get Burned

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. We don't.

Most of the computer programs available for the Color Computer are clones. Clones of video games like every fourteen-year-old in country plays. Clones of games every fourteen-year-old in the country is bored with.

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.

Jyym Pearson's machine language adventure games have been driving folks to distraction for years. Now you can challenge his worlds on your Color Computer. Worlds that demand every ounce of skill, ingenuity and intelligence you can muster.

The Institute, for example contains scenarios derived from your most horrifying nightmares, but this is a nightmare which you can escape through cunning and strategy.

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And if you tire of matching wits with the likes of Hitler and Lucifer, you can try Kenneth Kalish's arcade games.

Phantom Slayer is like no other game you've ever seen for the Color Computer, featuring 3-D graphics in which you move about in real-time. No delays for anything — even though you may want one so you can catch your breath.

And then there's Danger Ranger. It's the kind of game people would fight over at an arcade — if any arcade had a game like this. Danger Ranger blasts from the screen with speedy, exciting action and colorful graphics that quicken their pace as you increase your skill.

And finally, there's Invader's Revenge, a game that offers an interesting reversal to a common gaming concept. Fast-paced and fun. Don't try this one unless you think you're pretty adroit — and uncommonly sharp.

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ARTICLES

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Tired of writing screen-formatting code? This program will do it for you.
John Nicollas

Serial-to-Parallel Interface
This interface will let you use non-Radio Shack printers with your CoCo.
Don LeRoi

CoCo Word Processor
This Basic WP is great for correspondence and file merging.
Ken Knecht

Cavehunt
Can you make it past wizards and monsters and find your way out of the cave?
Charles Levinski

Tape Reliability
Bad tape loads and saves are always a bummer. Learn how to avoid them.
Ralph Tenny

Doculist/C
Program listings are often hard to follow. So, list them in a readable format.
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Print That Trace
Follow the program flow on paper, not on the screen.
Norman Manchevsky

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Build a plug-in voice box that will give you a large vocabulary (without voiding your warranty).
William C. Clements

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Jerry Hogan

 Daw Poker
With this casino-style draw-poker game all you have to lose is your pride.
Duane Rouch

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You can teach the physics of light in the classroom or at home.
James Wood

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Use these algorithms and techniques to print out contour graphics.
Delmar Searls

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Tour through the CoCo with your guides POKE and PEEK. Some useful utilities are also included.
Rusty LeBlang

Merge Maneuvers Made Easy
It’s not hard to merge Basic programs. Just try these methods.
Robert P. Bussell

Microline 82A Meets CoCo
Don’t want to pay $30 for a cable? You can build one at a fraction of that cost.
Leigh H. French

Color Backgammon for Two
You’ll never lose pieces to this game.
John P. Koch

DEPARTMENTS

Digressions
What’s in a name?

Graphically Speaking
Use graphics in business or scientific applications.
Delmar Searls

Reviews
TC-8C, Micronix keyboard, Donkey King, Tennis, two books. Edited by Barbara Jatkola

Product News
Edited by Mark E. Reynolds

The Basic Beat
Learn Basic painlessly, and have fun, too.
James Wood

Re: FLEX
Read this before you choose which FLEX you buy.
David Waster

Vol. 1. No. 1 June 1983

HOT CoCo (ISSN pending) is published 12 times a year by Wayne Green Inc., 80 Pine St., Peterborough, NH 03458. Phone: 603-924-9471. Second-class postage pending at Peterborough, NH, and additional mailing offices. Subscription rates in U.S. are $25 for one year, $38 for two years, and $53 for three years. In Canada and Mexico, $27.97—-one year only. U.S. funds. Canadian distributor: Micron Distributing, 409 Queen St. West, Toronto, Ontario.

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The challenge of inner space — the fury of an enemy that seemingly will not die. This isSEA DRAGON—a battle to the death under the high seas! Slide into the captain’s chair, take the controls and prepare yourself for the most incredible non-stop action this side of Davy Jones’ locker. SEA DRAGON puts you in control of a nuclear sub that’s armed from stem to stern with enough firepower to take on King Neptune himself — and you’ll need every missile, every torpedo, and every scrap of skill you can muster to survive.

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WHO ARE WE DOING THIS?

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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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 to-
gether for the good of all involved.

The ads, which some people gripe
about, are another important resource
for you. Think about this for a mo-
moment. Without a system-specific mag-
zine, 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 re-
member 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 maga-
zine 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 sup-
porters have a thousand computer
stores anxious to carry Apple-oriented
products. Computer stores, for the
most part, flatly refuse to touch any-
thing 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 per-
nicious and eventually does in the
whole marketing system for a manu-
facturer. 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 see if you are getting help or not.

From your viewpoint this means
that we're on your side and not mak-
ing excuses for Radio Shack where
they have screwed up. If you are get-
ing any other TRS magazines, you
might just think about that, particu-
larly 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 in business.
Programs that allow network-
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are screwing up? No, I say read the ads
and find your bargain with 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 infor-
mation 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
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<td>$2699</td>
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<td>w/16K Ext. Basic</td>
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- DMP-500: $1539
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*TRS-80 Color Computer is a trademark of Radio Shack, a division of Tandy Corp.
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 a reasonable price. Second, you need to work on things you have your own 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 always 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

**KAMIKAZE**  
$24.95  
Light off Tanaka Daisuke's Kamikazes, find and destroy his fleet before it eats you! Rich graphics include lighter vs lighter torpedoa and development vs ship. Kamikaze attacks, ship vs ship and more. 4 levels. 38K Cassette.

**KAMIKAZE-16**  
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See List of Advertisers on page 138.
IT ISN'T EASY CHOOSING A TITLE

HOT CoCo? It sounds like a dirty magazine," I heard that comment 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 has 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 etch 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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See List of Advertisers on page 138
Super “Color” Library™

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

No matter what kind of problem you are trying to solve with the Color Computer, there is a program in the ever-expanding integrated Super “Color” Library that will give you the solution. Faster. Better. Smarter!

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The Super “Color” Library has all the power, speed, dependability and compatibility you will ever need so build your library a volume at a time or put the full power of the complete library of problem solvers to work right away.

NEW!

Super “Color” Writer II™

VERSION 3.0 By Tim Nelson
THE INTELLIGENT WORD PROCESSOR

Check These Exclusive Features

MEMORY-SENSE adjusts to computer’s memory (16-64K) for maximum work space. TYPE-AHEAD, TYPOMATIC KEY REPEAT and KEY BEEP for the pros. 3 PROGRAMMABLE FUNCTIONS. AUTO PHRASE INSERT, COLUMN CREATION, TEXT FILE LINKING. HELP MENU. A TRUE EDITING WINDOW IN ALL 9 DISPLAY MÖDES. TRUE FORMAT WINDOW to display line lengths up to 255 characters, with horizontal and vertical scrolling to replicate the printed page including centered lines, headers, footers, page breaks, page numbers, margins, giving a perfect printed document every time. Also makes hyphenation a snap. TRUE AUTOMATIC JUSTIFICATION for neat, even left and right hand margins. Ability to use CHARACTER CODES for printing special characters available with your printer, freedom to embed as many PRINTER CONTROL CODES as desired anywhere in the text. EVEN WITHIN JUSTIFIED TEXT; 90-plus page tutorial manual.

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.

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The Super “Color” Mailer is a powerful multi-purpose mailing list merging and sorting program including lowercase display that uses files created by the Super “Color” Writer II. Combine files, sort and print mailing lists, print “Boilerplate” documents, automatically insert text in standardized forms, address envelopes, the list is endless
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By Peter A. Stark
The Super “Color” Speller is a fast machine-code proofreading program to correct Super “Color” Writer files. Automatically proofreads your documents against a 20,000 word stock dictionary; plus your own customized dictionary and corrects typos or marks them for special attention
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Operators Manual only $10.00 (Refundable with purchase)

NELSON SOFTWARE SYSTEMS  9072 Lyndale Avenue So., Minneapolis, Minnesota 55420  612/881-2777
32x16 & 51-64-85x21&24 Display
With Lowercase Descenders And
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DISK FEATURES: Read a directory, Display free granules, Kill
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Tutorial and sample templates are supplied with the program

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By Tim Nelson

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Super “Color” Terminal™

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The best has become even better, with many new features
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lowercase descenders, plus compatibility with the 64K Color
Computer. This user-friendly program makes communicating
with ANY computer a breeze even for a newcomer. Communicate
using your modem with all the popular information services such as
Dow Jones, Compass, Delphi Software, Source, and local BBS's, clubs,
friends, or the main-frame at work. You can dial directly
with other microcomputers, such as the TRS-80 I, III, LI
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FEATURES: MEMORY-SENSE to adjust to computer's memory
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Machine Language & BASIC programs " Set communications
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5 6 7 or 8. Parity Odd: Even or None Stop Bits 1 2 3 " Local
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It is structured in a simple and easy to understand menu system
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I t's here—a direct-replacement keyboard for your favorite machine, with honest-to-goodness key-switches 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.

Now, you can have one. $89.95

The Color Computer Professional Keyboard, with full stroke, positive action keyswitches, provides a feel normally associated with more expensive microcomputers and terminals. The finely textured keycaps, gray and black with white lettering, nicely complement the Color Computer's sleek appearance. And, the keyboard's high quality construction assures years of reliable operation. A 90-day limited warranty is provided. The four function keys, occupying the extra positions in the keyboard matrix, are an added bonus. Whether with your own software, or with that from vendors who have specially adapted theirs (such as Frank Hogg Laboratories' FLEX), the function keys enhance the keyboard's utility. BASIC programming examples and assembly language driver listings are included. The keyboard is custom made for the Color Computer by Macrotron, an experienced manufacturer of computer components and peripherals. Consequently, installation is a simple plug-in operation, requiring no soldering or cutting whatsoever. The installation procedure is detailed in an illustrated user's manual, which is included but also available separately for $2.00 (refundable with purchase). Two versions of the keyboard are available, one for revision E and earlier Color Computers and the other for the revision F (also known as A or ET) Color and TDP-100 computers. Please specify which version you have when ordering, if possible. Otherwise, include the complete catalog number and serial number.

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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 EX-EC 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.
REVIEWS

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; IPC suggests that daily is not too often. Also, you might need a better grade of tape. IPC recommends DuPont Cryolyn 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 @KII 1, which disables the interface. The computer powers up in Basic, and you access the new facilities with EX- EC 6H7H000, or in Color Basic with EXFC 51248.

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. IPC 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 resident 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-
SPIDER is absolutely the best game available for the Color Computer. Mario, in his blue suit, must jump the cars that travel along the ladders. The conveyors can be used to get to the relatively easy inclined-ramp screen. Upon completion of this feat, he faces the ladders. The conveyors can be used frequently. 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.

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.
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 cram's 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.
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 joystick sticks. 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...

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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 lightweight, 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 I is of particular interest. The author makes several comments on program flow and programming styles 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.
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
The Basic Beat

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 and an enter key. A number between 32,551 and 32,558 will be displayed. This shows the available extended memory. The difference is because of the visual appeal and the need for space to insert other lines.

Type PRINT MEM 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 RUN and enter. The screen should not be cleared. 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.

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 computer 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>
<thead>
<tr>
<th>Table 1. Tentative Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Month 1</strong></td>
</tr>
<tr>
<td>Line numbers</td>
</tr>
<tr>
<td>Variables</td>
</tr>
<tr>
<td>SHIFT left arrow</td>
</tr>
<tr>
<td>PRINT (comma, quotes, semicolon)</td>
</tr>
<tr>
<td>INPUT</td>
</tr>
<tr>
<td>LIST</td>
</tr>
<tr>
<td>GOTO</td>
</tr>
<tr>
<td>CLS</td>
</tr>
<tr>
<td>REM or '</td>
</tr>
<tr>
<td>RUN</td>
</tr>
<tr>
<td>SHIFT 0</td>
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<tr>
<td>SHIFT @</td>
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<tr>
<td>NEW</td>
</tr>
<tr>
<td>MEM</td>
</tr>
<tr>
<td>+</td>
</tr>
</tbody>
</table>

| **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                         |
| CSAVE                       |
| CLOAD                       |
| Change Assembly listing to Basic |
| Converting Model 1, 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 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.

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.
Time was when you could pull any computer magazine off the rack and it would suit your purpose. Not anymore. Today, you need a magazine that is tailor-made for your system, a magazine designed to fit your computing needs, a magazine that lets you move freely to expand your knowledge of computing and to use your computer to its fullest capacity.

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

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$).

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.

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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 sent to the format-menu 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 (PLS). 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.
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/Table/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-processing 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.

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See List of Advertisers on page 138
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.

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.

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 delay, to IC5(b) for use in the parallel output circuit.
When installing the enclosure as it will be mounted, and connect UART pin 18 to reset the data strobe.

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

**Table 1**

| C1,C2,C3—0.1µF disk capacitor |
| C4—10µF electrolytic capacitor |
| D1—1N914 diode |
| IC1—LM6402 UART |
| IC2—MCl489 quad line receiver |
| IC3—NE555 timer |
| IC4—CD4049 hex inverter/buffer |
| R1—3.9k ohm, 1/4 W resistor |
| R2—10k ohm miniature potentiometer |
| R3—100k ohm, 1/4 W 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**
3 display formats: 51/64/85 columns x 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 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 auto-justify means you type a load command only once no matter where you are in the tape.

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 based cassette system, for example, you get about 40K of memory to store text. So you don't need disk or FLEX to put all your 64K to work immediately.

64 COLUMNS (AND 85!)

Besides the original 51 column screen, Telewriter-64 now gives you 2 additional high-density displays: 64 x 24 and 85 x 24! Both high density modes provide all the standard Telewriter editing capabilities, and you can switch instantly to any of the 3 formats with a single control key command. The 51 x 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 screen width, Telewriter-64 can now promise you some of the best looking right justification you can get on 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 screen width, Telewriter-64 can now promise you some of the best looking right justification you can get on your printed page, so that "what you see is what you get." This makes exact alignment of columns possible and it makes hyphenation simple.

FEATURES & SPECIFICATIONS:

Printing and formatting: Drives any printer (LP/II/III, DMP-100/200, Epson, Okidata, Centronics, NEC, C. Itoh, Smith-Corona, Terminer, etc.).

Embedded control codes give full dynamic access to intelligent printer features like: underlining, subscript, superscript, variable font and 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 to 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 buffer or green background, corporate print 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

PROFESSIONAL WORD PROCESSING

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.

Telewriter-64 costs $49.95 on cassette, $59.95 on disk, and comes complete with over 70 pages of well-written documentation. (The step-by-step tutorial will have your writing with Telewriter-64 in a matter of minutes.)

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...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.
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.

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
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 display line will display the last line entered. 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 ; command. To back up a line, use the – command.

- Replace (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,
Listing continued

6050 IPZ$="L"ORZ$="1"THEN6230
6070 IFZ$="Q"ORZ$="q"THEN6260
6080 IFZ$="T"ORZ$="1"THEN6270
6090 IFZ$="X"ORZ$="x"THEN6290
6100 IFZ$="H"ORZ$="h"THEN6320
6105 IFZ$=CHR$(8) THEN6370
6110 IFZ$=CHR$(13) THEN6330
6120 GOTO0810
6130 IF LF=Z4 THEN6120
6140 PRINTMIDS(CS,LF,1);:DS=DS+MIDS(CS,LF,1);:LF=LF+1:GOTO6010
6150 ZS=ZS+"S"
6160 GOTO0810
6170 IFZ$="**"THEN6174
6171 FORZ2=LF TO LF+VAL(Z1$)-1
6172 GOSUB6500:PRINTZS;:DS=DS+ZS
6173 NEXTLF=Z2:Z1$="":GOTO6010
6174 GOSUB6500:PRINTZS;:LF=LF+1:DS=DS+ZS:GOTO6010
6180 IFZ$="**"THEN6220
6190 PRINT"*":FORZ2=LF TO LF+VAL(Z1$)-1
6200 PRINTMIDS(CS,LF,1);:NEXT
6210 PRINT"*":LF=Z2:Z1$="":GOTO6010
6220 PRINT"*":PRINTMIDS(CS,LF,1);:PRINT"*":LF=LF+1:GOTO6010
6230 IFLF=Z4 AND Z2=THENZ2=0:GOTO6255
6235 FORZ2=LF TO Z4
6240 PRINTMIDS(CS,LF,1);:DS=DS+MIDS(CS,LF,1)
6250 NEXT
6255 CS=DS=DS=**"PRINT=Z4=LEN(CS);:LF=LF+1:GOTO6010
6260 PRINT:GOSUB6510:DS=**"GOTO100
6260 GOSUB6570
6270 IFZ$=CHR$(95)THEN6010
6274 IFZ$=CHR$(8)THEN6410
6275 IFZ$=CHR$(13)THEN6330
6280 PRINTZS;:DS=DS+ZS:GOTO6270
6290 FORZ2=LF TO Z4
6300 PRINTMIDS(CS,LF,1);:DS=DS+MIDS(CS,LF,1)
6310 NEXTLF=Z4+1:GOTO6270
6320 LF=Z2+1:GOTO6010
6330 IF LF=Z4 THENPRINTCHRS(13):GOSUB6510:AS(A)=DS=GOTO100
6340 FORZ2=LF TO Z4
6350 PRINTMIDS(CS,LF,1);:DS=DS+MIDS(CS,LF,1)
6360 NEXTLF=Z4+1:GOSUB6510:AS(A)=DS=GOTO100
6370 PRINT"*":
6380 PRINTMIDS(DS,LEN(DS),1);:DS=LEFS(DS,LEN(DS)-1)
6390 GOSUB6500:IFZ$=CHR$(8)THEN6380
6400 PRINT"*":GOTO6020
6410 PRINT"*":
6420 PRINTMIDS(DS,LEN(DS),1);:DS=LEFS(DS,LEN(DS)-1)
6430 GOSUB6500:IFZ$=CHR$(8)THEN6420
6440 PRINT"*":GOTO6072
6500 PRINTCHRS(14);:ZS=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 FORZ2=0 TO 3
10015 IF Z2=1 THEN10040
10020 I3=PEEK(VARPTR(AS(I1)))+12
10030 POKE(VARPTR(AS(I1+1)))+12,I3
10040 NEXTI2,11:RETURN
11999 REM DELETE A LINE
12000 FOR I1=A1 TO E
12010 FOR Z2=0 TO 3
12015 IF Z2=1 THEN12040
12020 I3=PEEK(VARPTR(AS(I1)))+12
12030 POKE(VARPTR(AS(I1-1)))+12,I3
12040 NEXTI2,11:RETURN
13000 FORZ1=1 TO E
13010 PRINT4-2,X;AS(X)
13020 NEXTX;GOTO100
14000 PRINT"GLOBAL REPLACE (R)";PRINT"DELETE (D), OR FIND (F)?
14010 CS=INKEY$:IFZ$="**"THEN14010
14020 IFCS="R"ORCS="D"ORCS="d"ORCS="f"ORCS="F"THEN14030E
14030 PRINT"INPUT "FROM LINE":L1:IF L1THEN11=1
14040 INPUT" TO LINE";L2:IF L2>E THENL2=E
14050 IFL2=4THENL2=E
14050 PRINT"STRING TO SEARCH FOR":;PRINT"DON'T FORGET THE SPACE":
14060 PRINTEXTERN After A WORD.":L1:LINEINPUT"*";S1:IFCS="R"ORCS="r"THEN14060E
14070 ELSE14070
14060 PRINT"STRING FOR REPLACEMENT":;LINEINPUT"*";S2$14070 FORX=L1 TO L2
14080 P=INSTRAS(X),S1$:IF P>0 THEN14100
14090 NEXTX;GOTO100
14100 IFCS="d"ORCS="d"THEN14100ELSE14120
14105 IF=THENAS(X)=RIGHTS(AS(X),LEN(AS(X)))-LEN(S1$)+1:GOTO14000
14110 IF=THENAS(X)=LEFTS(AS(X),LEN(S1$),F-1)+GOTO14000
14110 LISTING
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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 selecting "Create new document" query with N.

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 selecting "Create new document" query with N.

You 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 AS (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.

• Global (G)—This will replace, delete, or find a specific word or phrase in a document.

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

099 14115 A$(X) =LEFT$(A$(X),F-1)+RIGHT$(A$(X),LEN(A$(X))-(F-1+LEN(S1))):GOTO14080
14120 IF CS ="R"ORCS ="r"THEN14123ELSE14140
14123 IF THENAS$(X) =S2$+RIGHT$(A$(X),LEN(A$(X)) -LEN(S1)):GOTO14080
14125 IF LENS1 =LEN(A$(X)) THENAS$(X) =LEFT$(A$(X),F-1)+S2$:GOTO14090
14130 A$(X) =LEFT$(A$(X),F-1)+S2$+RIGHT$(A$(X),LEN(A$(X)) -(F-1+LEN(S1))):GOTO14080
14140 PRINT:A$(X):PRINT"AGAIN?";
14150 BS =INKEY$:IFBS =""THEN14150
14160 PRINT:IFBS ="y"ORBS ="y"THEN14080ELSE100
1500 IF TTHENINPUT=IS CASSETTE READY;ANS:IFANS ="y"ORYBANS ="y"THENRETURNELSE1500
1510 RETURN
15100 INPUT"TAPE (T) OR DISK (D)";TDS:IFTDS ="t"ORTDS ="t"THENTHUDENT= 1:RETURN
15110 IF TDS ="d"ORTDS ="d"THENTHUDENT=1:RETURN
15120 GOTO15100

Program Listing 2

5 PRINT"PROGRAM COPYRIGHT 1981 BY KEN KNECHT"
10 CLEAR7000:PCLEAR1:N1=0:DIMTDS(200)
11 INPUT"TEXT ON TAPE (T) OR DISK (D)";TDS:IFTDS ="t"THENTHUDENT=1:GO TO700
12 IFTDS ="d"THENTHUDENT=1ELSE100
20 GOSUS4000
30 L1=0:P2=1:INPUT"JUSTIFY RIGHT";A1$:IFLEFT$(A1$,1) ="r"THENJ=1 ELSEJ=0
40 INPUT"DOUBLE SPACE";A2$:IFLEFT$(A2$,1) ="y"THENPL=0ELSEPL=VAL(PL$)
44 INPUT"FIRST PAGE NUMBER (DEFAULT IS 1)";PP$:IFPP$ =""THENPP=66ELSEPP =VAL(PPP$)
45 PP$=PP$+L1=0:PP =0
46 INPUT"LINE WIDTH (DEFAULT IS 60)";PW$:IFPW$ =""THENPW=66ELSEPW =VAL(PW$)
47 INPUT"LEFT MARGIN (DEFAULT IS 8)";LM$:IFLM$ =""THENLM=8ELSELM=VAL(LM$)
48 PRINT"PRINTED PAGE LENGTH (DEFAULT IS 55 LINES)";PL$:IFPL$ =""THENPL=55ELSEPL =VAL(PL$)
49 PRINT"PHYSICAL PAGE LENGTH DEFAULT";INPUT:IS 66;PP$:IFPP$ =""THENPP=66ELSEPP =VAL(PPP$)
50 PRINT"DIABLO PRINTER";A1$:IFLEFT$(A1$,1) ="y"THENPL=1ELSEPL=0
60 INPUT"PAGE NUMBERS";A1$:IFLEFT$(A1$,1) ="y"THENPL=1ELSEPL=0
70 INPUT"TITLE ON EACH PAGE";A1$:IFLEFT$(A1$,1) ="y"THENPL=1ELSEPL=0
80 IF LEFT$(A1$,1) ="Y"THEN100
90 N=0;DT=0;INPUT"VARIABLES";A1$:IFLEFT$(A1$,1) ="y"THENTHUDENT=1THIRDINPUT"VARIABLES TAPE READY;ANS:DT=1
92 IF LEFT$(A1$,1) ="Y"THENTHUDENT=1
95 OPEN"*","TD,DFS
96 IFEOP(DT)THEN99
97 N=N+1:LINEINPUT;TD,DFS(N):GOTO96
98 CLOSE
100 GOSUB1800
110 FORCP=1 TO NF
115 P6=P:7=P:8=P:9=A$:B$:="";CS=:="E";LP=0:CP=0
117 IPTD=1THENINPUT=TEXT TAPE READY;ANS
120 OPEN"*","TD,Als(PF)
130 IF B$=""AND(RIGHTS(B$,1)=""OR RIGHT$(B$,1)="")THENA=$B$:
135 BS =J9=LEN(A$):GOTO280
140 IF LEN(B$)>PW THENAS$=B$:B$="";J9=LEN(A$):GOTO280
145 IF EDP(TD) OR (B$=""AND E=1)THEN7000
149 IF EDP(TD) OR (B$=""AND E=1)THEN7000
150 LIA$=PRINT$("",A$:C=""
151 IF LEFT$(A$,1)=""THENPP=1ELSEPRINT$(A$,2)="":" THENPP=2
152 IFPP=1AND BS=""THENNEXXY=L1=1TOPP;PRINT=";:";NEXXY=L1=1
153 GOSUB1800;PF=0:GOTO150
156 IFPP=1AND LEN(B$)<PW THENPRINT$=2,TAB(LM);B$:B$="";FORXY=L1=1
160 TO PP;PRINT=";:";NEXXY=L1=0;PF=0;GOSUB1800;GOTO150
164 IFPP=2AND BS=""THENNEXXY=L1=1TOPP;PRINT$=2,TAB(LM);B$:B$="";FORXY=L1=1
165 IFPP=2AND LEN(B$)<PW THENPRINT$=2,TAB(LM);B$:B$="";FORXY=L1=1
166 IFPP=2THENXY=L1=1:BS=BS+"";CS=CS+"E";LP=LP+1:CP=CP+1
170 IF LEFT$(A$,1)=""THENTHUDENT=1ELSE190
172 IF N=1THENPRINT"****OUT OF VARIABLES DATA**";CLOSE:END
175 AS=DFS(N)
180 A$:"";A$:J9=LEN(A$)
189 ILEFT$(A$,1)=""THENAS=RIGHT$(A$,J9-1)ELSE260
200 IF BS=""THENPP=1
210 IFBS=""THENPP=1J9=LEN(A$):GOTO290
220 IF RIGHT$(B$,1)=""AND LEN(B$)+CP+1THENPRINT$=";TAB(LM);B$="";FORXY=L1=1

Listing continued

40 HOT CoCo June 1983
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<tr>
<td>FX80</td>
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<td>$639.95</td>
</tr>
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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.
FILE NAME? LETTER 1
CREATE NEW FILE? Y
* 1
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
* 1
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 could 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 59)? 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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Dennis Black 184
HOT CoCo June 1983 43
GAME
BY CHARLES LEVINSKI

CAVEHUNT

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.

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

**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

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

**Table 1. Variable List**

**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 thirteen 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 one and twenty 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
Listing continued

460 IF W=1 THEN 610
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 PRINT:PRINT: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 PX=PY-1
660 GOTO720
670 PY=PY+1
680 GOTO720
700 PX=PX+1
710 GOTO720
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 PRINT00,"YOU ARE PRESENTLY CARRYING"
745 FOR I=1TO2:IF=2ANDW2)<>20 THEN PRINT064,"AND ";
746 IF I=2 AND W2)<>20 THEN 840
750 ON(W1)-6 GOSUB5800,5810,5820,5830,5840,5850,5860
760 GOSUB5900
840 PRINT
850 PRINT
855 'WEAPONS P/U ROUTINE
860 PRINT:PRINT:IN THIS PLACE YOU FIND ":
870 ON A(PX,PY)-6 GOSUB5800,5810,5820,5830,5840,5850,5860
880 PRINT:PRINT:INPUT"WILL YOU PICK IT UP (Y OR N)?";AS
890 IF AS="Y" THEN 920
900 IF AS="N" THEN 830
910 GO TO 880
920 IF W1)=20 OR W2)<>20 THEN 1040
930 PRINT:PRINT"WHAT DO YOU WISH TO LEAVE?"
940 ON(W1)-6 GOSUB5800,5810,5820,5830,5840,5850,5860
945 PRINT"-1"
950 ON(W2)6 GOSUB5800,5810,5820,5830,5840,5850,5860
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)=W1):W1)=G:G=0
1010 GOTO1030
1020 G=A(PX,PY):A(PX,PY)=W2):W2)=G:G=0
1030 GOTO390
1040 IF W(1)<>20 THEN 1060
1045 W1)=A(PX,PY):A(PX,PY)=0

Listing continued
**ITEM 1 DOZEN**  
**2 DOZEN**  

<table>
<thead>
<tr>
<th>Item</th>
<th>1 Dozen</th>
<th>2 Dozen</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-05</td>
<td>7.50</td>
<td>13.50</td>
<td></td>
</tr>
<tr>
<td>C-10</td>
<td>8.00</td>
<td>14.40</td>
<td></td>
</tr>
<tr>
<td>C-20</td>
<td>10.00</td>
<td>18.00</td>
<td></td>
</tr>
<tr>
<td>Hard Box</td>
<td>2.50</td>
<td>4.00</td>
<td></td>
</tr>
</tbody>
</table>

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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.

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

Listing continued

Listing continued

Listing continued

Listing continued

Listing continued

Listing continued
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HOT CoCo June 1983 51
Tape Reliability

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)
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.

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 do you have? Can things go wrong before you have a problem, or are you half-way 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-
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.

**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. For 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—$7001 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-
stant is a measure of the difference between successive signal zero crossings; a tape that runs end to end with no deviations greater than 0.5 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) OA 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.

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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 I. 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 first byte of the resident program. 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 \((30 \times 256) + 1 = 7681\), 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., \((30 \times 256) + 9\)).

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., \((1 \times 256) + 4\)). 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...
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you must first know how to interpret 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 flag for a remark token (REM or '), as 63060 did for a quote.

Lines 36130-36180 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 columns 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 “\101 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.

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

Program Listing 2

63000 ' DOCULIST/C:V1.2
63010 CLEAR 500:CLS:PRINT"" doculist - INITIALIZING"";GOS
63020 PRINT""PRINTTAB(12):"";PRINT."" :PRINT"";SA=PEEK(25) *256+PEEK(26)
63020 NA=PEEK(LA) *256+PEEK(LA+1):LN=PEEK(LA+2) *256+PEEK(LA+3)
63030 IF LN=0 OR NA=0 THEN END
63040 TXT$=STRINGS(10-LEN(STR$(LN)) ,32)+STR$(LN) +"" :CNT=ll
63050 FORI=LA+4 TO NA-2
63060 C=PEEK(I) :IF C=34THENQ=(Q=0)
63070 IF C<128 AND C<>58 OR Q=-l THEN TXT$=TX
63080 IF C=58 THEN 63200
63090 ' BYTE IS TOKEN , SO CHECK
63100 FORX=A(C) TO A(C) +9 :IF PEEK(X) >128 THEN 63160
63120 IF LEN(TXT$)<69 THEN 63700
63150 TXT$=TXT$+CHR$(PEEK(X)-128) +"" :CNT=CNT+l :NEXTX
63160 TXT$=TXT$+CHR$(PEEK(X)) :CNT=CNT+l:NEXTX
63170 IF LEN(TXS)>9THENMENU=63240
63180 NEXTI:LA=NA:GOSUB63240 :GOTO63020
63190 'CHECK COLON
63200 IF PEEK(I-1) <58 AND PEEK(I+1)<13 THEN 63700
63210 IF PEEK(I+1)<58 THEN I=I+1:C=PEEK(I):GOTO63210
63220 GOSUB 63230:GOTO 63170
63230 'PRINT ROUTINE
63240 IFLEN(TXT$)>69 THEN PRINT$=-2.LEFTS(TXT$ ,70):TXT$=STRINGS(1
63250 '&RIGHTS(TXT$ ,70)+"":TXT$=STR$(13:GOTO63270
63260 TXT$=STRINGS(11,32) +"" :CN=12;Q=0
63270 IF LEN(TXS)>9THENMENU=63240
63280 'PRINT TAB TO THE NEXT COLUMN
63290 DIM A(111):A(0)=43622:J=1
63300 FORI=43622TO43822:IFPEEK(I)>128THENA(J)=I+1:J=J+1
63310 IFJ>560 THENERR:RETRY:EXIT
63320 A(53)=33155:J=54:FORI=33155TO33355:IFPEEK(I)>128THENA(J)=I
+1:J=J+1
63330 IFJ=27THENRETURN
63340 A(78)=43802:J=79:FORI=43802TO44800:IFPEEK(I)>128THENA(J)=I
+1:J=J+1
63350 IFJ=98THENRETURN
63360 A(98)=33309:J=99:FORI=33309TO33500:IFPEEK(I)>128THENA(J)=I
+1:J=J+1
63370 IFJ>12THENRETURN

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

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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.

Contact James Barbare/lo at RD#1, Box 241H, Tennent Road, English­ town, NJ 07726.

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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 &H7EO0). This has been done in Program Listing 3.

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

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

<table>
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<td>82E0 BEQ $82F1</td>
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<td>82E2 LDA #55B</td>
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<td>82E4 JSR &gt;$A282</td>
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<td>82E7 LDA &lt;$68</td>
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<td>82E9 JSR &gt;$BDC0</td>
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<td>82EC LDA #55D</td>
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**System Requirements**

16K, 32K RAM

Printer

64 HOT CoCo June 1983
Program Listing 2

10 REM ** DISPLAY TRACES ON THE PRINTER **
20 REM ** CLEAR AND RESERVE MEMORY **
30 CLEAR 200,.H7E00
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 + &H7E2E, 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 5: 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 126,63,38
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,.H7E00
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 + &H7E2E, 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 5: 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 126,63,38
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 4

7EE2 JMP >S726 Go to new routine
7F26 LDA #$FE Load 254 = Printer
7F28 STA <$6F Store in Device Number location
7F2A LDA #$3B Load ]
7F2C JSR >SA28 Go print
7F2F LDA <$6B Load line number
7F31 JSR >SBDC Go print
7F34 LDA #$5D Load ]
7F36 JSR >SA28 Go print
7F39 LDA <$00 Reset Device Number location
7F3B STA <$6F
7F3D JMP >SEFI Return to original code
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.

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

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.

System Requirements

Extended Color Basic
16K RAM
Printer Optional
and PA7, are latched separately by a bit, and accepts the AIR, or synthesizer control circuits and the audio amplifier 74LS74 dual flip-flop. The low-level 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 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 pre-cut 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-nun 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 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 the 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 PROM, 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 $CO00 (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 PBI) 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

These operations are handled easily in Basic by the following statements.

POKE &HF002, 2: POKE &HF003, 255

When run, the program first directs execution of the subroutine:

100 POKE &HF000, 0: POKE &HF001, P: POKE &HF000, 2

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

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

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ESCAPE FROM SPECTRE (Graphic Adventure) - You are a secret agent for British Intelligence sent on a mission to obtain the secret nerve gas formula being developed by S.P.E.C.T.R.E. to destroy the world. 16K Ext. Basic $17.95

SEARCH-A-WORD
This Program generates a word search puzzle to your specifications. You specify the size of the puzzle and the number of words that it is to hide within the puzzle. 16K or 32K Ext. Basic.

TAPE $17.95

FLEX VERSION $27.95

UTILITIES
COLOR MONITOR - Written in position independent code. (May be located in any free memory). Very compact. Only occupies 1174 bytes of memory. Full Featured. Includes Break-Pointing of machine language programs, register display and modify, memory display and modify, and block memory move commands. Displays memory in hex and ascii format on one line 8 bytes long. MACHINE LANGUAGE $24.95

ROM - This program is a utility that will move "most" 8K Rom-Packs to disk and allow you to run them from disk. Easy to use. Requires 64K. $17.95

SCREEN PRINT ROUTINE - Using your Epson or Microline Printer. Print the screen contents on a full size 8 1/2 x 11 sheet. 16K Ext. Basic $17.95

TAPE DUPE - Brand new machine language program that copies any tape effortlessly. Completely automatic. $16.95

DISK TO TAPE - Dump the contents of any disk to tape automatically. Machine Language $17.95

TAPE TO DISK - Load the contents of any tape to disk automatically. Machine Language. $17.95

MAIL LIST - Maintain a complete mailing list with phone numbers etc. Ext. Basic. $17.95

THE FIXER - Having trouble moving those 600 Hex programs to tapes? The fixer will help. Completely automatic. $17.95

TAPE CAT - All new machine language program lists contents of tapes to printer. Make a catalog of your tapes. $17.95

PROGRAM PRINTER UTILITY - This program will list basic programs to your printer in two column format. Saves paper and makes your listing look professional. Disk based. $17.95

ADD $1.00 POSTAGE & HANDLING • TOP ROYALTIES PAID • LOOKING FOR NEW SOFTWARE
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

---

**Table 1. English-Language Phoneme List**

<table>
<thead>
<tr>
<th>Example Word</th>
<th>Phoneme Symbol</th>
<th>Hex Code</th>
<th>Duration (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>pocket</td>
<td>EH3</td>
<td>00</td>
<td>59</td>
</tr>
<tr>
<td>end</td>
<td>EH2</td>
<td>01</td>
<td>71</td>
</tr>
<tr>
<td>heavy</td>
<td>EH1</td>
<td>02</td>
<td>121</td>
</tr>
<tr>
<td>(no sound)</td>
<td>PA8</td>
<td>03</td>
<td>47</td>
</tr>
<tr>
<td>putter</td>
<td>DT</td>
<td>04</td>
<td>47</td>
</tr>
<tr>
<td>rake</td>
<td>A2</td>
<td>05</td>
<td>71</td>
</tr>
<tr>
<td>bird</td>
<td>A1</td>
<td>06</td>
<td>103</td>
</tr>
<tr>
<td>measure</td>
<td>ZH</td>
<td>07</td>
<td>90</td>
</tr>
<tr>
<td>honest</td>
<td>AH2</td>
<td>08</td>
<td>71</td>
</tr>
<tr>
<td>inhibit</td>
<td>I3</td>
<td>09</td>
<td>55</td>
</tr>
<tr>
<td>inhibit</td>
<td>I2</td>
<td>0A</td>
<td>80</td>
</tr>
<tr>
<td>inhibit</td>
<td>I1</td>
<td>0B</td>
<td>121</td>
</tr>
<tr>
<td>maybe</td>
<td>M</td>
<td>0C</td>
<td>103</td>
</tr>
<tr>
<td>under</td>
<td>N</td>
<td>0D</td>
<td>80</td>
</tr>
<tr>
<td>bolt</td>
<td>B</td>
<td>0E</td>
<td>71</td>
</tr>
<tr>
<td>vague</td>
<td>V</td>
<td>0F</td>
<td>71</td>
</tr>
<tr>
<td>cheer</td>
<td>CH</td>
<td>10</td>
<td>71</td>
</tr>
<tr>
<td>shoe</td>
<td>SH</td>
<td>11</td>
<td>121</td>
</tr>
<tr>
<td>zip</td>
<td>Z</td>
<td>12</td>
<td>71</td>
</tr>
<tr>
<td>awful</td>
<td>AW1</td>
<td>13</td>
<td>146</td>
</tr>
<tr>
<td>slang</td>
<td>NG</td>
<td>14</td>
<td>121</td>
</tr>
<tr>
<td>furfer</td>
<td>AH1</td>
<td>15</td>
<td>146</td>
</tr>
<tr>
<td>looking</td>
<td>OO1</td>
<td>16</td>
<td>103</td>
</tr>
<tr>
<td>hook</td>
<td>OO</td>
<td>17</td>
<td>185</td>
</tr>
<tr>
<td>lie</td>
<td>L</td>
<td>18</td>
<td>103</td>
</tr>
<tr>
<td>brick</td>
<td>K</td>
<td>19</td>
<td>80</td>
</tr>
<tr>
<td>just</td>
<td>J</td>
<td>1A</td>
<td>47</td>
</tr>
<tr>
<td>hope</td>
<td>H</td>
<td>1B</td>
<td>71</td>
</tr>
<tr>
<td>gate</td>
<td>G</td>
<td>1C</td>
<td>71</td>
</tr>
<tr>
<td>fear</td>
<td>F</td>
<td>1D</td>
<td>103</td>
</tr>
<tr>
<td>made</td>
<td>D</td>
<td>1E</td>
<td>55</td>
</tr>
<tr>
<td>miss</td>
<td>S</td>
<td>1F</td>
<td>90</td>
</tr>
<tr>
<td>game</td>
<td>A</td>
<td>20</td>
<td>185</td>
</tr>
</tbody>
</table>

---

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

---

70 HOT CoCo June 1983
COLOR ALIEN DEFENSE
by Doug Schwartz

One of the fastest action arcade games!
Written in Machine Language.
16K Cassette $19.95

DEATH TRAP
by Rugby Circle

16K Cassette $19.95

COLOR CATERPILLAR®
by Rugby Circle

Don’t settle for less. Be sure to ask if the program was produced by Soft Sector Marketing so you don’t get the wrong version.
16K Cassette $19.95
Machine Language

COLOR GRAPHIC EDITOR
by Larry Ashmun

At last, a true Graphic Drawing program that permits the creation of graphic pictures on the screen storing them in one of 4 locations and recalling them as needed for review.
The pictures can be saved to disk to be loaded into the micro works disk editor. The graphics are saved in Assembler format or Basic Data Statements, but details are provided for using the information in a BASIC program. Works on cassette or disk systems.
Cassette $19.95

Written in Machine Language, but requires Extended or Disk Basic.
Program Listing. Phoneme-List Entry and Editing Program

10 'PHONE-LIST ENTRY AND EDITING PROGRAM
20 'BY WILLIAM C. CLEMETTS, JR.
25 'REQUIRES 16K EXTENDED BASIC
30 A=4HFO00:0=247
40 POKE+1,255:POKE+2,2:'CONFIGURE VIA
50 DHC5(64),PS(100),X(100),LG(160)
60 FORi=1TO44:READC$(1):NEXT
70 P=63:GOSUB580:J=1:'SILENCE SYMPOSIS & BEGIN NEW LIST
80 CLS:PRINT"BEGIN A NEW LIST OF PHONEMES"
90 INPUT$IFAS="EDIT"THEN120ELSEIFAS=""THENTHEN 110ELSEIF AS="T"THENTHEN 70ELSEIFAS="TAPE"THENTHEN480
100 GOSUB600:J=1:GOTO90
110 JH=1:GOSUB690:GOTO90:'SPEAK THE LIST
120 JH=1:'EDIT MODE BEGINS HERE
140 F=1:IF PEEK(343)$Q THENJ=J+1:LC=LB+LG(J):GOSUB1040:
150 ELSE150 'LEFT ARROW SPACES BACK
160 IF PEEK(343)$Q THENJ=J-1:LC=LB+LG(J-1)+1:GOSUB670:GOTO140:
170 ELSE160 'RIGHT ARROW SPACES FORWARD
180 IF PEEK(341)$=254 THEN PRINT@498,"change";:A$="":GOTO420:
190 ELSE190 'C-KEY CHANGES ONE PHONEME
200 IF PEEK(339)$Q THEN 260 'X-KEY EXTENDS THE LIST
210 J=J+1:LC=LA:PRINT$498,"extend";
220 GOSUB730
230 220 'A$=INKEY$:IF A$="""THEN 220 ELSE IF A$=CHR$(13) THEN 250
240 ELSE IF A$=CHR$(95) THEN 240 ELSE 230
250 A$=A$+A$:GOTO220
260 ELSEIF A$=CHR$(9) THEN 240 ELSE 230
270 JH=J-1:GOSUB690:
280 ELSE280 'H-KEY ENTERS HACK FUNCTION
290 280 'X-KEY ENTERS TAPE MODE
300 AA$=INKEY$:IF AA$="""THEN 300 ELSE IF AA$=CHR$(13) THEN 320
310 ELSE IF AA$=CHR$(95) THEN 240 ELSE 310
320 AA$=INKEY$:IF AA$="""THEN 300 ELSE IF AA$=CHR$(13) THEN 320
330 ELSE IF AA$=CHR$(95) THEN 240 ELSE 310
340 AA$=INKEY$:IF AA$="""THEN 300 ELSE IF AA$=CHR$(13) THEN 320
350 ELSE IF AA$=CHR$(95) THEN 240 ELSE 310
360 AA$=INKEY$:IF AA$="""THEN 300 ELSE IF AA$=CHR$(13) THEN 320
370 ELSE IF AA$=CHR$(95) THEN 240 ELSE 310
380 AA$=INKEY$:IF AA$="""THEN 300 ELSE IF AA$=CHR$(13) THEN 320
390 ELSE IF AA$=CHR$(95) THEN 240 ELSE 310
400 AA$=INKEY$:IF AA$="""THEN 300 ELSE IF AA$=CHR$(13) THEN 320
410 ELSE IF AA$=CHR$(95) THEN 240 ELSE 310
420 'H-KEY ENTERS LIST
430 'G-KEY ENTERS INSERT FNCTN
440 'J-KEY ENTERS DELETE FNCTN
450 'K-KEY ENTERS CHANGE FNCTN
460 'L-KEY ENTERS EXTEND FNCTN
470 'M-KEY ENTERS EDIT FNCTN
480 'N-KEY ENTERS TAPE FNCTN
490 'P-KEY ENTERS HACK FNCTN
500 'Q-KEY ENTERS EXIT FNCTN
510 'R-KEY ENTERS STOP FNCTN
520 'S-KEY ENTERS SPOKES FNCTN
530 'T-KEY ENTERS TAPES FNCTN
540 'U-KEY ENTERS BACK FNCTN
550 'V-KEY ENTERS FORW FNCTN
560 'W-KEY ENTERS INRT FNCTN
570 'X-KEY ENTERS DELT FNCTN
580 'Y-KEY ENTERS HTTM FNCTN
590 'Z-KEY ENTERS TAPES FNCTN

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 kayed it in and saved it. Run the program and enter the following phoneme mnemonics:

15 1S PAO PAO 1S PAO Y OO RO PAO K UH L UH2 R PAO K UHl M P H IU T R PAO S P E K I NG PAI PAI STOP AEI Y PAO H O P PAO Y U IA PAO H AEI V PAO F UH I N PAI W EH2 IS TH PAO PAO Y UH R PAO N IU W PAO T AWI Y YI 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-
A user-oriented, easy-to-use personal database management system for the TRS-80 Color Computer with these outstanding features:

- Keeps fies of program, names, addresses, bimonthly records, class or club records, anything.
- Variable record and field lengths
- Choice of display and printout formats
- Up to 8 user-definable fields


Silly Syntax

A sensationally educational version of a popular party game for the TRS-80 Color Computer. For 1 to 10 players. Uses a story into the computer. The program is presented in simple text format, which the program will then automatically rearrange into a readable form. The story is written to be humorous. Silly Syntax requires 16K Extended Basic. $9.95 recommended.

FOR YOUR TRS-80 COLOR COMPUTER

32K

STARFIRE

16K

Fly around the planet’s surface defending it’s inhabitants from being carried away by alien ships.

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HOT CoCo June 1983 73
THE TOP-RATED COCO WORD PROCESSOR:

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

Why is Telewriter so much better than the others? For one thing, it has overcome the 32x16 character display limitation of the Color Computer. No small feat, Telewriter accomplishes this by generalizing its own set of characters in software. You select 51x24, 64x24 or 85x24 character displays by merely issuing a format command. If you have ever used a word processing system, you know how important it is to be able to see a good portion of your text on the screen.

Telewriter-64 also generates true lower case characters. This is much preferable to the reverse characters that merely "represent" lower case letters in other co-co word processors.

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

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

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

Beyond impressive capability, Telewriter-64 simply makes any kind of writing a pleasure. It is a truly sophisticated system that is marvelously easy to learn and enjoyable to use.

Disk .... $59.95
Cassette : $49.95

EXTENSION CABLE FOR YOUR MODEM/PRINTER

Place your modem or printer where you want. 15 ft. cable with four-pin male and four-pin female D-sub connectors.

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5-9 3.50
10-99 2.75
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- Designed especially for the Color Computer ROM slot.
- High quality 3 piece injection molded black plastic with spring-loaded door.
- Same size and specifications as Radio Shack ROMpak

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- Custom made to fit precisely. Has same key layout.
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- Comes with six fun & useful programs on tape.
- Easy instructions show how to use it with Basic.
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WE PAY shipping on any order that includes at least one game
Use our convenient toll free 800 line.

GHOST GOBBLER

From Spectral Associates, this "Pac" theme game is the best of its type. Brilliant colors, 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: $24.95

PROTECTORS

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

CREATURE FEATURE

From Color Software, comes a lightening swift shoot & dodge the enemy game. It's clever cross between Robotron and Berserk themes, with bullets flying everywhere. Sold, 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

GHOST GOBBLER

FROGGER

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

Just released by The Comsoft 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

From Color Software. comes a lightning 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

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

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

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(212) 647-2864
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

**Table 2. Parts List**
The Original FLEX for Color Computers

* Upgrade to 64K
* RS to FLEX, FLEX to RS file transfer ability
* Create your own character set
* Automatic recognition of single or double density and single or doubled sided
* All features available for either single or multiple drive systems
* Settable Disk Drive Seek Rates
* Faster High Resolution Video Display with 5 different formats
* Save RS Basic from RAM to Disk
* Move RS Basic to RAM
* Load and save function on FLEX disk
* 13 Support Commands 8 with Source Text Languages Available

Pascal, Fortran, RS Basic, RS Assembler, TSC Basic, TSC Assembler, Relocating Assembler, Macro Assembler, Mumps

If you are tired of playing games on your TRS-80C" Color Computer, or tired that you are not running a very sophisticated program on your system, DATA-COMP's FLEX5, will allow you to actually USE the Color Computer as a COMPUTER POINTED TO MOVE UP TO THE FLEX® Operating System. If you want to have REAL PROGRAMMING POWER, by using an Extremly Powerful full BUSINESS BASIC, PASCAL'S C Compilers, the full-brown Macro Assembler, with the capability of using your peripherals, continuously improving the wheel, YOU ARE READY TO MOVE UP TO THE FLEX® Operating System. If you would like to see what you could COULD USE A COMPUTER IN YOUR BUSINESS or begin to make your computer start PAYING IT'S OWN WAY by doing some Computer Work for the millions of small businesses around you, such as Wordprocessing, Payroll, Accounting, Inventory, etc. then YOU ARE READY TO MOVE UP TO THE FLEX® Operating System. Now, DATA-COMP can help you!

DATA-COMP has everything you need to make your TRS-80C" Color Computer WORK for YOU, from Parts and Pieces to Fulf. Ready To Use SYSTEMS. DATA-COMP designs, sells, services, and SUPPORTS Computer SYSTEMS. not just Software. CALL DATA-COMP TODAY to make your Computer WORK FOR YOU!

**System Requirements**

**FLEX® Specifications**

- Special General Version x Editor & Assembler which normally set for $50.00
- FLEX® Conversion for the TRS-80C" Color Computer with 16K RAM with EXT. BASIC
- Double Drove Disk Cable
- 1 Diskette
- Special General Version of FLEX® 

**DISK DRIVE PACKAGES**

- D180K Radio Shack Color Computer, Radio Shack Color Disk Controller, a Disk Drive System, Special General Version of FLEX®;
- A Box of 10 Double Density Diskettes, A COMPLETE, ready to run SYSTEM on your Color TV Set.

**PARTS AND PIECES**

- Radio Shack Disk Controller
- Radio Shack Double Density Disk Drive
- Radio Shack Double Side 2 Density Disk
- Single Drive Cabinet with Power Supply
- Single Drive Cabinet with Power Supply
- Single Drive Disk Cable for RS Controller
- Single Drive Disk Cable for RS Controller
- Micro Tech Products, Inc. LOWER CASE ROM Adapter
- Radio Shack BASIC Version 1.1 ROM
- Radio Shack Extended Basic ROM

**Contact Information**

P.O. Box 794, HIXSON, TN 37343
1-615-842-4601

DATA-COMP

---

Write to William Clements, P.O. Box 2662, University of Alabama, College of Engineering, University, AL 35486.
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.

<table>
<thead>
<tr>
<th>0 NAMEFILE</th>
<th>DATAFILE</th>
<th>H0</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 COMENT1</td>
<td>COMENT2</td>
<td>PAGE1</td>
</tr>
<tr>
<td>6 PAGE2</td>
<td>PAGE3</td>
<td>PAGE4</td>
</tr>
<tr>
<td>9 NAMEFILE</td>
<td>Ov</td>
<td></td>
</tr>
<tr>
<td>12 CBUG</td>
<td>MOUSE</td>
<td>HEXCONV</td>
</tr>
<tr>
<td>15 SIX</td>
<td>PHONENUM</td>
<td>CHECKERS</td>
</tr>
<tr>
<td>18 LUNER.IND</td>
<td>RS232</td>
<td>FORMBILD</td>
</tr>
<tr>
<td>21 PAINTLIN</td>
<td>ROADRACE</td>
<td>FIFTEEN</td>
</tr>
<tr>
<td>24 BALL</td>
<td>TYING</td>
<td>FOURTH</td>
</tr>
<tr>
<td>27 MICE</td>
<td>BABYBUG</td>
<td></td>
</tr>
<tr>
<td>30 ********</td>
<td>********</td>
<td></td>
</tr>
<tr>
<td>36 ********</td>
<td>********</td>
<td></td>
</tr>
</tbody>
</table>

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 NS(T)
1030 FOR I=0 TO T: NS(I)="********":NEXT
1040 K=0:AUDIO ON
1050 FOR I=0TO21: READ P:POKE(I+R),P :NEXT
1060 OPEN"O",-1,1,**
1080 CLOSE-1:PI$="1982":P2$="DATA"
1110 CLS:PRINT@129, "ENTER DESIRED OPERATION & THEN PRESS ENTER"
1111 PRINT00,"COPYRIGHT (C) 1982 BY J O HOGAN"

System Requirements

4K, 16K RAM
Extended Color Basic
The Micro Works Software Development System (SDS80C) is a complete 6809 editor, assembler and monitor package contained in one Color Computer program pack. It is more powerful than most BASIC based editors and monitor packages and is easily used by professionals and beginners alike. It contains a disk-based editor, macro assembler and monitor, as well as sample programs. The editor, assembler and monitor are co-resident, eliminating tedious program loading and debugging.

Price: $99.95

SOFTWARE DEVELOPMENT SYSTEM

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

The powerful screen-oriented editor features fonts, changes, moves, copies and much more. All keys have automatic 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 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.

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Now you can use your printer with your modem! Your computer can be an intelligent printing terminal. Talk to timesharing services or other personal computers, print simultaneously through a second printer port and display text stored in memory. Dump to a cassette tape, or printer, or both. Microtext can be used with any printer or no printer at all. It features user-configurable duplex/parity for special applications, and can send any ASCII character. No 'fields' needed for general purpose modules! Microtext is available in ROMPACK, ready-to-use, for $59.95.

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GAMES

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Pac Attack — Try your hand at this challenging game by Computerware, with fantastic graphics, sound and action! Cassette requires 16K. Price: $24.95
Berserk — Have fun zapping robots with this Hi-Res game by Mark Data Products. Cassette requires 16K. Price: $24.95
Adventure — Black Santam and Calixto Island by Mark Data Products. Each cassette requires 16K. Price: $19.95 each.
Cave Hunter — Experience vivid colors, bizarre sounds and eerie creatures in hot pursuit as you wind your way through a cave maze in search of gold treasures. This exciting Hi-Res game by Mark Data Products requires 16K for cassette version. Price: $24.95

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Program Listing 2. Remarks

05 'ALL LINES ENDM IN 5 ARE COMMENT LINES AND WILL NOT RUN IN 4K
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
1205 'DO THE ML PROGRAM (READ TAPE UNTIL NAME BLOCK IS READ THE
1215 '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 DESCRIPTION
1775 'OPEN TAPE BUFFER FOR OUTPUT, NOW LOOP "T" TIMES
1785 'WRITE NAMES TO TAPE, WRITE DATE & DESCRIPTION THEN CLOSE
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 MENU
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 PCM

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 pro-
gram 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 re-
turning 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 Name-
file, 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 alphabetical 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-007F H).

Write to Jerry Hogan at 544 Douglas St., Redwood City, CA 94063.
Why risk losing your shirt at Las Vegas? Play casino-style poker with the computer's money.

**System Requirements**

- Extended Color Basic
- 16K RAM

This slot-machine draw-poker game for the Color Computer requires only 16K of memory, Extended Color Basic, and your typing time. Not one nickel of your hard-earned cash is at risk.

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 X(1)= 1;X(2)= 13;X(3)= 12;X(4)= 11;X(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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Program notes
- Menu selection
- Instructions
- Payoff list
- Store card symbols and numbers
- Dimension the arrays
- Display the cards
- Card change routine
- Compute card holding
- Screen displays and sound

Program Breakdown

Table 1. Program Breakdown

<table>
<thead>
<tr>
<th>D(1)</th>
<th>D(2)</th>
<th>D(3)</th>
<th>D(4)</th>
<th>D(5)</th>
<th>S(1)</th>
<th>S(2)</th>
<th>S(3)</th>
<th>S(4)</th>
<th>S(5)</th>
<th>WIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF</td>
<td>1</td>
<td>13</td>
<td>12</td>
<td>11</td>
<td>10</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>200</td>
</tr>
<tr>
<td>SF</td>
<td>9</td>
<td>13</td>
<td>12</td>
<td>11</td>
<td>10</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>55</td>
</tr>
<tr>
<td>F</td>
<td>8</td>
<td>13</td>
<td>12</td>
<td>11</td>
<td>10</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>F</td>
<td>8</td>
<td>13</td>
<td>12</td>
<td>11</td>
<td>10</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>S</td>
<td>8</td>
<td>9</td>
<td>12</td>
<td>11</td>
<td>10</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4K</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>10</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>3K</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>2</td>
<td>10</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>FH</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>15</td>
</tr>
</tbody>
</table>

Table 2. Values to Check Winning Combinations

Program Listing

Listing continued...
**COLOR TERM + PLUS +**

An Intelligence Terminal Program For The Color Computer or TDP 100.

**Features:**
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- Examine Buffer
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**See List of Advertisers on page 138**
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 by 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.

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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

<table>
<thead>
<tr>
<th>Hand</th>
<th>Ways</th>
<th>Odds</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. RF</td>
<td>4</td>
<td>1 in 649,740</td>
<td>0.00015</td>
</tr>
<tr>
<td>2. SF</td>
<td>5</td>
<td>1 in 72,193</td>
<td>0.0013</td>
</tr>
<tr>
<td>3. 4K</td>
<td>108</td>
<td>1 in 4,165</td>
<td>0.024</td>
</tr>
<tr>
<td>4. FH</td>
<td>3,744</td>
<td>1 in 694</td>
<td>0.145</td>
</tr>
<tr>
<td>5. F</td>
<td>5,108</td>
<td>1 in 509</td>
<td>0.2</td>
</tr>
<tr>
<td>6. S</td>
<td>10,200</td>
<td>1 in 255</td>
<td>0.4</td>
</tr>
<tr>
<td>7. 3K</td>
<td>54,912</td>
<td>1 in 47</td>
<td>2.1</td>
</tr>
</tbody>
</table>

Table 4. Rank of Hands

<table>
<thead>
<tr>
<th>Hand</th>
<th>Ways</th>
<th>Odds</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF</td>
<td>4</td>
<td>1 in 649,740</td>
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<td>S</td>
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</tr>
<tr>
<td>3K</td>
<td>54,912</td>
<td>1 in 47</td>
<td>2.1</td>
</tr>
</tbody>
</table>

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;l: PCLS :S CRE ENl,l see
890 LINE(16,16) -(48,64).PSET,B
900 LINE(16,16) -(92,64).PSET,B
910 LINE(288,16) -(288,64).PSET,B
930 L=0:DRAW"C71"
940 DRAW"S4BM32,72": IFL=lTHEN1730
950 DRAW"S4BM77,72": R6D6L6D6R6": IFL=lTHEN1730
960 DRAW"S4BM125,84": R6U6MUSU6L6": IFL=lTHEN1730
970 DRAW"S4BM173,72": D6R6N6U6D6": IFL=lTHEN1730
980 DRAW"S4BM221,84": R6U6L6U6R6": IFL=lTHEN1730
990 'DISPLAY THE CARDS
1000 FOR A=lTO5
1010 IFA=1THENDRAW"BM30,60": H=37:GOSUB1640:DRAW"S8BM22,32":GOSUB1500
1020 IFA=2THENDRAW"BM78,60": H=85:GOSUB1640:DRAW"BM78,32":GOSUB1500
1030 IFA=3THENDRAW"BM126,60": H=133:GOSUB1640:DRAW"BM118,32":GOSUB1500
1040 IFA=4THENDRAW"BM174,60": H=181:GOSUB1640:DRAW"BM166,32":GOSUB1500
1050 IFA=5THENDRAW"BM222,60": H=229:GOSUB1640:DRAW"BM214,32":GOSUB1500
1060 NEXTA
1070 IFB=0THEN1690
1080 GOTO1690
1500 'CARD VALUE SUBROUTINE
1510 IFn(0)=lTHENDRAW"XN$: RETURN
1520 IFn(0)=2THENDRAW"X0$: RETURN
1530 IFn(0)=3THENDRAW"X5$: RETURN
1540 IFn(0)=4THENDRAW"X9$: RETURN
1550 IFn(0)=5THENDRAW"XS$: RETURN
1560 IFn(0)=6THENDRAW"XS$: RETURN
1570 IFn(0)=7THENDRAW"XT$: RETURN
1580 IFn(0)=8THENDRAW"XU$: RETURN
1590 IFn(0)=9THENDRAW"XV$: RETURN
1600 IFn(0)=l0THENDRAW"XX$: RETURN
1610 IFn(0)=11THENDRAW"XX$: RETURN

Hello thayuh. This is Eben Flow, proprietor of the Fish or Cut Bait Company, buyer and seller of lobstah bait for 49 years. My hobbies are collecting linoleum samples, squashing flies and playing pac-person on my home computer. But here on Martinicus Rock, off the coast of Maine, the power can be a tad erratic. So, to cure the brownout and blackout problems, and to keep them spikes and surges off my picture tube, I got me a MAYDAY Uninterruptible Power Supply from SUN RESEARCH. Them fellas fixed me up real good and real light on my pocketbook, too. Got me a MAYDAY for my mini-calculator with a voltage regulator and everything for only 325 clams. They even included the battery in a nice waterproof box. Handy out here, you know. Now, if MAYDAY would only keep them sea dogs out of my barrel . . .

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Many of my fellow teachers denounce the idea of micros in class, saying that computers will never replace teachers. This may be true, but then slides, movies, and audio tapes haven’t replaced teachers either. Schools usually lack the time and money to supply much one-on-one instruction; a computer, which proceeds at the student’s pace in a way a movie or record can’t, combines individual aid with infinite patience.

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.

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**Program Listing 1**

```
10 REM JAMES W. WOOD, 424 N. MISSOURI, ATWOOD, IL. 62913, JUNE 1981
20 CLS: PRINT: PRINTTAB(10)"ADDITION COLORS"
30 A$(1)="TO ADD COLORS IN THE PHYSICS LAB TWO OR THREE PROJECTORS MAY BE USED. EACH ONE IS PRODUCING A DIFFERENT COLOR OF LIGHT. IF THE BEAMS ARE OVERLAPPED ON A SCREEN YOU CAN SEE WHAT COLOR RESULTS.
40 A$(2)="YOUR PROJECTORS CAN PROVIDE FAR MORE COLOR COMBINATION THAN THE TV-50 IS CAPABLE OF AT THIS TIME."
50 A$(3)="WHEN THE COMPUTERS CAN HANDLE MORE COLORS AND SHADES SOMEONE WILL MATHEMATICALLY PREDICT WHAT COLOR WILL ULTSTE THE ADDING OF TWO OTHERS AND HAVE THE COMPUTER SHOW THE RESULT."
60 A$(4)="A SCIENTIST NAMED DORES TED HAS DONE MUCH WORK ON THIS TOPIC."
70 A$(5)="BUT FOR NOW LETS LOOK AT THE CLASSIC ADDING OF THE THREE BEAMS OF LIGHT. THE BEAMS USED WILL BE RED, BLUE, AND GREEN."
90 RETURN: TO40:B=RETURN
100 CLS: PRINT39, "ADJUST COLORS"; PRINT64,"RED BLUE GREEN MAGE NT"; PRINT96,STRINGS(3,191)+CHR$(128)+STRINGS(4,175)+CHR$(128)+STRINGS(5,143)+CHR$(128)+STRINGS(7,239),
110 PRINT168, "CYAN YELLOW WHITE"; PRINT192,STRINGS(2,243)+CHR$(128)+STRINGS(6,159)+CHR$(128)+STRINGS(5,287);
120 PRINT384, "PRESS ANY KEY TO CONTINUE;"
130 A$="INKEY$: IF A$=" THEN 130"
140 GOTO39
150 COLOR63
160 CLASSPRINT39,CHR$(177)+CHR$(179)+STRINGS(6,191)+CHR$(179)+CHR$(163)+CHR$(167)+STRINGS(5,175)+CHR$(163)+CHR$(162);
170 PRINT69,CHR$(177)+CHR$(183)+STRINGS(7,191)+STRINGS(4,239)+STRINGS(8,123)+CHAR(182)+CHR$(162);
180 PRINT100,CHR$(183)+STRINGS(8,191)+STRINGS(6,239)+STRINGS(8,175)+CHR$(162);
190 PRINT132,CHR$(183)+STRINGS(7,191)+STRINGS(8,239)+STRINGS(8,175);
200 PRINT163,CHR$(181)+STRINGS(8,191)+STRINGS(8,239)+STRINGS(8,175)+CHR$(178);
210 PRINT196,STRINGS(8,191)+STRINGS(6,287)+STRINGS(8,175);
220 PRINT229,CHR$(180)+STRINGS(5,191)+STRINGS(5,191)+STRINGS(6,207)+STRINGS(3,223)+CHR$(159)+STRINGS(6,159)+CHR$(178);
230 PRINT261,CHR$(180)+STRINGS(5,191)+STRINGS(5,191)+STRINGS(5,287)+STRINGS(5,287)+CHR$(175)+STRINGS(7,223)+CHR$(174)+CHR$(168);
250 PRINT312,STRINGS(16,143);
260 PRINT360,STRINGS(16,143);
280 PRINT392,CHR$(133)+STRINGS(14,143)+CHR$(138);
280 PRINT425,CHR$(140)+STRINGS(12,143)+CHR$(142);
290 PRINT458,CHR$(132)+STRINGS(14,143)+CHR$(140)+STRINGS(8,143)+CHR$(140)+CHR$(136);
300 PRINT494,STRINGS(4,143);
310 PRINT488,"PRESS ANY KEY TO CONTINUE;"
320 A$="INKEY$: IF A$=" THEN 320: GOTO449:
330 BS(1)="RED PLUS BLUE"
340 BS(2)="RED PLUS GREEN"
350 BS(3)="BLUE PLUS GREEN"
360 BS(4)="MAGENTA PLUS GREEN"
370 BS(5)="YELLOW PLUS BLUE"
380 BS(6)="RED PLUS CYAN"
390 CS(1)="MAGENT"
400 CS(2)="YELLOW"
410 FORX=1TO5
420 N=RND(6): IF(M(1)=THEN428ELSEM(1)=1:PRINTWHAT IS * BS(N): INPUT
430 IFBS(CS(N)>PRINTTAB("SORRY, IT IS :CS(N)=FORT=1TO88:RETURN;"
440 PRINT"CORRECT":CC+2=1:NEXTX
450 PRINT"YOU GOT :CC" OUT OF 5 CORRECT"
460 FORT=1TO123: NEXTX
470 CLASSPRINTTab(5)"SUBTRACTION OF LIGHT"
480 PRINT Actions lab results may be different because the filter."
490 A$="";
500 A$="IT IS NOW TIME TO STUDY THE RESULT OF PASSING LIGHT THROUGH A COLORED FILTER."
510 BS(2)="A FILTER PLEASE COLORS WHICH MAKE UP THE COLOR OF THE FILTER."
520 A$=""
530 (A$="A RED FILTER Passes red light."
540 BS(3)="A YELLOW FILTER WILL PASS RED AND GREEN LIGHT BECAUSE YELLOW IS THE COMBINATION OF RED AND GREEN."
550 BS(6)="LET'S LOOK AT LIGHT AND FILTERS."
560 FORM=1TO6 =LENS(M): FOR=1TO40:PRINTMID(B$:M,E,1): FOR=1:
570 TO39: NEXT: PRINT: NEXTW
580 CLASSPRINT65,"RED FILTER;"
590 IF=4: M=63: N=29: D=63:GOSUB640
600 CLASSPRINT65,"GREEN FILTER;" P=1: M=29: N=63: D=6GBUS40
610 CLASSPRINT65,"BLUE FILTER;" P=2: M=63: N=29: D=63:GOSUB640
630 GOTO639
640 FOR=6TO12:SET(31,Y,P)=SET(38,Y,P)=NEXTX
650 FORX=1TO29:SET(X,7,4)=FORT=1TO28: NEXTX: IF=63THENFOR=32TO
660 FORX=1TO29:SET(X,9,3)=FORT=1TO28: NEXTX: IF=63THENFOR=32TO
670 FORX=1TO29:SET(X,11,1)=FORT=1TO28: NEXTX: IF=63THENFOR=32TO
680 FORX=1TO100: NEXTX: RETURN
690 CLASSPRINT1, "MAGENTA LIGHT AND YELLOW FILTER"
700 BS(2)="RED LIGHT AND RED FILTER"
710 BS(3)="WHITE LIGHT AND BLUE FILTER"
720 BS(4)="CYAN LIGHT AND RED FILTER"
730 BS(5)="BLUE LIGHT AND MAGENTA FILTER"
740 BS(6)="BLUE LIGHT AND RED FILTER"
750 ES(1)="RED"; CS(1)="MAGENTA IS RED AND BLUE. THE YELLOW WHICH MAKES UP RED AND GREEN. RED IS THE ONLY COLOR PRESENT WHICH WILL BE TRANSMITTED BY THE FILTER."
760 ES(2)="RED"; CS(2)="DIFFICULT"
770 ES(3)="BLUE"; CS(3)="WHITE IS RED, BLUE, AND GREEN. A RED AND GREEN ARE TRANSMITTED."
780 ES(4)="NONE"; CS(4)="CYAN IS BLUE AND GREEN. THEREFORE RED IS NOT TRANSMITTED BY THE FILTER"
790 ES(5)="BLUE"; CS(5)="MAGENTA PASSES BLUE AND RED. THE RE IS NO RED."
800 ES(6)="NONE"; CS(6)="A RED FILTER DOES NOT PASS BLUE LIGHT"
810 FORX=1TO5
820 PRINT
830 N=RND(6): IF(M(1)=THEN428ELSEM(1)=1:PRINTWHAT IS * BS(N): INPUTS
840 IFBS>CES(N)>PRINTTAB("SORRY, PRINTS(N): FOR=1TO7013
850 NEXTX: GOTO468
860 PRINT"YOU NOW HAVE :CC> OUT OF 10 CORRECT"
870 FORX=1TO1288:NEXTX:CLASSPRINT194,"WASN'T THIS ENLIGHTENING?"
```
If you are interested in contour graphics, here are some algorithms for use on dot-matrix printers.

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.

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-

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**System Requirements**

16K RAM
Extended Color Basic
Printer Optional

---

![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.](image)
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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:

\[
\text{Screen } Y = Y \cdot \cos(A) + Z \cdot \sin(A)
\]

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 \( \text{MAX} \) 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

![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.](image)

![Fig. 3. Each line of sight is processed from bottom to top. This makes it easier to find hidden points.](image)

```basic
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 : 'PLOT Screen,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. OFropes below and above X-AXIS
125 FOR X=-NL TO NL : 'CROSS ALL 17 ROPEs FROM BOTTOM TO TOP
130 Y=X/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*(CY+S*.2)+.5) : 'TRANSFORM ALTITUDE INTO SCREEN HEIGHT
2060 IF Y>MAX THEN MAX=Y ELSE 2090 : 'IF Point IS HIGHER Than previously plotted
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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a point. This distance is denoted $R$ and is given by $R = \sqrt{x^2 + y^2}$ (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.
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 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 complete, add

```
ADD: 0 DIM A(32)
CHANGE:
110 FOR I = -64 TO 0
125 FOR K = -NL TO 0
1400 R = SQRT(X*X + Y*Y)
1010 Z = 3*EXP(-R*R/4) - 1
ADD:
140 A(-K) = Z
155 GOSUB 3000
2080 PSET(128 - Xl,96 - Y)
```

In addition, subroutines have been included to let the user save a previously stored image from 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

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

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

POMODE 4 is normally a two-color
mode. However, when a screen image is
processed in POMODE 3 and then dis-
played in POMODE 4, something inter-
esting 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 POMODE 3) with the top of
the grid white and the bottom red. The
contrasting colors make a very attrac-
tive display.

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 in-
to a screen height.

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

Line 105 speeds up program execu-
tion by making use of a dual clock rate.
As I understand it, memory operations
in ROM (especially the ROM chips con-
taining the Basic interpreter) are execut-
ed 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 op-
erate properly under these conditions. If
such is the case in your situation, simply
delete lines 105 and 165. Line 165 re-
turns 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 com-
puter is running with a dual clock rate.

If, for any reason, program execu-
tion is halted prior to line 165, press the
reset button on the rear of the com-
puter. 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, calcu-
lates X, and scales it to the correct
screen value. Terrain X starts at - 4. By
multiplying X by 30, the screen X values
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 symme-
try of the terrain. If a square base is de-
sired, 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.

Program Listing 2. A highly modified version of the simple program in Listing 1. It pro-
duces 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 ad-
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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.”

**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 successiveropes, 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.)

---

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.
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 = -3 to 0.
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.

### 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 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 \((-1)^N\) in one term of the calculation of Y (line 118 of Listing 4). When N = 1 then \((-1)^N\) is negative, yielding the point below the middle. On the other hand, when N = 2 then \((-1)^N\) 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 \( Y \) coordinates change in the same length. The terrain is now covered with a rectangular grid of lines that will let you view the changing contours in two directions. (Fig. 7.A)

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. (Fig. 7.C)

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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 (Figs. 7B and 7C). Within each segment, N (line 117) is set at 0 for the left half of each group (Fig. 7C). In line 112, K selects the point below the right (Fig. 7B). The variable Ki n line 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 a group. The program then moves to the next group (NEXT I) 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 I command at line 142.

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

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 2t( ) or 3t( ), where again an expression involving R goes inside 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^t( - R• R), and Z = 2•3^t( - R• R/4) – 1 are all examples where the expression for R is multiplied by 1.25 to increase the height of the display.
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 screenprint 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.

![Figure 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.](image1)

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

![Figure 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.](image2)

```
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
```

![Figure 13. A Simple Example of Display 3 (Listing 4).](image3)

```
1000 R = SQR(X*X + Y*Y)
1010 Z = 2.5*EXP(-R*R/2)
DOT DENSITY = 16
ANGLE = 75 DEGREES
```

![Figure 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.](image4)

```
1000 R = SQR(X*X + Y*Y)
1010 Z = 1.5 - 3*EXP(-R*R/2)
DOT DENSITY = 16
ANGLE = 65 DEGREES
```

![Figure 15. The circular base is obtained by adding this line to Listing 4: 122 IF Y< -SQR(16-X*X) THEN 135.](image5)

```
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. 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.
DEMYSTIFYING SYSTEM RAM

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 I. 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

<table>
<thead>
<tr>
<th>Address</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>23-24</td>
<td>top of RAM</td>
</tr>
<tr>
<td>25-26</td>
<td>start address of Basic program</td>
</tr>
<tr>
<td>31-32</td>
<td>end address of Basic program</td>
</tr>
<tr>
<td>55-56</td>
<td>name of last variable used</td>
</tr>
<tr>
<td>111</td>
<td>DEVNUM—device number for CHROUT</td>
</tr>
<tr>
<td>124</td>
<td>cassette block type</td>
</tr>
<tr>
<td>125</td>
<td>cassette block length</td>
</tr>
<tr>
<td>126-127</td>
<td>cassette buffer address</td>
</tr>
<tr>
<td>135</td>
<td>last key pressed in program</td>
</tr>
<tr>
<td>136-137</td>
<td>cursor address</td>
</tr>
<tr>
<td>148</td>
<td>cursor timer</td>
</tr>
<tr>
<td>149-150</td>
<td>line printer baud rate</td>
</tr>
<tr>
<td>151-152</td>
<td>line printer delay</td>
</tr>
<tr>
<td>153</td>
<td>line printer comma field width</td>
</tr>
<tr>
<td>154</td>
<td>line printer last comma field</td>
</tr>
<tr>
<td>155</td>
<td>line printer line width</td>
</tr>
<tr>
<td>156</td>
<td>line printer current position</td>
</tr>
<tr>
<td>157-158</td>
<td>EXEC address of machine-language program</td>
</tr>
<tr>
<td>175</td>
<td>trace flag 0 = off, 79 = on</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Address</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>182</td>
<td>present PMODE number</td>
</tr>
<tr>
<td>234</td>
<td>drive operation (0-3)</td>
</tr>
<tr>
<td>235</td>
<td>drive number (0-3)</td>
</tr>
<tr>
<td>236</td>
<td>track number (0-34)</td>
</tr>
<tr>
<td>237</td>
<td>sector number (1-18)</td>
</tr>
<tr>
<td>238-239</td>
<td>buffer address</td>
</tr>
<tr>
<td>240</td>
<td>disk I/O error codes</td>
</tr>
<tr>
<td>274-275</td>
<td>timer value</td>
</tr>
<tr>
<td>278</td>
<td>upper/lowercase flag 0 = on, 255 = off</td>
</tr>
<tr>
<td>283-284</td>
<td>keyboard delay constant</td>
</tr>
<tr>
<td>338-345</td>
<td>keyboard rollover table</td>
</tr>
<tr>
<td>346-349</td>
<td>joystick pot values</td>
</tr>
<tr>
<td>359</td>
<td>disable Print 126 = on, 128 = graphics, 255 = off</td>
</tr>
<tr>
<td>474-481</td>
<td>cassette file name</td>
</tr>
<tr>
<td>485-486</td>
<td>EXEC address of cassette-loaded machine-language program</td>
</tr>
<tr>
<td>487-488</td>
<td>load address of cassette-loaded machine-language program</td>
</tr>
<tr>
<td>512-730</td>
<td>free RAM usable by machine-language programs</td>
</tr>
<tr>
<td>733-981</td>
<td>keyboard input buffer (noncompressed format)</td>
</tr>
<tr>
<td>1024-1535</td>
<td>text screen memory</td>
</tr>
</tbody>
</table>

Table I. Memory Map of System RAM
Setting The Standards

WHAT THEY ARE SAYING ABOUT COLORPEDE

"The Rainbow, Dec. '82"... an outstanding offering. "N. Vernon, IN..." the best graphics I have seen to date. "Erie, PA... it is great!" "Dayton, OH..." the best graphics and playability of any color computer game. "McKeesport, PA...

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print anything to the text screen and will still clear the screen. 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 CLEAR

This reverses alphanumerics and graphics. If you type "PRINT CHR$ (191)" and enter, an "A" will appear 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.

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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=6H66C ' POINTS TO DS KCON
20 PRINTTAB(8)"COLOR DISK DRIVE";PRINTTAB(6)"HEAD CLEANING DRIVE"
30 PRINT"0102,""REMOVE PROGRAM DISKS"
40 PRINT"0299,""INsert CLEANING DISK IN DRIVE"
50 PRINT"0224;""INPUT""DRI VE 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,"H EAD IN POSIT ION
80 A=0:B=34:C=1:G OSUB110
90 A=34:B=0:C=1:G OSUB110
100 POKE&H FF40,0:R UN
110 FORX=A TO B STEP C
120 POKE23 4,l ' SET S DISK TO NO OPERATION
130 POKE235 ,DR ' SE TS DRIVE NUMBER
140 POKE236,X ' SE TS TRACK NUMBER
150 PRINT@304 ,X;
160 FORY=1 TO70: A=USR0(0) : N EXTY ,X
170 RETURN

Program Listing 2

10 CLS:PRINT"M ACHI NE LANGUAGE TRANSFER DRIVER FROM CASSETTE TO DISK":PRINT"PROGRAM: "
20 FORX=474T0481 : NA$=NA$+CHR$(PEEK(X)) : NEXT : PRINT@73,NA$
30 S T=PEEK(4 87) *25 6+PEEK(488) : E N=PEEK(126) *256+PEEK(127) : EX=PEEK(157) *256+PEEK(158) : ST=ST+EX-PEEK(485) *256+PEEK(486)
40 PRINT"ST ART ADDRES S"ST: PRINT"ENDIN G ADDRES S" EN : PRINT"EXECUT ING ADDRE SS"EX
50 INPUT"HOW MANY COPI ES";NO:IFNO<=0 THEN END
60 FORX=1 TO NO : PRINT@224," INSERT DISK IN DRIV E" : PRINT "K EY <E NTER> T O COPY"; LINEINPUT A$:1 MNA$ ,S T,E N,EX: NEXT: END

Program Listing 3

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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.

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.

Program Listing 4

10 PHASE0,L:PCLEAR:CLEAR10,8192
20 CLS
30 PRINTTAB(7)"PROGRAM PAK COPIER"
40 PRINT
50 FORX=51 TO 530
60 READA$
70 POKE X,VAL(" &H"+A$)
80 NEXT
90 DEFUSR 0 =511
100 PRINT@ 64,:I NPUT" ENTER MEMORY SIZE (16 OR 32) ";ME
110 IF ME<>16 AND ME<>32 THEN 100
120 IF ME=32 THEN ST=24576 ELSE ST=8192
130 POKE65315,54 "DISABLE CARTRIDGE INTERRUPT"
140 LINE INPUT"INSERT PROGRAM PAK IN CARTRIDGE SLOT AND KEY <ENTER>";A$
150 A=USR0(ST)
160 PRINT"PROGRAM PAK DUMPED"
170 INPUT"HOW MANY COPIES";C
180 IF C=0 THEN 240
190 FORX=1 TO C
200 PRINT@256,"POSITION TAPE--PRESS PLAY AND RECORD"
210 LINE INPUT"KEY <ENTER>";A$
220 CSAVEM"ROMPAK",ST,ST+8192,ST
230 NEXT
240 END
250 REM MACHINE LANGUAGE SUBROUTINE
260 DATA BD,03,ED,1F,1,10,BE,C0,00,A6,A0,A7,80,10,8C,E0,00,26,F6
,39,8,0

Program Listing 4

PRO-COLOR-FILE

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TRS-80 is a trademark of the Tandy Corp.
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.
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 $7000 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 &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 LIST 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 $3000. You should also change line 400 to ORG $7000. The 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 $3000.

Program Listing 1. Basic Program Merge Utility

<table>
<thead>
<tr>
<th>Line</th>
<th>Instruction</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0010</td>
<td>* A BASIC PROGRAM MERGE UTILITY</td>
<td></td>
</tr>
<tr>
<td>0012</td>
<td>* COPYRIGHT DECEMBER 1982</td>
<td></td>
</tr>
<tr>
<td>0014</td>
<td>* BY</td>
<td>ROBERT P. BUSSELL</td>
</tr>
<tr>
<td>0016</td>
<td>CLS EQU SA828 CLEAR SCREEN</td>
<td></td>
</tr>
<tr>
<td>0018</td>
<td>RENUM EQU $8A3A ENTRY TO RENUM WITH ALL INPUTS SET</td>
<td></td>
</tr>
<tr>
<td>0020</td>
<td>SCREEN EQU SA30A DISPLAY ADDRESS</td>
<td></td>
</tr>
<tr>
<td>0022</td>
<td>ORG $7000</td>
<td></td>
</tr>
<tr>
<td>0024</td>
<td>INIT LBSR INST DISPLAY INSTRUCTIONS</td>
<td></td>
</tr>
<tr>
<td>0026</td>
<td>RNUM LEAX NUMTAB, PCR</td>
<td>LOAD MERGE TABLE</td>
</tr>
<tr>
<td>0028</td>
<td>LOO #10 GET CONSTANT</td>
<td></td>
</tr>
<tr>
<td>0030</td>
<td>STD $CF SET UP MERGE</td>
<td></td>
</tr>
<tr>
<td>0032</td>
<td>ADDO ,X GET LAST LINE USED</td>
<td></td>
</tr>
<tr>
<td>0034</td>
<td>LNUM</td>
<td></td>
</tr>
<tr>
<td>0036</td>
<td>STD $D1 CLEAR START LINE</td>
<td></td>
</tr>
<tr>
<td>0038</td>
<td>LDD ,Y GET NEXT LINE</td>
<td></td>
</tr>
<tr>
<td>0040</td>
<td>CMPY #0 AT END</td>
<td></td>
</tr>
<tr>
<td>0042</td>
<td>BGT LNUM NO, GET MORE</td>
<td></td>
</tr>
<tr>
<td>0044</td>
<td>STD ,X SAVE FOR NEXT MERGE</td>
<td></td>
</tr>
<tr>
<td>0046</td>
<td>ADD #10 INCREMENT</td>
<td></td>
</tr>
<tr>
<td>0048</td>
<td>CMPY #0 AT END</td>
<td></td>
</tr>
<tr>
<td>004A</td>
<td>BGT LNUM NO, GET MORE</td>
<td></td>
</tr>
<tr>
<td>004C</td>
<td>STD ,X SAVE FOR NEXT MERGE</td>
<td></td>
</tr>
<tr>
<td>004E</td>
<td>ADD #10 INCREMENT</td>
<td></td>
</tr>
<tr>
<td>0050</td>
<td>CMPY #0 AT END</td>
<td></td>
</tr>
<tr>
<td>0052</td>
<td>BGT LNUM NO, GET MORE</td>
<td></td>
</tr>
<tr>
<td>0054</td>
<td>STD ,X SAVE FOR NEXT MERGE</td>
<td></td>
</tr>
<tr>
<td>0056</td>
<td>JRN RENUM LEAVE ROUTINE AND RENUMBER</td>
<td></td>
</tr>
<tr>
<td>0058</td>
<td>JSR CLS CLEAR SCREEN</td>
<td></td>
</tr>
<tr>
<td>005A</td>
<td>LEX TEXT,PCR GET MESSAGE</td>
<td></td>
</tr>
<tr>
<td>005C</td>
<td>ILOOP LDA ,X GET CHARACTER</td>
<td></td>
</tr>
<tr>
<td>005E</td>
<td>JSR ILOOP NO MORE DATA</td>
<td></td>
</tr>
<tr>
<td>0060</td>
<td>JMP RENUM LEAVE ROUTINE AND RENUMBER</td>
<td></td>
</tr>
<tr>
<td>0062</td>
<td>JSR SCREEN DISPLAY IT</td>
<td></td>
</tr>
<tr>
<td>0064</td>
<td>BSR ILOOP MORE TO GET</td>
<td></td>
</tr>
<tr>
<td>0066</td>
<td>ILOOPI RTS RETURN</td>
<td></td>
</tr>
<tr>
<td>0068</td>
<td>MRG LEX FLINE,PCR</td>
<td></td>
</tr>
<tr>
<td>006A</td>
<td>LDD ,X GET FIRST LINE</td>
<td></td>
</tr>
<tr>
<td>006C</td>
<td>CMPD #0 IST PASS?</td>
<td></td>
</tr>
<tr>
<td>006E</td>
<td>BNE MRGI NO,CONTINUE</td>
<td></td>
</tr>
</tbody>
</table>

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HOT CoCo June 1983 115
This routine is called at a point after the change lines 2000-2020 of the prompt stead of 7000, 703B, and 7050 messages number (address $05), and new line 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 $7100 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 for loading the next program to be saved in FUNE. Execution of the subroutine at label MRG (address $703B) resets the Basic pointers at addresses $19-$1C (25-28 decimal) to the next available location. The initialization executed at address $7100 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 for loading the next program to be saved in FUNE. Execution of the subroutine at label MRG (address $703B) resets the Basic pointers at addresses $19-$1C (25-28 decimal) to the next available location.

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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 1 1/2 inches of the gray cable insulation to expose the four colored wires inside. Remove 1/4 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 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 3—gnd
pin 4—data out
pin 5—(optional)
pin 6—dsr
pin 7—gnd
pin 11—superv data out
pin 12—

jumper between

---

pin 20—dtr

---

---

Fig. 2. Soldering Instructions

The color of computer serial printer cable.

PN 26-3020 Color Computer serial printer cable $4.95
PN 276-1547 Submini 25 (male) plug $2.99
PN 276-1549 Hood (optional) $2.19

Table 2. Parts List from Radio Shack

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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
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

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340 SOUND$,2:1:NEXT X
350 IF DZ=8 THEN 4B0 ELSEFXOR=11056:1 NEXT
360 FOR X=90 TO DZ+12-12+90 STEP 12
370 LINE(X,Y)-(X+6,Y+6),PSET,BF:IF T=2 THEN PAINT(X+3,Y+3),4,1
380 SOUND$,2:NEXT X
400 "DRAW "FROM?"
410 PAINT(188,280),1,1
420 DRAW"BM164.184/R4/L4/D3;R4/L4/D4/"
430 DRAW"BM+8,-8/U7/R4/D3;L4/P6/"
440 DRAW"BM-4,-8/U7/R5;D7;L5;R5/"
450 DRAW"BM+4,-8/U7/R4/L4/D7/"
460 DRAW"BM+5,-6/U2/R5;D4/L3;D4/"
500 "PICK POINT
510 IF BR(P,T)=" THEN P=1:GOTO650
520 PS=INKEY$:IF PS="THEN520
530 IF PS="C" THEN 7278 ELSE IF VAL(P$)=" THEN590
540 IF ASC(P$)>59 OR ASC(P$)<48 THEN620
550 PPS=INKEY$:IF PPS=" THEN590
560 IF ASC(PPS)=" THEN590
570 IF ASC(PPS)>
580 =PS+PPS
590 P=VAL(P$) IF P>24 THEN700
600 "CHECK LEGALITY
610 IF BR(P,T)>6 THEN650
620 GOSUB1580:GOTO310
630 "PICK DIE
650 IF D1=8 THEN D=D2:GOTO838
660 IF D1=8 THEN D=D1:GOTO838
670 IF D1=D2 THEN D1:GOTO838
671 IF P>THEN710
672 IFP=2:THEN690
674 IF BR(P+D1,T)<2 AND BR(P+D2,T)<2 THEN710
675 IF BR(P+D1,T)= AND BR(P+D2,T)=2 THEN D2:GOTO838
680 IF BR(P+D2,T)=1 AND BR(P+D1,T)=2 THEN D1:GOTO838
685 IFP=0 AND BR(D1,T)=1 AND BR(D2,T)=2 THENGOSUB1580:GOTO1270
690 IF BR(25-D1,T)=1 AND BR(25-D2,T)=2 THEN D2:GOTO838
695 IF BR(25-D2,T)=1 AND BR(25-D1,T)=2 THEN D1:GOTO838
696 IF P=0 AND BR(25-D1,T)=1 AND BR(25-D2,T)=2 THENGOSUB1580:GOTO1270
700 "DRAW "DIE?"
710 LINE(164,182)-(222,192),PRESET,BF
720 DRAW"BM164.184/D8;R3;E21/U4;H2/L3/"
730 DRAW"BM177,184/D7;B5;R6;U7/R4/L4/D3;R3;L3;D4/R4/"
740 DRAW"BM+5,-6/U2/R5;D4/L3;D4/"
745 "PICK DIE
750 DS=INKEY$:IF DS=" THEN 758
760 IF DS="C" THENGOSUB1580:GOTO1270
770 IF D=VAL(D$)
780 IF D>D1 AND D<D2 THENGOSUB1580:GOTO310
800 "CHECK LEGALITY
810 IF DP IS DESTINATION POINT
820 IF CHECK DESTINATION POINT NOT COVERED
830 IF T=1 THEN DP=P ELSE IF DP=D-P
840 IF T=2 THEN IF P=0 THEN DP=25-D
850 IF DP<1 THEN940
860 IF BR(DP,T)=1 THEN980
870 IF DP>24 THEN 998 ELSE IF DP<1 THEN 948
880 GOTO1020
890 FOR Z=1 TO 18
900 IF BR(Z,1)=6 THEN1800
910 NEXT Z:IF DP=25 THEN1830 ELSE FOR Z=19 TO P-4
920 IF BR(Z,1)=6 THEN1800
930 NEXT Z:GOTO1830
940 FOR Z=24 TO 7 STEP-1:IF BR(Z,2)=8 THEN1800
Listing continued

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"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."

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.

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
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 TI, 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.

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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)**
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 compli-

cated. 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:

\[
SF = \frac{(256/W)}{(192/H)} = \frac{(256\cdot H)}{(192\cdot W)}
\]

For my system this is about 1.2; it may be somewhat different for yours.

\[
0 \text{ PI} = 3.141592: \text{GOSUB 1: GOTO 0000}
1 \text{ INPUT "SCALE FACTOR": SF: PMODE 4, 1: PCLS}
2 \text{ XO} = 128: YO = 96: X = 0: Y = 0: M = -1: GOSUB 1: RETURN
10 \text{ XX} = \text{INT(SF} \cdot X + .5): YY = \text{INT(Y + .5): IFABS(M)} = 2 \text{THEN} SX = SX + XX: SY = SY - YY: GOTO 12
10 B \text{ IF ABS(M)} = 2 \text{THEN} SX = SX + XX: SY = SY - YY: GOTO 12
2 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
14A \text{P$ = STR$(SX) + "," + STR$(SY)}
14B \text{IF M>0 THEN DRAW "M" + P$ ELSE DRAW "BM" + P$}
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.

\[
\text{X, Y is the destination point.}
\text{M = 1 indicates a drawn line using absolute coordinates.}
\text{M = -1 indicates a blank move using absolute coordinates.}
\text{M = 2 indicates a drawn line using relative coordinates.}
\text{M = -2 indicates a blank move using relative coordinates.}
\text{M = -3 indicates a blank move using absolute coordinates, and the destination point will}
\text{become the new origin.}
\]

First, convert X and Y to integers (rounded off). SF is a scale factor which is discussed in the text.

\[
10A \text{ XX} = \text{INT(SF} \cdot X + .5): YY = \text{INT(Y + .5)}
\]

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).

\[
10B \text{ IF ABS(M)} = 2 \text{THEN} SX = SX + XX: SY = SY - YY: GOTO 12
\]

Otherwise, X and Y are absolute coordinates and the origin (X0, Y0) is used as the reference point.

\[
11 \text{ SX} = X0 + XX : SY = Y0 - YY
\]

Make sure the screen coordinates are within bounds.

\[
12 \text{ IF SX<0 THEN SX =0 ELSE IF SX>255 THEN SX = 255}
\]

Form the string for the DRAW command.

\[
14A \text{P$ = STR$(SX) + "," + STR$(SY)}
\]

Perform the correct draw operation (blank move or draw line).

\[
14B \text{ IF M>0 THEN DRAW "M" + P$ ELSE DRAW "BM" + P$}
\]

If necessary, reset the origin.

\[
15 \text{ IF M = -3 THEN X0 = SX : Y0 = SY}
\]

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
```

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
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 SCREEN 1, 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*
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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.

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-

Table 1. Relationship Between Polar and Rectangular Coordinates

<table>
<thead>
<tr>
<th>X = R * cos θ</th>
<th>Y = R * sin θ</th>
</tr>
</thead>
<tbody>
<tr>
<td>R = sqrt(X^2 + Y^2)</td>
<td>θ = arctan(Y/X)</td>
</tr>
<tr>
<td>Note: arctan is the arctangent function. The arctangent of Y/X is the angle (θ) whose tangent is Y/X (i.e., tanθ = Y/X).</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. The Relationships Between Degree Measure and Radian Measure

<table>
<thead>
<tr>
<th>Angle in Degrees</th>
<th>Angle in Radians</th>
</tr>
</thead>
<tbody>
<tr>
<td>n * 180</td>
<td>n * π</td>
</tr>
</tbody>
</table>

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Graphically Speaking

ing polar coordinates. For any regular polygon, the value of R is constant. The value of $e$ changes uniformly by an amount equal to $360/\text{NS}$, where NS is the number of sides. Thus, for a regular hexagon the angle $e$ changes by 60 degrees from one vertex to the next.

**Example 3**

You can use polar coordinates to write a program that will draw a regular hexagon. Since $e$ 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...
Graphically Speaking

Program Listing 6. Drawing a Hexagon Using Polar Coordinates

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 = I : GOSUB 10
1100 NEXT I
1110 :
1115 GOTO 1115

Program Listing 7. String Art

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 vertices 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

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.

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C.C. Calc costs $25 for disk or cassette. Order from Trans Tek, 194 Lockwood, Bloomingdale, IL 60108, 312-351-1210.

Reader Service 552

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...
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The Assembler supports the full complement of 6800 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 CORES-9 standard Editor/Assembler comes on tape for $29.95. The CORES-9 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 CERCO, 5566 Ricochet Ave., Las Vegas, NV 89110, 702-452-0632.

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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).

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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).
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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 FLEX is not compatible with any of the CoCo FLEX work, and how they vary.

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 disk-drive number address; press the enter key and it will jump to the address.

The three characters following 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 command 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 filenames 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.

Re:FLEX
Re:FLEX

- 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 $FF00 to $FBB4. It uses an MC146818, a battery-powered CMOS clock with 50 bytes of RAM from $FF8E to $FBB8. 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...
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 FLEX 09.

The installation disk is the first one you will use. It contains the RSDSKO.BIN, RETERMIO.BIN, SDC.CMD, NEWDISK.CMD, and APPEND1.TXT files, which are needed to create the FLEX.SYS 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.SYS 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 RLDSK.O/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 keyLoad and disk I/O routine to the FLEX.CORE and renaming it FLEX.SYS.

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.SYS 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.
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.
DISKE.COM—isa 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.COM—lets you set the disk-drive number and the rate at which the disk drive will step at either 6ms, 12ms, or 30ms.
MAKESYS.COM—is used after the NEWDISK command to create a FLEX system disk.
MEMEX.COM—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.COM—formats a new single- or double-density disk.
P.COM—directs the output to the printer.
RSDIR.COM—reads the Radio Shack directory.
RSREAD.COM—copies a Radio Shack Basic file to a FLEX disk by using a byte-by-byte method and no date conversion.
RSBIN.COM—copies a Radio Shack binary file to a FLEX disk using the same method as the RSREAD.COM.
RSWRITE.COM—copies a FLEX disk to Radio Shack disk with no date conversion.
SAVEROM.COM—saves the ROM to disk.
SDC.COM—single-disk copy routine that lets you use one disk to copy a file.
USERKEY.COM—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.COM—lets you jump to Basic with no provisions to use the disk.
EXT.COM—is the external terminal utility that lets you use a serial terminal. This is an extremely powerful routine.
HELP.COM—is another powerful program that helps you by providing an outline of the utility.
INT.COM—returns to Color Computer from the EXT mode.
LINK.COM—informs the boot loader where the FLEX operating system resides on the disk.
MOVEROM.COM—transfers Basic and Extended Basic from ROM to memory.
NEWDISK.COM—formats a new single- or double-density disk.
P.COM—is the system printer routine.
PUTBOOT.LDR—makes a newly made disk bootable for FLEX.
SDC.COM—is a single-disk copy program.
SETUP.COM—lets you set the system up according to your preference.
XSCREENS.COM—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
Re:FLEX

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.

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.
Re:FLEX

- 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 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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