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For Users of TRS-80™ Color Computers

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The Devil's Disk Editor by Bill Barden

Robotics:

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- What It Was, Is, and Will Be

Dissecting ROM— by Commander

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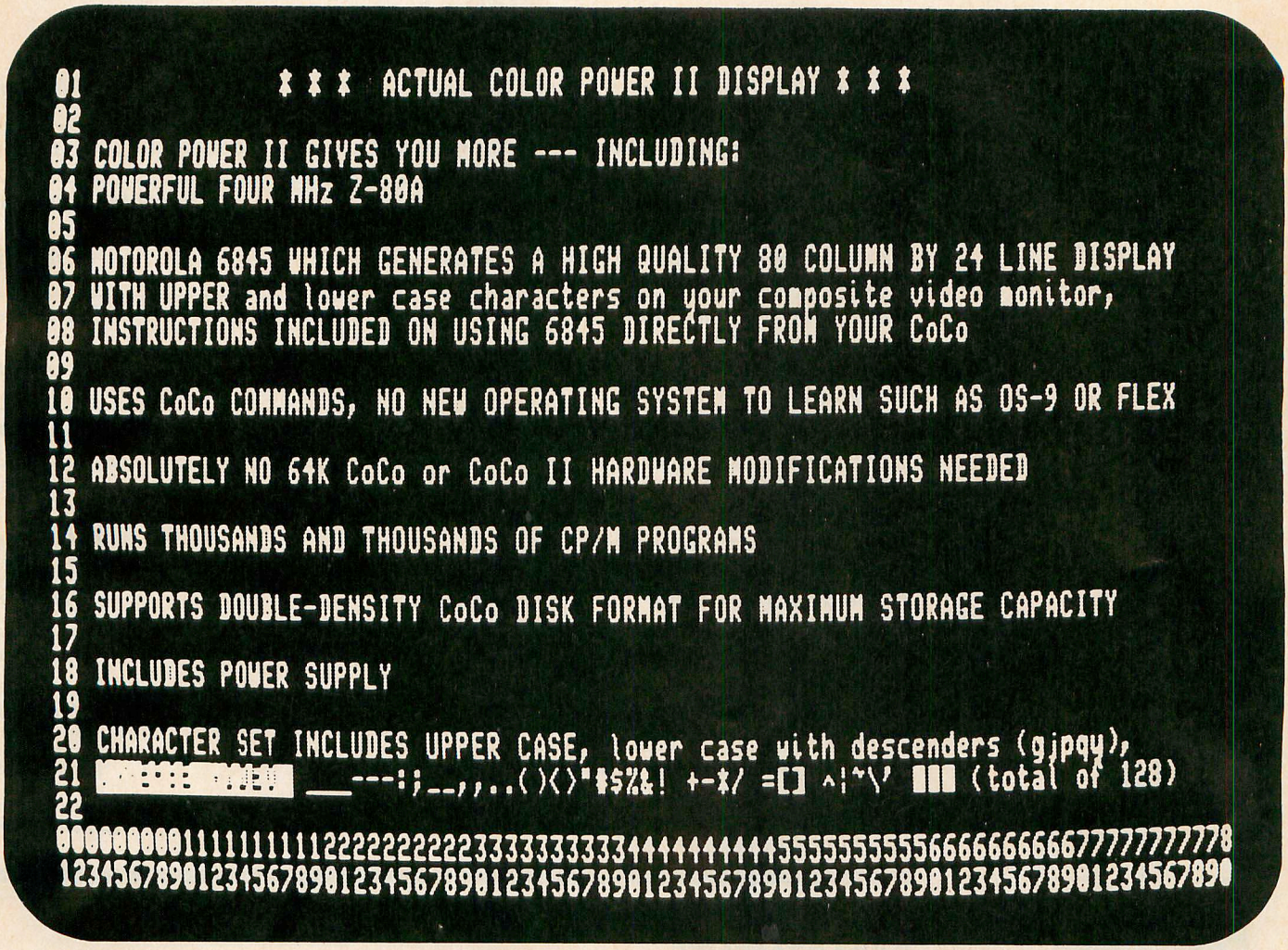

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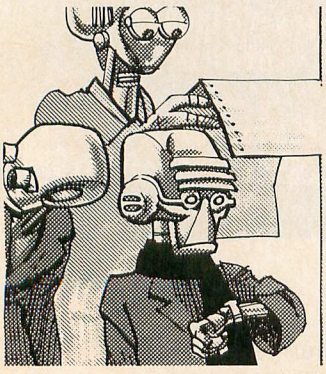

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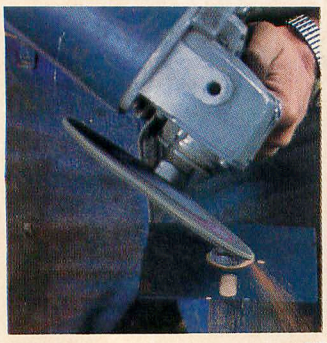

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41/Dissecting Your ROM by Jake Commander ***(Utility)***
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73/Newton by David Bartz ***(Math)***
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87/About Robots by Jamie Tietjen ***(General)***
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96/Spelling Pizazz! by Jeanlee M. Poggi ***(Education)***
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99/The Devil's Disk Editor by William Barden, Jr. ***(Tutorial)***
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114/Sorcerer's Puzzles by Richard Ramella ***(Game)***
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121/Custom Color by Dennis Kitsz ***(Tutorial)***
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Color Accountant, Amdek disk drives, Dynacalc, and more!

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Cover
"Mixed Media" by Robert Lorenz

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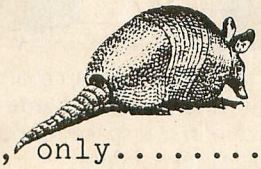

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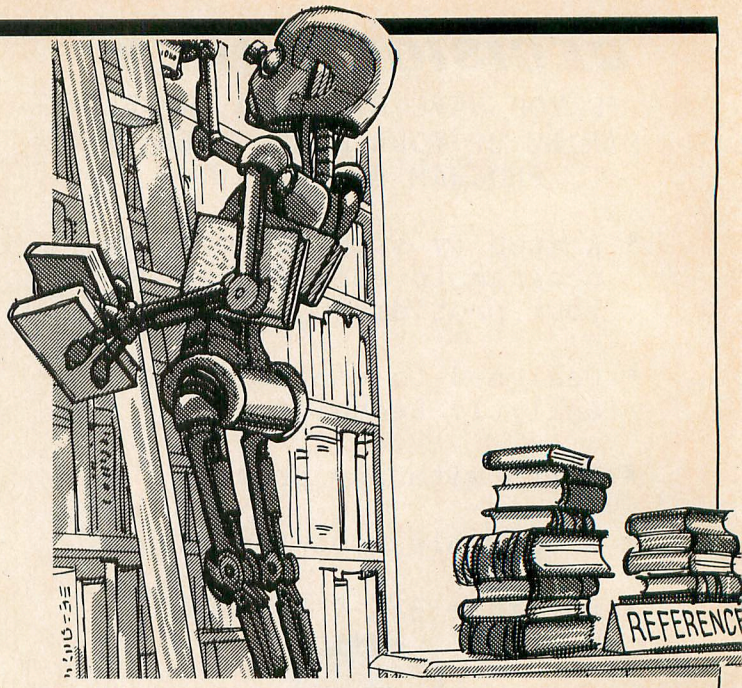
PEEK (04,84)



Robotics isn't yet an integral part of the microcomputer world; its technology is too complex and the price is prohibitive. It is mostly found in industry. However, things change in a more or less rapid fashion in our world — what was unknown last year may be commonplace next year. As robotics becomes more involved, more important to business, as more large and technically-oriented companies put their research and development crews to work on the problem of robots, the technology has begun to seep down in our direction. Robots aren't so far removed from our lives — and becoming less so.

To find out how much of our daily living is affected by robots even now, and to speculate on the future, GOTO 87, where Technical Editor Jamie Tietjen lets his mind roam. Then GOTO 56 to discover how some enterprising high school students made robotics affordable for everyone.

Now you're determined to have a robot of your very own, GOTO 28 to check your home finances and discover how long it will be before your savings account will permit the project!

If the wait seems too long to bear, you'll need some recreation to take your mind off your woes. GOTO 121 for the Game of Life; then GOTO 25 to read about The Grand Prize Winner in the assembly language category of last year's Summer Programming Project (the program was too long to print; send us a self-addressed envelope and we'll send you the listing!); and finally, relax with Poke and Sunflower — GOTO 114. Then if you're ready for a chuckle — GOTO 15 to discover what lies Behind The Fallen Gate!

Jake continues his dissection of ROM, this month by looking at the first byte of Extended Color Basic (GOTO 41); and Sanford's in-depth look at Color Basic ROM is completed this month — GOTO 80. Another series continuation you won't want to miss is Bill Barden's tutorial on disks. This month he begins a presentation that will help you do unheard-of things to your disks (GOTO 99).

Color Computing For Kids this month discussed the Read statement (GOTO 132); and those of you with learning-disabled students should GOTO 96 for a practice program for reading and spelling.

And finally — GOTO 73 for a subroutine that makes quick work of finding roots to numbers.

There are a few April Fools giggles scattered throughout this issue; keep your eyes open. What follows here is a glossary of April Definitions to add to your fun (compliments of Jamie Tietjen, Technical Editor).

— D.M., Editor

April Definitions

algorithm — *a*ll *go*ing in *rhythm,* applied to operation of any system. Seldom if ever, achieved.

assembly language — used by harried technical magazine editors dealing with too many program submissions for too few magazine pages. Characterized by active and forceful verbs: "hack it here," "hang it upside-down," "shoot it down," etc.

back-up — what a programmer does when he sees the overnight growth that took place in his In basket.

binary — a schizophrenic bird.

boolean logic — programs coded to heckle the end-user.

bubble memory — a storage medium characterized by its extremely light weight and volatility. Made of a thin film shaped into a binary zero in real space. Good place to store records of questionable tax deductions.

character generator — the situations and details of everyday life that turn ordinary people into characters.

character set — those characters associated with a certain editor or magazine.

character string — a set or group of characters searching for their editor in one day.

clock rate — the measurement of the approach of workdue deadlines. Amazingly, this rate steadily increases once it is first noted.

cross talk — heated communications between distantly related departments.

end-of-file — the most effective part of a smooth-program execution aid device, especially when used in a jabbing motion. Also, the time at which the device stops working effectively.

interrupt handler — a terse phrase used to disarm the average office crasher.

line feed — canned remark given to superior in response to work progress inquiries.

machine language — used to converse with computers and other office equipment. Characterized by near-expletives, such as: "darn bucket of bits!," "mangling copier-shredder!," "fickle 'puter phone!" and the like.

memory protection — notepaper and pencil.

monitor — device used to prevent underflow errors.

negative logic — "if in doubt, take it out!"

pipelining — pushing important data through a series of workers. Results in large propagation delays and considerable confusion.

propagation delay — time required for a correction to make it into the final work unit.

refresh — lunch time.

stack overflow — when the pile in your In basket falls over.

stack pointer — one's superior, especially, just before stack overflow.

sync — found in kytchen.

underflow error — when workflow falls short of input and output demand.

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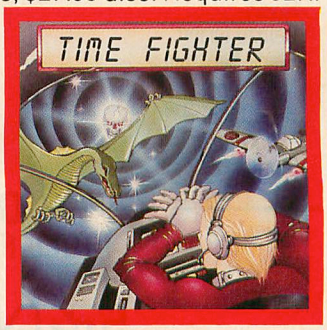

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THE Color Computer... MAGAZINE

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INKEY$

All letters are subject to editing for space considerations.

INKEY$
The Color Computer Magazine
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Memory Upgrade

I recently purchased a 16 to 32K upgrade kit from Quasar Animations. It was a Jarb kit and there was a soldering error on the SAM socket. The 33-ohm resistor was soldered to pin 34 instead of pin 35. I realize this was an easy mistake to make because of the close proximity of the pins. However, the instructions did not show which pin was the correct one.

After several hours of hand-wringing, re-installing, head-scratching and magazine-reading, I found a diagram in your magazine which showed the error. After re-connecting the resistor to the proper pin, the kit worked fine.

I would like to thank Dennis Kitsz, who wrote the article on memory upgrades, for this invaluable information.

I have notified Quasar and Jarb of this error.

Gordon Weigleb
Clarksville, IN

System Integration

Your answer (DEFUSR, December, 1983) to J.E. of Gainsville, FL, concerning attaching a non-Radio Shack printer to the Color Computer is probably correct but not complete. If J.E. is using Basic 1.0, his Color Computer lists Basic programs in 7-bit serial ASCII, but Scripsit outputs data in 8-bit ASCII. J.E. may only need to reconfigure his printer for 8-bit data, a drill required on the Radio Shack line printers also. A printer operating with the ROMpak Scripsit should also be set for one stop bit, no parity, and 600 baud.

I recently added a Teletex TTY daisywheel printer to my Color Computer and found it to list Basic programs when set to 7 bits and type Scripsit files when set to 8 bits. Much to my surprise, I also found that it will list Basic programs if set to 8 bits, providing the serial interface switch is off (this function takes the printer off-line when a data transfer error occurs). I haven't tried to figure out why yet.

John Jamieson
Herndon, VA

Rainbow Adventure

Rainbow Adventure is a new computer school and Color Computer resource center. We have had several requests from local school districts who want to hear from other schools using Color Computers.

Being a people oriented computer center (which sells no computers) we also would appreciate hearing from school districts presently using Color Computers.

Mary Jane Spencer, Prop.
Rainbow Adventure
P.O. Box 355
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Shippensburg, PA 17257

Hocus POKEus

There is a very powerful POKE anyone with Extended Basic can use. It will work on 16K, but it may or may not work on 32K. Try this: type POKE 359,13 Enter. Now type SCREEN 1,1. Any graphics mode will work! Be sure not to misspell any of the words. Usually memory location 359 holds 126. The only problem is that the screen won't go back to text unless you type POKE 359,126 or SCREEN 0.

Greg Taylor
Naperville, IL

Bulletin Boards

Michigan BBS

Saginaw, Michigan's Bulletin Board operates Monday through Friday from 4 p.m. to 10 p.m. and Saturday through Sunday from 10 a.m. to 10 p.m. Use 300 baud, eight data bits, one stop bit, no parity and log-on with Enter. Data line is (517)793-1579. For more information contact: Tom Schopp, 4814 Schneider St., Saginaw, MI 48603 or call (517)793-9035.

Indiana BBS

The Department of Aviation Technology at Purdue University, West Lafayette, Indiana, is operating an aviation bulletin board system on weekends and holidays. The system will operate from 5 p.m. Friday until 8 a.m. on Monday, and all day on holidays. The system is operating on a 64K Color Computer, and will be restricted to aviation topics only. It can be accessed by calling (317)743-3897.

Kudos for Kitsz

I just read Mr. Kitsz's article on the Quaver program in the December issue. At the end of the article on Quaver Mr. Kitsz mentions a G.B. from San Jose, CA who thought Mr. Kitsz was something of an egotist.

I don't pretend to know Mr. Kitsz or whether or not he is an egotist. However, I do know that I bought my Color Computer at a time when the support for it was almost nil. It was quite distressing to read other journals and pray for a program devoted to the Color Computer. Did G.B. buy his computer in the early lean days? To me, it does not sound as if he did. I am glad there is a D. Kitsz who takes time to support the Color Computer with monthly articles covering hardware and software. In short, Mr. Kitsz writes timely articles involving timely subjects.

G.B. if you are an expert on Color Computer software or hardware haven't you been keeping your flame under the proverbial bushel basket?

Greg Settle

Recycling

San Pablo Institute, a non-profit public charity, is forming a computer education program for economically disadvantaged children in San Francisco, especially those whose families would otherwise be unable to afford computers and extensive instruction. The club is a free service program of San Pablo Institute offering programming instruction and giving children an opportunity to meet and share ideas with other children interested in computers.

The San Pablo Computer Club is seeking donations of computers and peripherals which will be lent to club members for "hands-on" learning at home. Donations are tax deductible. We pay for shipping.

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INKEY$

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Help for HJL-57

In July, I ordered the HJL-57 keyboard for the Color Computer. I found the keyboard would, in some cases, print double characters. I returned this keyboard to HJL and they replaced it. Two weeks later, the keyboard developed the same problem, and I returned the second keyboard.

A few days later, I got a telephone call from the manufacturer. He told me the "problem" was caused by the F2 function key being locked down.

My thanks go to HJL-57's manufacturer for their prompt follow-up on my problem. Their one year warranty on the keyboard is good news, also.

George K. Terhune
Hoffman Estates, IL

Club Search

I am interested in joining or forming a Color Computer club on Long Island, NY. Anybody with information please contact me at 9 Stalker Lane, E. Setauket, NY or phone me at (516)928-7324.

John Enrigues
E. Setauket, NY

Piracy and Prices

In response to the piracy article in the August 1983 issue of Color Computer, I would like to say that I do not condone software piracy, but I can see why there is so in Color Computer User Groups. Dealers are charging too much for software that can be made rather cheaply. For example, the Game Writer for my Color Computer sells for $89 dollars — while I can buy an Arcade Writer for my IBM PC for $49.95. Dealers are over-charging for Color Computer software while higher quality, less expensive software is being made for other computers. Software pirates sell illegal software copies for much less than dealers are selling legal copies, so everybody benefits, the user saves money on a quality piece of software and the pirate gains money.

I hope dealers lower software prices so everybody benefits: the user saves money, the dealer gains money, and the pirate is gone!

Ethan C. Nobles
Benton, AZ

Line By Line Letters

I recently added a DMP 100 to my system along with a ROMpak Color Scripsit. Scripsit is a good utility but I found it to be cumbersome for simple one page letters where form is not critical. I wrote a simple three line program to serve as a line oriented work processor:

```
 5 X=1 : CLS
10 PRINT X;:LINE INPUT"?";
   A$:PRINT#-2,TAB(10)A$:
   X=X+1:IF X>66 THEN X=1
20 GOTO 10
```

Simply set the paper so the top is under the print head and run the program. Tap Enter a few times to get the first printed line properly spaced and type away. The program counts lines. When you get near the bottom of the sheet (66 lines per page) just tap Enter until the line numbers start again at 1 (which will be the top of the next sheet).

Line length has to be watched, however. Fill the screen line after the prompt and the next full screen line. Watch word length as you near the end of the second screen line. This gives a page line of about 56 characters. If you forget to stop, it will print to the paper's edge and onto the next line.

All keyboard controls work, such as back-spacing to erase and using Shift key and 0 key for upper-and lowercase.

Extended Basic is needed since it uses the LINE INPUT command to indent and punctuate.

George R. Bard
Lawrenceville, GA

Sounds and Colors

Here is a program I wrote for non-Extended Basic computers which uses the RND function to make all sounds and CLS colors.

```
10 A=RND(255)
20 SOUND A,10
30 B=RND(8)
40 CLS(B)
50 GOTO 10
```

Robert Magrino, Jr.
Long Valley, NJ

Stepper

I have a change to suggest for David Jenkins' program Stepper (January, 1984). The program runs fine, but on a 32K Color Computer it takes up almost all memory, leaving only about 8K to use for programs. This is very simple to fix, just change the lines below:

```
90 CLEAR 200, 16326 TO 90 CLEAR
   200, 32711
100 FOR X= 16327 TO 16381 TO
   100 FOR X= 32712 TO 32766
130 POKE 360,63:POKE 361,199
   TO 130 POKE 360,127:POKE
   361,200
```

This patch will work on both programs, the one with the pause and the one with the delay.

Sean M. Hetrick
Littleton, CO

Directory:XXX

I found "Directory:XXX" (January, 1984) by Byron Palmer interesting and useful. One drawback for me was that the program did not recognize Color Scripsit files as such, and

Fix (01,84)

Starship Hercules Fix

Please note there are 2 to 5, not 25, mobile starbases in Starship Hercules which was reviewed in "A Grab-Bag of Reviews" (Jan. 1984, page 29).

Cruncher Fix

William L. Harris, Jr. noticed an error in his assembly language program, "Cruncher" (Jan. 1984). The program was written using extended addressing; when he altered it for position independant code, Line 2830 of the assembly language program was not changed to position independant code. Change Line 2830 from:

```
0178  EF  9F  01AA 02830      STU    [SAVE]
```

to:

```
0178  EF  9D  002E 02830      STU    >[SAVE,PCR]
```

and change Line 560 of the Basic loader from:

```
560  DATA 167, 192, 32, 222, 79, 95, 239, 159, 1, 170
```

to:

```
560  DATA 167, 192, 32, 222, 79, 95, 239, 157, 0, 46
```

Line 540 may also be confusing to someone typing it in. In general, use of the #'(char) option is clearer than using a hexadecimal number for the character, but in this case, it is hard to tell that this line is comparing register A with the space character. Line 540 should therefore read CMPA #$20 instead of CMPA #'(spacebar).

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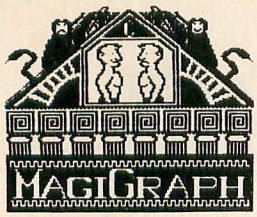

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treated them all as having errors. The following changes will help anyone using Scripsit.

```
190 IF A< > 0 and FT< > 32 and
    N = 0 THEN PRINT #DN,
    "ERROR"
310 IF FT = 32 THEN PRINT #DN,
    "SCRIP";
320 IF FT > 3 and FT < > 32 THEN
    PRINT #DN, "UNKNO";
350 IF GA = 255 OR FT = 32 THEN
    PRINT #DN," GAPS"; ELSE
    PRINT #DN," CONT";
360 IF GA < > 255 and FT < > 32
    THEN 420
```

The only problem I have had with the program is it occasionally misses the end of file for the last file on the tape.

Michael D. Feit
Livermore, CA

Software Dissatisfaction

Regarding your review of "TeeeOfff," (Dec. 1983) may I warn readers that this is undoubtedly one of the most overhyped games on the market. The graphics are average and club selection is limited to three, though over 20 clubs are claimed. The game becomes dull very quickly.

One contributing factor to piracy is that Color Computer users must make costly software decisions based all too often only on manufacturers' "hype." I think we need some more critical reviewing in the media to help combat this and/or a readers' forum in which we can alert each other to exaggerated claims and poor buys.

Unless there's an opportunity to learn more about software from a variety of sources, piracy is bound to increase as people seek to minimize their risk.

Alan Jay Weiss
Summit, NJ

And An Answer

With any game, computer or otherwise, opinions will differ from one person to another. We feel your review of "TeeeOfff" is a fair one. Obviously Mr. Weiss feels the program is not as good as the review indicated; others have told us the review didn't do the game credit.

We exchanged the program for Mr. Weiss several weeks before he wrote you. Also, concerning the clubs, the selection of these is very closely related to joystick operation, and you need good joysticks to make use of all the clubs. For you programming types, the joysticks read from 0 to 63, and only one or two numbers separate the clubs. Cheap or worn joysticks mean fewer clubs available.

Mr. Weiss seems to be saying that piracy if OK because programs are not always as advertised. Auto companies "hype" their products, but that doesn't give me the right to steal cars! At Prickly-Pear we handle the problem of customers not liking what they get by making exchanges; most companies won't because they believe the customer will make a copy before sending the program back.

We are sorry that Mr. Weiss didn't like TeeeOfff, but we

Fix (02,84)

Joystick Fix

In "Atari Joystick Adapter" (page 135) Figure 2 is missing the eighth resistor that should be between pin 4 and connection G.

Utility Fix

In "View Utility" (Feb. 1984, page 120) photos 1 and 3 should read photos 3 and 1. Photos 2B and 4 should also be reversed.

would ask him not to make a matter of taste into an excuse for software theft.

William A. Nolan
Prickly Pear Software

File It

Keith Baker's "File It" is a nice program and has a better screen appearance than many. May I suggest one tiny improvement? Between Line 144 and Line 146 add: 145 IFL$ = CHR$(13)THEN 144. This will prevent skipping the verification screen if you are in a hurry and hit Enter too many times after making entries.

Jim LaLone
Ooltewah, TN

Mix and Match

I recently saw the following ad on Los Angeles' dial-up computerized yellow pages, BUYPHONE:

ROOMMATE WANTED: I am looking for a roommate to share a two bedroom apartment... You also may have partial use of my IBM PC computer...

Maybe it should be recast:

LONELY COMPUTER SEEKS PLAYMATE. Also included, partial use of apartment...

David Lappen

Aw, Shucks...

I would like to praise you on a great magazine. I don't know how you did it, but you've managed to bring together all the great Color Computer authors and talent to produce a high quality magazine. Every article I read, whether it was written by an author I've heard of or an author I've never heard of, is of top-notch quality. As long as there are magazines like yours, the Color Computer won't get pushed out of the market so easily. Keep up the good work.

Gary Hall

Gee, thanks! — Ed.

Clubs

Plaquemine, LA

The Plaquemine Color Computer User's Group invites anyone with TRS-80 Color Computers, Dragons, TDP-100s or MC-10s in Plaquemine or surrounding areas to join us. We put out a bi-monthly newsletter. Dues are $10 for individual membership or $6 for family membership. Meetings are held each second Saturday. Contact us at (504)687-8459 or write to: 919 Charles Drive, Plaquemine, LA 70764.

Ontario

Niagara Regional Color Computer Club (about 80 members) meets every second Sunday in the cafeteria of Confederation High School (670 Tanguay Ave., Welland) between 1 p.m. and 4 p.m. Contact Gerry Chamberland at (416)357-3462, Gilles Prescott at (416)734-3529 or write to: 7707 Jubilee Dr., Niagara Falls, Ontario, Canada L2G 7J3.

Acadiana, LA

The Cajun Color Club, serving the Acadiana, Louisiana area, is open to TRS-80 Color Computers, MC-10, TDP-100, Dragon, and other 6809 users. Meetings will include clinics, demonstrations, reviews, and free software. For more information write: Bob Hoevel, 104 Karen Street, New Iberia, LA 70560 or call (318)365-7706.

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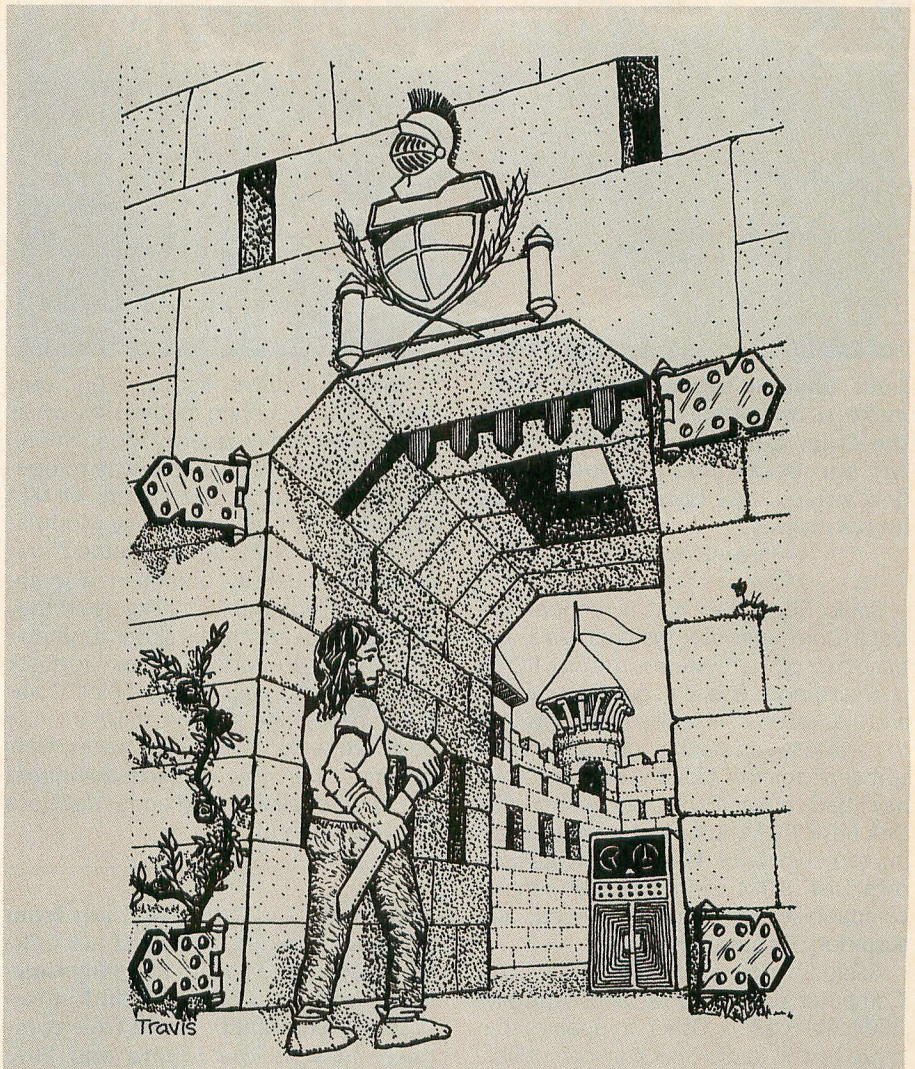


Hmm... so that's the key to success!

by Clinton Lawrence

ARJDAN HAD HEARD OF THE INvasion of his native city while he was living in a distant kingdom, and the news infuriated him. Whatever he had stolen from his fellow Tecforian citizens was nothing more than his living, and though they scorned him, he still loved the city.

He resolved to return to Tecforia, and the tales that the conquerors were nearly invincible demons did not sway his determination. His friends told him that his cause was futile and he would do well to stay away from Tecforia.

"Nonsense," Arjdan replied. "To do so would be cowardice, and I do not feel like a coward today."

They argued that his many Tecforian enemies would kill him sooner than would any invader.

"They would not dare kill their liberator," Arjdan dismissed the suggestion. "More likely they would reward me with a thousand times what I have stolen from them."

His friends, seeing he could not be persuaded to give up his journey, finally wished him well, even though he stole a battle sword from one of them.

When he arrived at the walls of Tecforia, he found the main gate to the city had been torn from its supports, and lay on the ground outside the wall. Appalled at this disgrace, he marched through the open gateway, his sword drawn, ready to slash to tiny pieces the beings who had so defaced his city. But inside the walls, he stopped, and stared at a wondrous sight.

Tecforia had been transformed from a dusty, mundane metropolis that only a native could love, to a polished, shining, glorious landmark. Any respectable thief could make a fortune in the new Tecforia, and the victims, even the poorest, would hardly notice the loss. Arjdan's resolve wilted as he saw merchants singing in the street. He stumbled a few steps forward before a voice called to him.

"Welcome to Tecforia. You are the one thousandth person to enter the city today. Take this coupon to the inn of your choice, and you may obtain free lodging for the night. I hope your stay in Tecforia is a pleasant one."

Arjdan looked around, trying to find the weird voice's source, but could see no one around him.

"If you do not wish to take your coupon, you may donate it to the next traveller who enters the city."

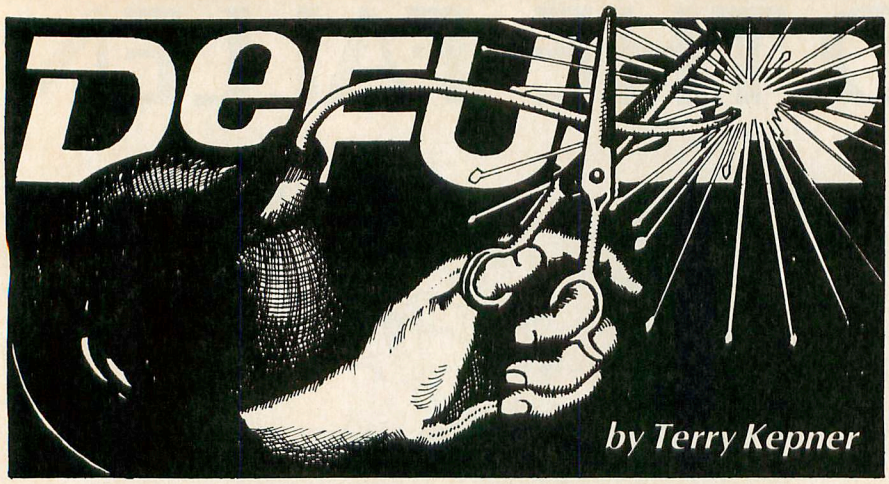
Arjdan then located the source of the voice, a small box to the side of the entrance not ten feet from where he stood, and he noticed a small card protruding from the front of it. Arjdan walked over to it and grabbed the card.

"What sort of demon are you?" he demanded, knowing it must be one of the conquerors. "I expected to see Tecforia ground into rubble, and I find it more prosperous than ever."

"I am one of many computers who now rule the city," it replied. "Rest assured that we are benevolent beings with no desire to destroy. We have made merchants richer through more efficient trade. Don't you agree that Tecforia is now the world's model city?"

Arjdan nodded. "Yes, I may even return to live here. It's a paradise, especially for thieves. But tell me — if you do not destroy, why has the majestic gate of Tecforia been torn from its supports?"

The computer replied, "For trade to operate at maximum strength, we had to find barriers to lower. The peak efficiency could only be achieved if we eliminated all unnecessary gate delays." ■ ■ ■



Does anyone besides Radio Shack make a complete disk package for the Color Computer? What do *density* and *tracks* mean? I want to get disk drives, but don't want to pay lots of money.

—Peter Hoch, Las Vegas, NV

Radio Shack has had a monoply on Color Computer disk systems, since the main part of that system is the disk ROMpak cartridge. Other people now make and market disk controller ROMpaks, but to be totally compatible with all the disk software for the Color Computer they have had to pay royalties on Microsoft's Disk Basic ROM, in order to avoid violating copyright laws. Those who write their own Disk ROM can't get 100 percent compatibility without lots of work and suspicion of outright copying.

Radio Shack's latest price for its Color Computer drive 0 (drive and controller ROMpak) is $399. Other companies that make or sell Radio Shack or compatible equipment include: S & N Enterprises, $374 for drive 0; J & M Systems, Ltd., $449 for drive 0; Micon Enterprises, $389 for drive 0; American Small Business Computers, $399 for drive 0; Compukit, $449 for drive 0; $399 for thinline drive 0. F & D Associates sells a partial disk controller kit for $49.50; additional parts bring the total near $150, without a drive or cable.

A disk is like a phonographic record, only the information is stored using magnetic particles *on* the surface instead of grooves *in* the surface. Unlike a record, which has just one groove that slowly spirals from the outside rim to the inside, a computer disk has concentric rings of data encoded on it. Each of these rings is called a track. Rings are used instead of a steady spiral so you can quickly and accurately move across the disk to find information without having to read the intervening information to keep your place.

When disk drives first came out, they used a data recording method known as MFM (Modified Frequency Modulation). Someone else discovered a way to double the amount of data stored, MMFM (Modified Double Frequency Modulation). Hence the original method was called single density, and the new method was called double density. Now they can also squeeze tracks closer together, so there are 40-track drives and 80-track drives. Stock Radio Shack Color Computer drives and Microsoft Disk Color Basic are set up for only 35 tracks, from the time when no one had quite figured out how to reliably read and write close to the center hub.

Every time I CLOAD anything from my tape recorder, a Radio Shack CCR-81, I lose all the Sound and Play functions, both in a program and in immediate command mode (the computer accepts the Sound and Play commands, but nothing happens when I run them). Reset doesn't help; only turning the computer off and back on restores these functions. I have a 32K Extended Basic 1.1 model. ROMpaks work fine. Any ideas on how I can get things to work correctly?

—Katherine Koundouriotis, Eureka, CA

I assume you mean these commands work when you first turn on the computer, then fail to work after you CLOAD a program. I also assume that commands like AUDIO ON don't seem to help things.

Do you have the Radio Shack Color Computer diagnostic ROMpak (#26-3019, $19.95)? If you don't, get one and use it to check out the ROMs, RAM, and all the other functions of your computer.

What you're checking for is a failure with either the ROMs or the peripheral support chips. When you run a check on the ROMs, the computer will give you a checksum number. Write it down and call a Radio Shack Computer Repair Center and ask the technician if the checksum you've received is good. If it isn't, then your problem is with the Color Basic ROM chip, which will have to be replaced. If the peripheral support chips are bad, one of the other diagnostic tests should point it out.

If the ROMpak says your computer is OK, but the computer still *malfunctions*, you'll have to take it to the repair center and demonstrate the problem to the technician. If you're doing something wrong, he should spot it. If you're not, maybe he can tell you what's wrong, what needs to be done, and how much it'll cost.

Good luck.

In your March 1983 issue I saw an article on upgrading my Color Computer. This article said I only have to add a resistor, cut eight capacitors, move jumpers from their 4K position to their 16/32K position, add a bus wire to another jumper, and replace the original RAMs with 4164 dynamic RAMs to go from 16K to 32K.

In the same issue are advertisements for three kinds of 4164 RAMs: 150ns ceramic; 200ns plastic; and 200ns ceramic. Which type do I use?

Also in that issue is an article for expanding a TDP-100 to 64K. This article says to remove the RFI shield, move three jumpers to the 64K position, install a jumper, and remove eight capacitors. Are the eight capacitors the same as in the 16K to 32K upgrade? What RAM do I need? The procedure was for the TDP-100. Is it the same for the Color Computer?

—Serge Alepins, Quebec, Canada

The 16K to 32K upgrade you mention is essentially identical to the 64K upgrade. The TDP-100 is identical to the latest version of the original Color Computer (not the Color Computer 2). They are referred to interchangeably as the F board and the NC board. For complete information on upgrading any original Color Computer (versions D through NC) to 64K, please read Dennis Kitsz's Custom Color in the October, 1983 issue. (Owners of D boards please note January 1983 FIX.)

As for what RAM chips to use, ceramic chips are thermally more efficient than plastic (they cool better), and 150ns

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chips (ns means nanosecond, one billionth of a second) are faster than 200ns chips. Any of the three will work in any Color Computer, but the faster they can run and the cooler they run the more reliable they are. The choice is yours.

I have a problem with the disk drive I bought. I found that the high speed mode, POKE 65495,0, does not work with my disk drives. Some of my programs require that extra speed. Does anyone have an alternative?

— Sean Hayries, Naples, ME

You don't mention if your machine locks up under high speed with the disks plugged in, or if only disk I/O fails. Here are the two possibilities: lock-ups are caused by an extra large capacitor on the cartridge select line (CTS). This capacitor (C85) is 220pF. With disks attached, the cartridge select takes too long to enable the disk ROMs, and the 6809 receives *no* instructions and locks up. Reduce C85 to 22pF (some people just cut it out) and lock-ups should not occur.

If your computer survives the "vitamin E" POKE, but disk commands fail, nothing is wrong. Neither the disk controller chip nor the software timing routines were designed to function under high speed operation. Either load your software and then turn high speed on, or write your programs to turn high speed off during actual disk I/O.

Please note that high speed operation can increase the temperature of the already hot running SAM chip, leading it to early retirement. Large capacitors on the E and Q clock lines seem to be the biggest contributors to the problem. On D and E revisions they are 56 pF, parts C73 and C75. On F and NC boards they are parts C36 and C37. Moderately reducing these (they shouldn't be cut out) should help beat the heat.

I have a 16K Extended Basic computer. PRINTMEM produces 8487 instead of 14631. How do I get all the computer's memory?

— Don Adamski, Berwyn, IL

The difference between what you expected and what you received in response to PRINTMEM is due to the automatic setup of four graphics pages in memory by Extended Basic. Each of these pages takes up 1536 bytes, so an appreciable amount of space is used.

When you first turn the computer on, type PCLEAR1:?MEM. The response should be 13095. The PCLEAR command has reduced the number of graphics pages from four to one. Unfortunately, you can't use zero as an argument for the PCLEAR command, so you can't eliminate the last graphics page with it to get the maximum RAM (13095+1536=14631).

To get rid of the last page, type POKE25,6:NEW. Then type ?MEM. The response should be 14631, giving you all the RAM available to your computer, except that required by the operating system.

If you decide to use the graphics pages later, just use the PCLEAR command and reserve the appropriate number of pages. If you want to go back to maximum memory size, you have to wipe out the current program in memory. Using the POKE without the New command won't do the job properly.

If you read the recent review of available home computers in *Consumer*

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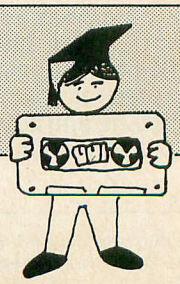

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***Reports*, you must be pleased that they rated the Color Computer very high on the list of computers to be used by hobbyists.**

They didn't recommend the Color Computer for "serious" word processing, however, because of the limitations inherent in using a color TV instead of a monitor.

Is there any way to improve the quality of output? Are there any monitors which can be used with the Color Computer?

Consumer's Union also suggested that it wasn't worthwhile to buy a DOS for the same reason. I have yet to take the plunge into disk drives and would appreciate some advice. Any comments?

—Jeffrey Sneider, Syracuse, NY

Yes, you can improve the quality of output, but you have to get a standard video monitor and a hardware kit for connecting it to the Color Computer. Computerware (P.O. Box 668, Encinitas, CA 92024, (619)436-3512) sells one such device, VideoPlus, for $24.95. No soldering is needed. All you need do is supply the monitor. Green Mountain Micro (Roxbury, VT 05669, (802)485-6112) has the TV Buff for $15. PBJ, Inc. (911 Columbia Ave., North Bergen, NJ 07047 (201)330-1398) sells The Word-Pak, an 80 column video board for the ROM slot and monitor, for $139.95 including software. Check ads for other suppliers. I've seen black and white video monitors for as little as $99. For more information on video monitors, refer to the October 1983 issue of **Consumer Reports.**

Another alternative, although less satisfactory, is to buy a new color TV. The newer models are better designed, with higher bandwidths which give better character definition (monitors have even higher bandwidths, which is why they are superior to standard televisions). A cheaper solution is a TV interference filter, such as Radio Shack's #26-3019, $1.99, and others.

Most of the problem is the Motorola video control circuitry. The dot width of the Color Computer screen is 256 dots. If you divide this by 32 you get eight dots across per character. If you want more characters per line, the dots per character decreases, which makes it more difficult to clearly define the character. With 64 columns on the screen, you have only four dots per character. Considering that most dot matrix printers use 7 by 9 fields for their characters, and people complain that the characters are hard to read, you can see the problem with characters that are only four dots wide.

If fuzziness is the problem and you want the best display possible, buy a monitor and the hardware kit needed to patch it to the Color Computer.

As for disk drives, remember that the Consumer Union articles were for people who haven't yet purchased a computer. They suggested that if you were going to get a complete disk-based system for word processing, you could probably find a better buy, such as a single-disk Model 4. Since you already own a Color Computer, you've already made a sizeable investment of money in both hardware and software. To switch to a new computer, rather than add drives to your existing system, would be hard to justify unless you knew the advantages of the new system would completely offset the money already spent on your Color Computer. ■ ■ ■

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GOTO SCHOOL

by Dr. Paul Kimmelman

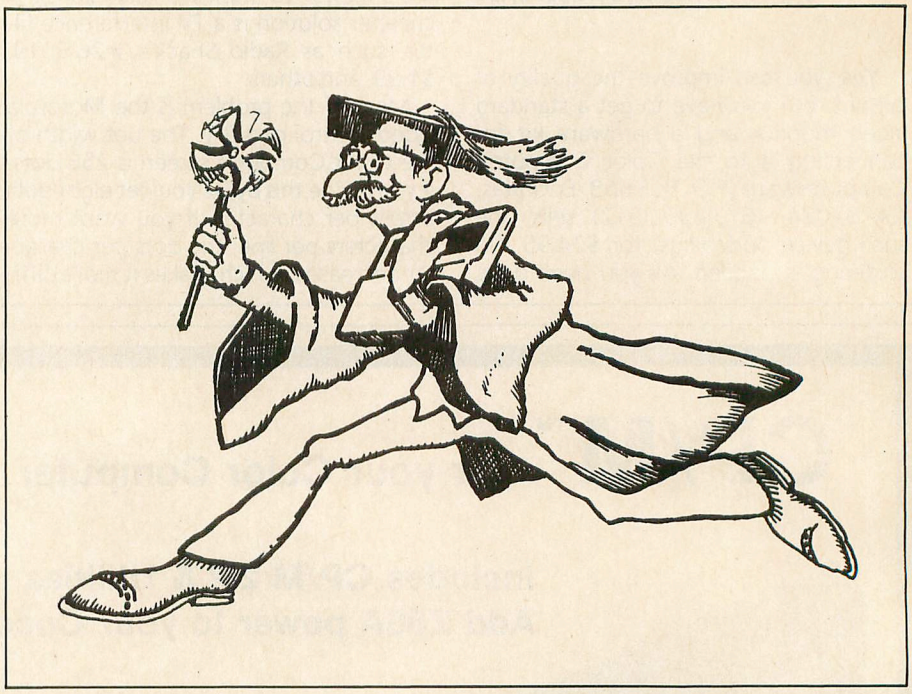
IMAGINE ATTENDING COLLEGE at any time of day or night without leaving your home or office. Consider what possibilities having a private instructor would open. Individualized instruction — you bet! This educational scenario is now becoming a reality through TeleLearning Electronic University. You need only push a button on your microcomputer keyboard to be in direct communication with your professor. Once contact is established, according to TeleLearning officials, student/instructor learning interaction will be nearly the same as that which occurs in the traditional classroom.

TeleLearning is just the beginning of computerized education techniques that may revolutionize home and school education. TeleLearning plans to become an "electronic university," offering nearly 170 courses. To access TeleLearning, the student must purchase a "knowledge package" consisting of a course catalog and the computer program that will link the user's computer with the company's network of teachers. The price of the "knowledge package" will vary from $100 to $230. After the initial package purchase, the computer user may sign up for courses which could cost anywhere from $35 to $150 per hour; the price will depend on how well-known your professor is. The courses will include topics such as classical musical writing and Lamaze Birth Techniques.

The course fee will cover telephone and network transmission charges as well as the electronic lectures. The student will receive the text of lectures and graphics to accompany them, transmitted from the teacher. It will even be possible to print each screen of information.

The program is interactive. Students can stop transmission of a lecture to type questions to the teacher, who in turn will immediately type a response if arrangements were made for this beforehand.

TeleLearning Electronic University is divided into three categories: elementary education, adult education, and accredited programs. The elementary program is for gifted children or children needing private tutorial assistance. It will also include subjects not traditionally taught in the elementary school, like space exploration or individual tutorial lessons.



French, Scriptwriting, Geology, Accounting, Computers and just about any conceivable topic could become the curriculum for adults. Each subject could be individually tailored to meet the student's needs.

Finally, the accredited program is for those studying for a degree or certificate. Instead of a traditional mail correspondence course, it would be possible to use *electronic mail* to complete the school's requirements.

Where could electronic classes lead us? Certainly it will change the traditional concept of education. Perhaps students some day will not have to go to school, but instead could stay home and use home computers to get education.

What are some of the implications of electronic text and learning? An exploratory study was written in 1982 at Stanford University. The report was a comprehensive study which investigated children and electronic text and the challenges and opportunities offered by this new literacy.

The study dealt with teletext, videotext, and interactive cable television. There are distinguishing characteristics between teletext and videotext. *Videotext* refers to electronic text transmitted via cable or telephone. Typically, videotext is received on an ordinary television set equipped with a decoder and requires a request channel from the user back to the distribution site. *Teletext*, on the other hand, captures a signal that is being broadcast generally, and doesn't allow for interactive use like videotext.

more

An Important Bulletin for Home Computer Users

This is the only programming system you'll ever need for your home computer.

If you own a small home computer, the story we're about to tell you could be of great help. It's about a revolutionary new software programming system that will let you and your entire family take full advantage of that machine you bought. But first things first, so here's a list of the home computers this product was specifically designed for: Atari 400, 600, 800, XL Series; Commodore Pet, VIC 20 and 64; IBM PCjr; TRS-80 color computer; TI-99/4A and the Timex Sinclair 1000, 2048 and 2068. If you own one of these computers, it would be well worth your time to read further.

THE PROBLEM WITH HOME COMPUTERS

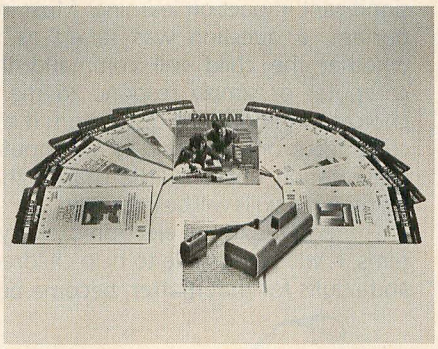
As you probably know, the problem with these small computers is how to get good software into them. Keyboard entry is too time consuming. Diskettes do the job well, but the loaders are expensive and so are the diskettes. Cassette loading is less expensive, but the cassettes themselves still aren't cheap and sometimes a program has to be read again and again before it actually is entered. Furthermore, few of these software manufacturers guarantee their product to run at all.

So unfortunately, a lot of these potentially useful computers are relegated to just game-playing or, even worse, they find their way onto a closet shelf somewhere behind the bowling ball or last year's magazines.

THE SOLUTION IS DATABAR SOFTWARE

Now, thanks to the engineers at Databar Corporation, you can bring your computer back to life. They have developed OSCAR—which stands for an Optical Scanning Reader. What it does is read a bar code program in much the same manner as your local supermarket reads the bar code information on your grocery products. OSCAR plugs directly into your computer, and can read even complex programs extremely fast. In fact, in a recent time test it took a graduate computer programmer 1 hour, 9 minutes and 43 seconds to successfully type-in a program. To enter that same program, it took an eight-year-old child with no computer experience only eight minutes and 17 seconds.

With OSCAR, programming is also inexpensive. The bar code programs read by OSCAR are printed on paper, making the programs inherently a lot less costly to produce than cassette tapes or diskettes. And because the programs cost less to produce, they can be sold to you for significantly less.



But, just because they cost less doesn't mean they aren't of the highest quality. In fact, they are so good and reliable, we are almost alone among software manufacturers to guarantee our product to run as advertised.

Databar Corporation has already developed an extensive library of programs ranging in subject matter from non-violent games to science, health, home management, writing skills and more. These programs are readily available at your local computer store and they retail for under $10

THE DATABAR CLUB

But amazingly, you can get great software programs for an unbelievable $1.25 each—if you choose to join the Databar Club. Every charter member gets 12 monthly issues of the Databar magazine each featuring at least eight great programs. In addition, this family oriented magazine also features articles on related subjects and computer use in general. The subjects covered by the software include: games, home management, classroom learning, health, law, science, writing skills, and computer programming. What's more, Databar Club members get a three-ring binder for their software programs as well as eligibility for exciting contests.

But whether you join the Databar Club or purchase individual program packages from your favorite retailer—OSCAR can dramatically change the amount and quality of the use you get out of your computer. And let's face it: in the not so distant future much of an individual's competence will be tied up in how well he or she interfaces with a computer.

This trial offer includes OSCAR plus the premier issue of Databar magazine. OSCAR is backed by a full 1-year warranty and if you aren't 100% satisfied with OSCAR, then you can return the unit within 30 days for a full refund.

To order, credit card holders call toll free and ask for OSCAR, or send a check plus $1.50 for shipping and handling for each unit ordered.

OSCAR with the premier issue of Databar magazine can be yours for only $79.95. And the premier edition of Databar magazine provides all details necessary for joining the Databar Club. So send for your OSCAR today—and take full advantage of your computer tomorrow.

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The study attempted to look at two main ideas: the behavioral issues in children's use of electronic text systems, and a features analysis of the differences between electronic text systems and how they may affect children's use of and learning from the systems.

The report concluded with questions for future research: who learns what from which electronic text system, and with what effects on other learning and behavior? The remainder of this article will attempt to summarize the highlights of the Stanford study. This study is particularly important to educators because of the need to explore the relationship of "literacy" to educational technology.

It isn't difficult to look back to when educational television was introduced with the claims that it would help all children be able to learn easier and better. It didn't work; so much for unsupported claims. Now we are hearing similar claims for the use of databases and electronic text. Unlike television, however, the use of electronic text requires the user to *be* literate. Reading a menu, the instructions, and text presumes a certain degree of reading ability. Perhaps reading electronic text will be a motivator to help children become better readers.

One thing is certain, however: those who are better readers will continue to read and those who do not have access to this technology and can't read well will continue to fall further behind.

The study looked at activities in progress. One 13 year old girl used the videotext terminal at home to read weekly features on careers. The career features included addresses where more information could be obtained, letting her supplement her interest.

In another city a 12 year old girl used the video encyclopedia to help with homework assignments. Her work "amazed" her teacher.

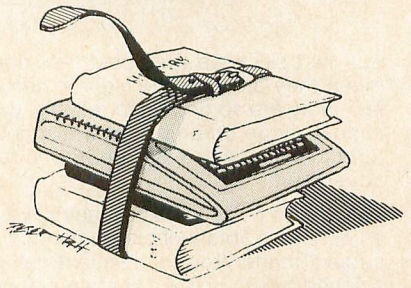
Finally, fifth, sixth and seventh graders were taken by subway to a major university several times a week to use word processors. The researchers wanted to know whether computer-based systems can improve children's writing skills and encourage a positive attitude toward writing and composition. The assignments were simple: a letter to a friend, short story, or a brief description of themselves.

What the researchers found shouldn't surprise you. The children spent longer amounts of time working on their assignments than their pencil and paper counterparts. It appears that the students found the assignment interesting and, therefore, their attention span lengthened, allowing them to work longer.

Further, and also a positive influence, was the fact that the students shared their work with their peers. It wasn't unusual to observe them exchanging drafts of their projects and listening to suggestions made by their friends.

The study was careful to point out that the differences among computer systems (hardware and software) will have a significant impact on learning. Most important, a question was raised as to whether the child will command the computer or simply respond to menu choices, an important distinction. If the child needs only respond to a computer presentation, there is little chance that his thinking skills will be improved.

Through the use of electronic text systems, it will be possible to help children, and adults for that matter, become better thinkers. This process, called *cognitive development,* can be used with certain computer applications to help learners assimilate and analyze information, discover the processes of thinking, and acquire strategies for problem-solving.



Seymour Papert, developer of Logo, noted that children could use a computer to become better thinkers earlier than psychologists had believed possible. Thus Logo was developed, a program that utilizes thinking skills and structure. As of this writing it may be too early to prove Papert's claim, but certainly casual observation of children working with Logo has indicated the results are positive. Very young children have shown the ability to write simple programs that create designs, like a square, circle and triangle.

The features of videotext need to be considered when it is used for learning. If the rate of presentation of material is too slow, it may discourage older students. While young children just learning to read will need a long display time, fast readers tend to become bored with the slower rate. Scrolling is important, but only if an interrupt key is present so the child may stop the display for as long as necessary to read the text.

Character resolution, the quality of the text on your screen, was the second-most important feature of displays. While hard to believe, the researchers found some character resolution system's quality poorer than teletype characters of fifty years ago.

When uppercase characters only are used in displayed text, principles of capitalization are not reinforced. Being able to distinguish between a proper noun and common noun becomes the responsibility of the student, and *this is almost* impossible for *young learners*. Conversely, the absence of lowercase letters can be confusing to early learners who are trying to make the distinction between upper- and lowercase letters.

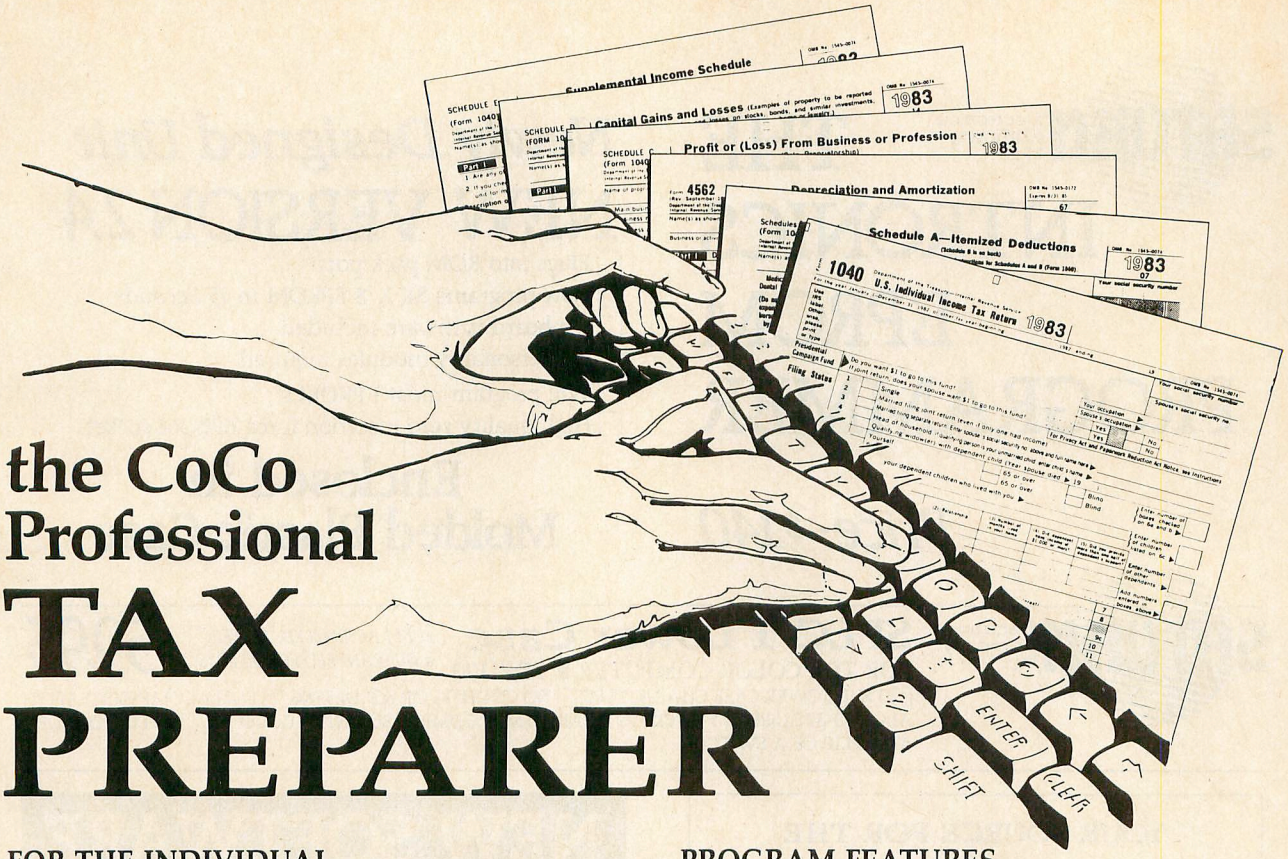
The consensus of research findings over many years was that color, while it may be an important motivator, has little effect over black and white on cognitive learning. Music and sound effects were found to be an attractive accompaniment to the program.

Finally, being able to keep the programs running is essential. Complex procedures will not encourage students to work with the system, and programs need to be "crashproof" when working with young children. Some suggestions included blocking out the Break, Reset, or control keys.

The Stanford research team found that children were willing to try harder to read electronic text than printed text. While no conclusions as to why children preferred electronic text were offered, the team noted that the children liked to call up and read newspaper-like files from a videotext system.

It was also discovered that electronic mail use was a strong motivator for children. Children's willingness to compose electronic messages was only superseded by their willingness to read messages sent by others. Since this activity requires both reading and composition, it further justifies the use of the database in education.

This study is only the beginning of research on electronic text and education. The questions it answers only give rise to new issues. At what grade level should electronic text be used, how, and for what subjects? Should this concept be used to supplement instruction or introduce new information? What implications, if any, will arise over the long term from the use of electronic text for education? These questions and others will only become more important as the use and number of databases with educational purposes grows. ■ ■ ■



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MORE Summer Programming Project WINNERS

illustration by Rod McCormick

64K Disk Basic

BUGS, BY ROLAND Knight and David Shewchun, is the Grand Prize Winner in the assembly language category of the Summer Programming Project. Bugs is a fast-paced maze game with many move possibilities.

The Program Listings for Bugs are unfortunately much too long to publish in the magazine. Send a note to "Bugs," **The Color Computer Magazine**, Highland Mill, Camden, ME 04843, and include your name and address, and we will send you the listings.

For your convenience, the loading and running instructions for typed-in listings follow the game description and operating instructions.

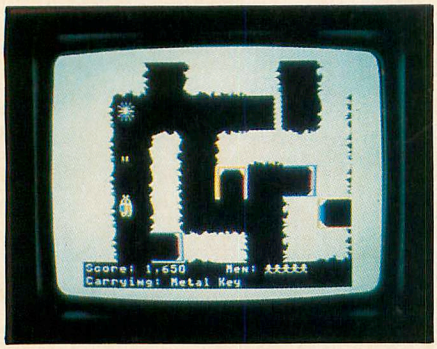
The Story

The time is far in the future. The space shuttle is a thing of the past, long outdated. Space travel is now common. The human race has spread throughout the galaxy.

Around the year 2198 AD, a small, backward little planet was discovered. This planet is inhabited by a race of funny little creatures known as Fesgegs. Fesgegs feed on iron found in the core of their planet. They live underground in miles of tunnels they created for the sole purpose of mining their iron. For transportation in these tunnels they use small "cars" that resemble bugs.

The human race considered this race of creatures and their planet to be backward and of no threat to anyone. Several

years later a startling discovery was made: the backward Fesgegs had discovered the nuclear bomb. Man suddenly considered the race to be a threat. At first an attempt to form an alliance was made. This failed because the Fesgegs consider the human race to be intruders. In fact, they planned to test their newly discovered bomb by attacking several human space stations in the vicinity of their planet.



Bugs In Progress

This is the point in the story where you come in. You have been sent to the Fesgegs' planet to destroy the bomb and save the human race! As is always the way, your mission will not be easy. But give it a try anyway, please.

Operation

This game is a little complicated, and it is difficult to describe how it works. We recommend that you play the game as you read these instructions.

When the program first starts, there is a brief introduction consisting of a short graphic animation. Press Enter to begin playing. The screen will clear and the playing field will be displayed.

You control the small bug that starts in the upper left hand corner. Movement is controlled with the four arrow keys. Your terrain is the mining tunnels of the Fesgegs. Although you can run into walls without harming yourself, touching any Fesgeg or a Fesgeg's bullet results in the loss of one man. The bottom of the screen displays the number of men you have left, your score and the objects you are currently carrying.

Objects are very important in Bugs. Objects can be obtained in object squares (see below). To fire, press the space bar. You have limited rapid fire capabilities, allowing up to four of your bullets to be on the screen at any one time. You will notice that many tunnels run off the edge of the screen. Moving off the screen by means of these tunnels results in the screen clearing and a new section of terrain is displayed.

Your screen is actually a window displaying only a small section of a large maze of tunnels. There are several special areas you must know about to play Bugs. These areas are referred to as squares (of which there are several types).

Bug Creator Squares: All enemy bugs originate from these squares, so stay clear of them if at all possible!

Object Squares: Once you are fully in this square you can exchange the object you are currently carrying with the one in the square, by pressing Enter. The object in the square is not displayed, so you must pick it up to see what it is. Pressing Enter a second time will again exchange the object you are carrying with the one in the square.

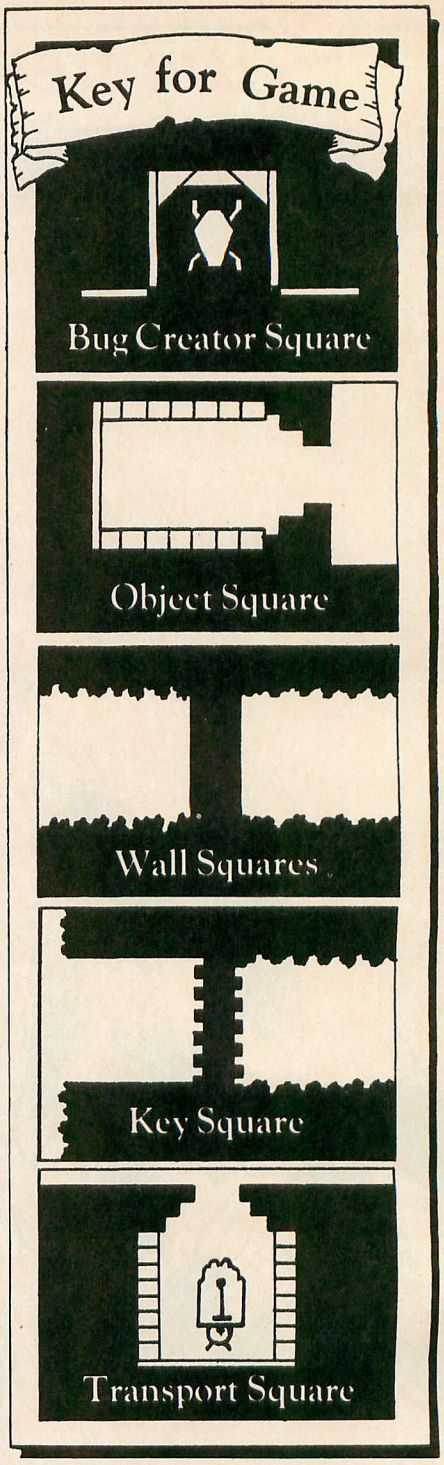
Wall Squares: These walls include a colored wall running down their centers. This wall blocks your passage but can be destroyed by a missile. Missiles can be obtained from object squares. To fire a missile, face the wall you wish to destroy and press F. Note that missiles only destroy colored walls. Once a missile is fired it is gone forever (or at least until you start a new game).

Key Squares: These squares also contain a wall blocking your passage. To remove these walls you must be carrying a key. There are many keys in the game, all of which can be obtained from object squares. To remove the wall, move up against the wall and press Clear. If you are carrying the proper key the wall will disappear.

Transport Squares: These squares transport you to a different section of the Fesgegs' mine shafts. You may or may not be transported off the screen. To transport, enter the square and press T.

Special Areas: There are two special areas in Bugs. At one point in the maze a wall crushes your bug out of existence. In another area a slippery section of tunnel sends you smashing into a wall (in this case you lose a man). Both these traps can be deactivated by the use of objects.

Your ultimate goal is to destroy the Fesgegs' bomb, but to do this you must first find it. Once you have done so, you must obtain the long range missile. This is operated as normal missiles are, except it destroys only the bomb. To use it, carefully aim yourself at the hole in the side of the reactor and press F. If your aim is



Control Keys
Arrow keys: Movement of your bug ship
Enter: Used to get objects in object squares
Clear: Used with a key to open key squares
T: Used in a transport square to transport to a new area
Space bar: Fires a bullet from your bug ship

Scoring
Small white bug: 100 points
Spider bug: 300 points
Star bug: 250 points
Up down bug: 150 points

good you will destroy the bomb and gain 10000 bonus points. Unfortunately, after you do this the Fesgegs quickly build a new reactor and the whole thing starts over!

For your convenience, pressing Clear instead of Enter at the introduction page will put the game in practice mode. In this mode you cannot be destroyed. To exit practice mode press the Reset button.

The following are instructions on how to type in and run Bugs. *Note*: To type in Bugs you will need two blank disks. In these instructions they will be referred to as disk 1 and disk 2. When saving programs typed *in use* the name given in the first line of the program.

1. If you are unsure whether or not your computer has 64K RAM then type in and run 64KTEST/BAS. This will tell you if you have 64K RAM or not.

2. Type in COMPILE/BAS and save on disk 1.

3. Leaving COMPILE/BAS in memory type in BUGDATA/BAS and save on disk 1. Then type RUN. This will create Bugdata/BIN and will point out any errors in the typing.

4. Type DEL990–.

5. Repeat steps 3 and 4 for WALL DATA/BAS, MAZEDATA/BAS, TRANDATA/BAS, TITLEPAG/BAS, and CHRSET/BAS.

6. Type BG1/ASM into Editor Assembler (Radio Shack Editor Assembler was used) and save the source code on disk 2. Assemble BG1/ASM on disk 1 using the name BG1/BIN.

7. Repeat step 6 for BG2/ASM, BG3 ASM, BG4/ASM, and BUGS3/ASM.

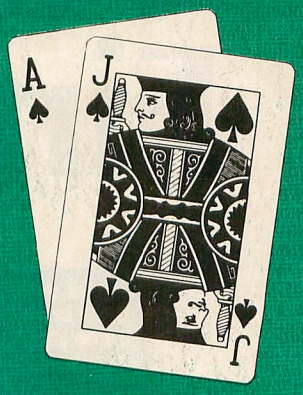
8. Type in CHECK/BAS and save on disk 1. Then type RUN. This will verify the assembly language part of Bugs and will point out errors and tell you where they are.

9. Copy BUGS3/BIN onto disk 2 from disk 1.

10. Type in MERGE/BAS and MERGE2/BAS and save on disk 1. Run MERGE/BAS, and when prompted by the program insert disk 2 in drive 0 and press Enter.

11. Turn the computer off and then on. Type in BUGS/BAS and BUGS2/BAS and save on disk 2. To run Bugs type RUN"BUGS".

B L A C K J A C K P R O



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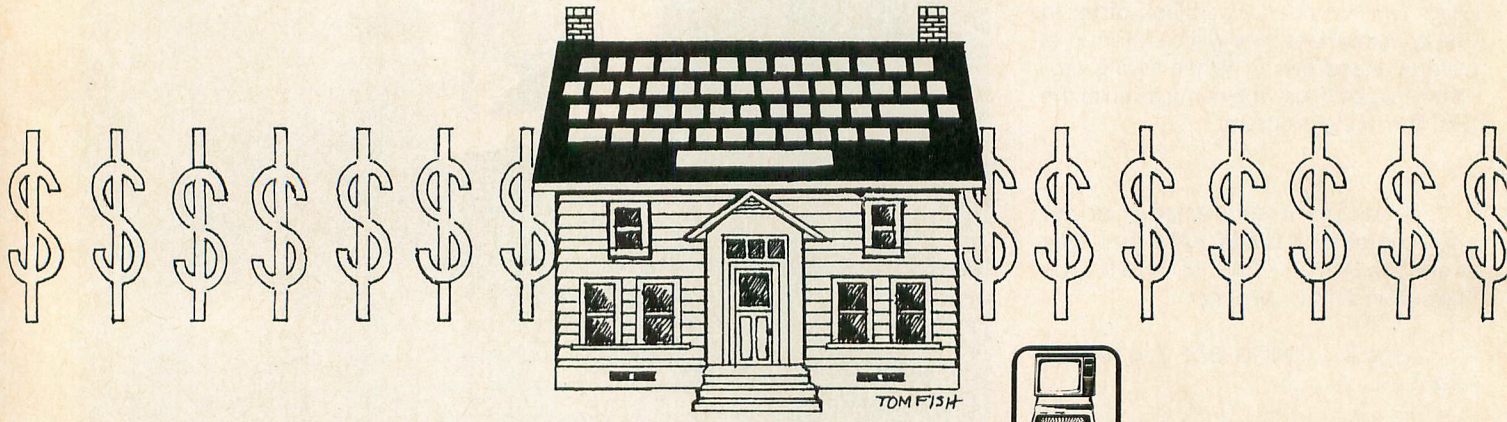
Home Finance



16K Color Basic

by Daniel Jamet

MANY COMMERCIAL home finance programs are on the market, available to Color Computer owners. If you have considered purchasing one, you probably found them written to encompass many types of home finance. You may never use some of the commercial program features and some may not fit your budgeting as well as you would like.

I offer the following program as a solution to this problem, with detailed explanations of each routine. You can customize the program to match your individual financial picture and make improvements if you choose. To do this you need a familiarity with Color Computer Basic.

This program consists of five routines. The first calculates monthly income, the second considers fixed expenses, the third considers variable expenses, and the fourth displays the financial statement. The fifth routine prints the financial statement and can be omitted if you do not have a printer. When I first wrote this program I did not have a printer and I added the printing routine later when I purchased the Radio Shack DPM-200 printer.

Using the Program

The first routine computes total monthly income. Enter what's left of your salary after taxes and also enter the number of pay periods for the month because they vary from person to person.

```
*******VARIABLE EXPENCES*******
GROCERIES      =    $85.00
ELECTRIC BILL  =    $45.00
GAS BILL       =    $12.00
WATER BILL     =    $10.00
TELEPHONE BILL=     $34.00
HEALTH COST    =    $53.00
CLOTHING COST  =    $26.00
CHARGE CARD    =   $153.00
ADDITIONAL EXPENSES
=$ 0

PRESS H AND <ENTER> TO CONTINUE
?
```

Variable Expenses Screen

```
YOUR VARIABLE EXPENSE TOTAL
$ 418
THIS MONTH'S EXPENSES TOTAL
$ 418
WHEN YOUR EXPENSES ARE SUBSTRAC
-TED FROM YOUR INCOME, THE
AMOUNT REMAINING IS: $ 607
ANY FUNDS TO SAVINGS? YES OR NO.

?
```

Financial Statement Screen

The program then asks if you have any additional income. If yes, enter the amount.

The second routine computes total monthly fixed expenses. Since these expenses are for the most part constant from month to month, they are entered directly into the program so they won't have to be keyed in every month. You will need to substitute the names and amounts of your fixed expenses for the sample I used. If you need more fixed expenses you can add more lines, but make sure to also increase the summation line, Line 500. For example, if you have boat payments add the following lines:

```
401 REM BOAT PAYMENT = $000.00,
402 LET F = 000,00
```

and change Line 500 to

```
500 LET FX = A + B + C + D + E + F
```

The third routine is for the variable expenses. Again, change the names of these expenses to reflect your specific needs. A routine for additional unplanned expenses is provided. If you use it you will be asked to enter the description of the expense and the amount. Now the total variable expense, the total monthly expense and remaining income are displayed, and you are asked if you want to enter any funds to savings. If so, enter the amount and your new ready cash total will be displayed. The program contains a deficit routine that, when your

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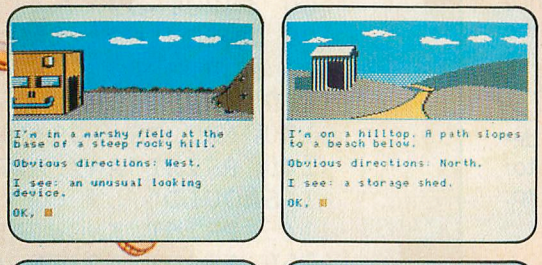

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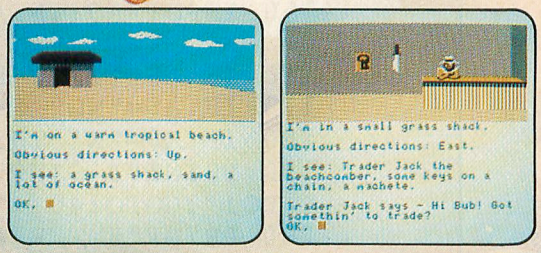

Actual photographs taken from Calixto Island screen.

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expenses are greater than your total income, will give you the choice to withdraw from your savings, borrow from a source of credit, or reduce your variable expenses.

The fourth routine displays the balance sheet showing the result of all calculations. You will need to change the names of the expenses in the Print statements to match any modifications you have made in the fixed and variable expenses routines.

The fifth routine prints the balance sheet. Again, you will have to change the Print statements to agree with the changes you have made. This routine can be deleted if you do not have a printer. To do so, delete Lines 3000 to 3210, delete Line 2550, change Line 2555 to: PRINT"(4)QUIT", and change Line 2580 to: ON Z GOTO 1000, 10, 1900, 2590.

Line by Line

5–220 calculates monthly income.
300–500 considers fixed expenses.
505–2050 considers variable expenses.
2055–2600 displays balance sheet.
3000–3210 prints hard copy of balance sheet. ■ ■ ■

Program Listing. Home Finance

```
5 CLS
10 PRINT@4,"-HOME FINANCE ANALYS
IS-"
20 PRINT:PRINT:PRINT
50 PRINT"INPUT SALARY:";
60 INPUT DS
90 PRINT"HOW MANY PAY PERIODS TH
IS MONTH?"
100 INPUT DP
130 LET TS=(DS*DP)
140 PRINT"ANY ADDITIONAL INCOME
I SHOULD"
145 PRINT"KNOW ABOUT?"
150 INPUT A$:IF A$="YES" THEN 20
0
160 IF A$="Y" THEN 200
170 IF A$="NO" THEN 300
180 IF A$="N" THEN 300
190 PRINT"A SIMPLE YES OR NO WIL
L DO!":GOTO140
200 PRINT"ENTER ADDITIONAL AMOUN
T OF"
```


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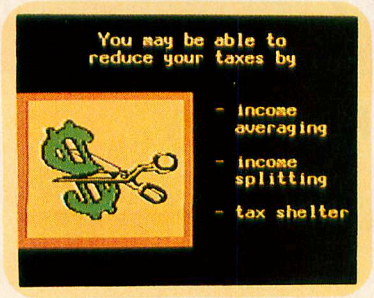

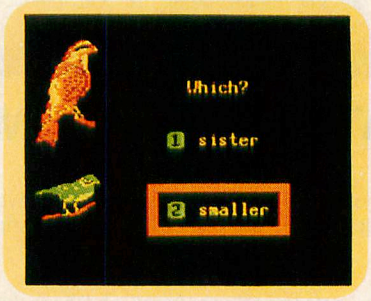

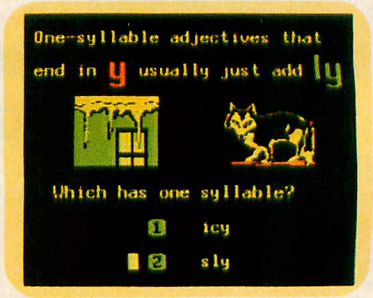

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```
205 PRINT"INCOME."
210 INPUT AS
220 LET TS=TS+AS
300 REM FIXED EXPENSE CALCULATIO
NS
310 REM MORGAGE=$000.00
320 LET A=000.00
330 REM ALLOWANCE=$000.00
340 LET B=000.00
350 REM CAR PAYMENT=$000.00
360 LET C=000.00
370 REM CAR INSURANCE=$000.00
380 LET D=000.00
390 REM LIFE INSURANCE=$000.00
400 LET E=000.00
500 LET FX=A+B+C+D+E
505 CLS
600 PRINT:PRINT
610 PRINT"I WILL NEED INFORMATIO
N"
620 PRINT"REGARDING THIS MONTH'S
 VARIABLE"
625 PRINT"EXPENSES."
630 PRINT:PRINT"GROCERIES COST?"

640 INPUT M
650 PRINT"ELECTRIC BILL?"
660 INPUT N
670 PRINT"GAS BILL?"
680 INPUT P
690 PRINT"WATER BILL?"
700 INPUT Q
701 PRINT"TELEPHONE BILL?"
705 INPUT U
710 PRINT"HEALTH COST?"
720 INPUT R
730 PRINT"CLOTHING COST?"
740 INPUT S
750 PRINT"CHARGE CARD BILL?"
760 INPUT T
770 PRINT"ANY ADDITIONAL EXPENSE
S? YES OR NO."
780 INPUT B$:IF B$="YES" THEN 83
0
790 IF B$="Y" THEN 830
800 IF B$="NO" THEN 1000
810 IF B$="N" THEN 1000
820 PRINT"A SIMPLE YES OR NO WIL
L DO!":GOTO 780
830 PRINT"PLEASE DESCRIBE THE AD
DITIONAL"
```

more

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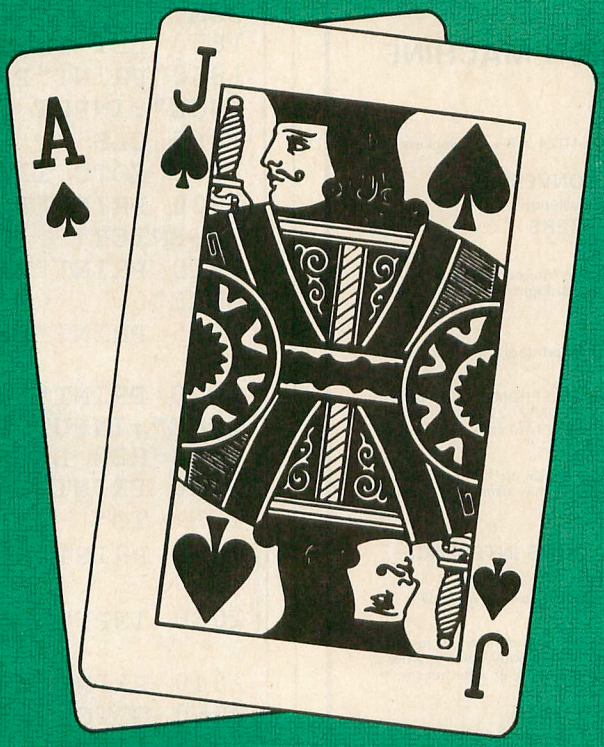
```
840 PRINT"EXPENSE IN TWENTY CHAR
ACTERS"
845 PRINT"OR LESS."
850 INPUT AX$
860 PRINT"PLEASE ENTER THE AMOUN
T"
870 PRINT"OF THE ADDITIONAL EXPE
NSE."
880 INPUT AX
1000 LET VX=M+N+P+Q+R+S+T+U+V+AX

1110 PRINT"PRESS <ENTER> TO COUN
TINUE":INPUT Z$
1115 CLS
1120 PRINT"YOUR VARIABLE EXPENSE
 TOTAL":PRINT "$";VX
1130 PRINT"THIS MONTH'S EXPENSES
 TOTAL":PRINT"$";(VX+FX)
1140 PRINT"WHEN YOUR EXPENSES AR
E SUBSTRAC"
1150 PRINT"-TED FROM YOUR INCOME
, THE"
1155 PRINT"AMOUNT REMAINING IS:
$";(TS-(VX+FX))
1160 IF (TS-(VX+FX))<0 THEN 1400
1170 PRINT"ANY FUNDS TO SAVINGS?
 YES OR NO."
1180 INPUT C$:IF C$="YES" THEN 1
230
1190 IF C$="Y" THEN 1230
1200 IF C$="NO" THEN 2000
1210 IF C$="N" THEN 2000
1220 PRINT"A SIMPLE YES OR NO WI
LL DO!":GOTO 1170
1230 PRINT"ENTER AMOUNT DESIRED.
"
1240 INPUT SV:IF (TS-(VX+FX+SV))
<0 THEN 1600
1250 PRINT"PRESS <ENTER> TO CONT
INUE":INPUT Z$
1255 CLS
1260 PRINT"WHEN SAVINGS ARE DEDU
CTED FROM"
1270 PRINT"YOUR READY CASH, YOUR
 NEW READY"
1275 PRINT"CASH REMAINING IS: ";
(TS-(VX+FX+SV))
1280 LET RC=(TS-(VX+FX+SV)):GOTO
 2000
1400 PRINT"PRESS <ENTER> TO CONT
INUE":INPUT Z$
1405 CLS
1410 PRINT"WARNING! CALCULATIONS
 SHOW A"
1420 PRINT"DEFICIT IN THIS MONTH
'S FINANCES"
1430 PRINT"CHOOSE AN OPTION FROM
 THE MENU"
1435 PRINT"BELOW."
1440 PRINT:PRINT"(1)WITHDRAW FRO
M SAVINGS"
1450 PRINT"(2)BORROW FROM SOURCE
 OF CREDIT"
1460 PRINT"(3)REDUCE FLEXIBLE EX
PENSES"
1470 PRINT:PRINT"ENTER CHOICE NU
MBER."
1480 INPUT CN
1490 ON CN GOTO1700,1800,1900
1600 PRINT"SAVINGS AMOUNT HAS CR
EATED A"
1610 PRINT"DEFICIT. PLEASE REFIG
URE SAVINGS"
1620 LET SV=0 : GOTO 1170
1700 PRINT"ENTER AMOUNT FROM SAV
INGS"
1710 INPUT SN
1715 CLS
1720 PRINT"THIS AMOUNT WILL NOW
BE ADDED"
1730 PRINT"TO YOUR INCOME, AND A
 NEW"
1735 PRINT"READY-CASH BALANCE SH
OWN."
1740 LET TS=TS+SN
1750 PRINT"PRESS <ENTER> TO CONT
INUE":INPUT Z$
1755 CLS
1760 GOTO1140
1800 PRINT"ENTER AMOUNT BORROWED
."
1810 PRINT"ALL LOANS WILL IMPACT
"
1815 PRINT"EXPENSES."
1820 INPUT BN
1825 CLS
1830 PRINT"THIS AMOUNT WILL NOW
BE ADDED"
1840 PRINT"TO YOUR INCOME, AND A
 NEW"
```

more

BLACKJACKPRO

☎ Enter 55 on TeleResponse page 159



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5. PERIPHERAL INTERFACE ADAPTER
   Adds two more 8 line ports with control lines for printers and other devices
6. EPROM PROGRAMER
   Has ability to read and/or program the following EPROMS: MCM 68766 MCM68764 MCM68732 MCM2532 2764 2732 2716
   2716 type EPROMS may be plugged into the 2K RAM sockets if desired
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    Of RAM bank select for machine with 32K to allow selection of the other 32K bank-machine language programs may be placed in MIM's RAM or 2716 EPROM's, allowing full use of the computer's 65536 bytes of RAM for data, graphics, etc. -- software control of a hardware bank select in MIM can provide almost as much memory to BASIC users
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```
1845 PRINT"READY-CASH BALANCE SH
OWN."
1850 LET TS=TS+BN
1860 PRINT"PRESS <ENTER> TO CONT
INUE":INPUT Z$
1865 CLS
1870 GOTO 1140
1900 PRINT"THE FIGURES THAT YOU
RE-ENTER"
1910 PRINT"WILL REPLACE THE VARI
ABLE"
1915 PRINT"EXPENSES ENTERED EARL
IER."
1920 PRINT"PRESS <ENTER> TO CONT
INUE":INPUT Z$:CLS:GOTO 600
2000 REM BALANCE SHEET
2010 PRINT:PRINT"PRESS D AND <EN
TER> TO"
2020 PRINT"DISPLAY BALANCE SHEET
."
2030 INPUT F$:IF F$="D" THEN 207
0
2040 PRINT"WHAT???"
2050 GOTO 2010
2055 CLS
2070 PRINT"*******INCOME*******F
IXED*******"
2080 PRINT"********************EX
PENSES*****"
2090 PRINT USING"SALARY     =$$##
##.##";(DS*DP)
2110 PRINT USING"ADDITIONAL=$$##
##.##";AS
2120 PRINT USING"TOTAL      =$$##
##.##";TS
2130 PRINT USING"           MORTG
AGE    =$$####.##";A
2140 PRINT USING"           ALLOW
ANCE   =$$####.##";B
2150 PRINT USING"           CAR P
MT.    =$$####.##";C
2160 PRINT USING"           CAR I
NSUR.  =$$####.##";D
2170 PRINT USING"           LIFE
INSUR.=$$####.##";E
2250 PRINT:PRINT"PRESS N AND <EN
TER> TO DISPLAY"
2260 PRINT"THE NEXT BALANCE SHEE
T."
2270 INPUT D$:IF D$="N" THEN 230
0
2280 PRINT"WHAT???":PRINT:GOTO 2
250
2300 REM
2305 CLS
```

☎ Enter 32 on TeleResponse page 159

```
2310 PRINT"*******VARIABLE EXPEN
CES*******"
2330 PRINT USING"GROCERIES      =
$$####.##";M
2340 PRINT USING"ELECTRIC BILL =
$$####.##";N
2350 PRINT USING"GAS BILL       =
$$####.##";P
2360 PRINT USING"WATER BILL     =
$$####.##";Q
2365 PRINT USING"TELEPHONE BILL=
$$####.##";U
2370 PRINT USING"HEALTH COST    =
$$####.##";R
2380 PRINT USING"CLOTHING COST =
$$####.##";S
2390 PRINT USING"CHARGE CARD    =
$$####.##";T
2395 PRINT"ADDITIONAL EXPENSES"
2400 PRINT AX$;"=$";AX
2401 PRINT:PRINT"PRESS H AND <EN
TER> TO CONTINUE"
2402 INPUT F$:IF F$="H" THEN 240
4
2403 PRINT"WHAT???":PRINT:GOTO24
01
2404 REM
2405 CLS
2410 PRINT"FIXED EXPENSES TOTAL:
$";FX
2420 PRINT"VARIABLE EXPENSES TOT
AL:$";VX
2430 IF SV>0 THEN PRINT"AMOUNT T
O SAVINGS IS: $";SV
2440 IF SN>0 THEN PRINT"AMOUNT F
ROM SAVINGS IS: $";SN
2450 IF BN>0 THEN PRINT"AMOUNT B
ORROWED IS: $";BN
2460 PRINT"REMAINING READY-CASH
IS:$";(TS-(VX+FX+SV))
2470 PRINT"PRESS Y AND <ENTER> F
OR MENU."
2480 INPUT E$:IF E$="Y" THEN GOT
O 2500
2490 PRINT"WHAT???":PRINT:GOTO 2
470
2500 REM
2505 CLS
2510 PRINT"WOULD YOU LIKE TO:"
2520 PRINT"(1)RE-DISPLAY THE ENT
IRE BALANCE SHEET"
2530 PRINT"(2)RE-RUN THE PROGRAM
 FROM START"
2540 PRINT"(3)RE-RUN THE VARIABL
E-EXPENSE"
```

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```
2545 PRINT"   PORTION"
2550 PRINT"(4)PRINT HARD COPY"
2555 PRINT"(5)QUIT"
2560 PRINT"ENTER NUMBER OF CHOIC
E."
2570 INPUT Z
2575 CLS
2580 ON Z GOTO 1000,10,1900,3000
,2590
2590 PRINT:PRINT
2600 PRINT"********HAVE A NICE D
AY********":END
3000 CLS
3005 PRINT@197,"POSITION TOP OFF
 PAPER"
3010 PRINT@260,"PRESS <ENTER> WH
EN READY":INPUT Z$
3011 FOR I=1 TO 2
3012 PRINT#-2,CHR$(27);CHR$(54):
NEXT I
3015 PRINT#-2,CHR$(27);CHR$(14)
3020 PRINT#-2,"      FINANCIAL S
TATEMENT";CHR$(27);CHR$(15)
3025 FOR I=1 TO 2
3030 PRINT#-2,CHR$(27);CHR$(54)
3035 NEXT I
3040 PRINT#-2,"****************
*INCOME****************FIXED***
***************"
3045 PRINT#-2,"****************
**********************EXPENCES*
***************"
3050 PRINT#-2,USING"        SALAR
Y    =$$######.##";(DS*DP)
3055 PRINT#-2,USING"        ADDIT
IONAL=$$######.##";AS
3060 PRINT#-2,USING"        TOTAL
     =$$######.##";TS
3065 PRINT#-2,USING"
                  MORTGAGE    =$$
#####.##";A
3070 PRINT#-2,USING"
                  ALLOWANCE   =$$
#####.##";B
3075 PRINT#-2,USING"
                  CAR PMT.    =$$
#####.##";C
3080 PRINT#-2,USING"
                  CAR INSUR.  =$$
#####.##";D
3085 PRINT#-2,USING"
                  LIFE INSUR.=$$
#####.##";E
```


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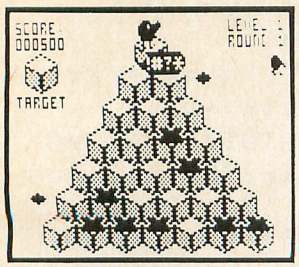
```
3090 PRINT#-2,CHR$(27);CHR$(54)
3095 PRINT#-2,"****************
******VARIABLE EXPENCES********
***************"
3100 PRINT#-2,USING"GROCERIES
  =$$#####.##";M
3105 PRINT#-2,USING"ELECTRIC BIL
L =$$#####.##";N
3110 PRINT#-2,USING"GAS BILL
  =$$#####.##";P
3115 PRINT#-2,USING"WATER BILL
  =$$#####.##";Q
3120 PRINT#-2,USING"TELEPHONE BI
LL=$$#####.##";U
3125 PRINT#-2,USING"HEALTH COSTS
  =$$#####.##";R
3130 PRINT#-2,USING"CLOTHING COS
TS=$$#####.##";S
3135 PRINT#-2,USING"CHARGE CARDS
  =$$#####.##";T
3140 PRINT#-2,"ADDITIONAL EXPENS
ES"
3145 PRINT#-2,AX$;"=$";AX
3150 FOR I=1 TO 2
3155 PRINT#-2,CHR$(27);CHR$(54):
NEXT I
3160 PRINT#-2,USING"FIXED EXPENC
ES TOTAL:$$#####.##";FX
3165 PRINT#-2,USING"VARIABLE EXP
ENCES TOTAL:$$#####.##";VX
3170 IF SV>0 THEN PRINT#-2,USING
"AMOUNT TO SAVINGS IS:$$#####.##
";SV
3175 IF SN>0 THEN PRINT#-2,USING
"AMOUNT FROM SAVINGS IS:$$#####.
##";SN
3180 IF BN>0 THEN PRINT#-2,USING
"AMOUNT BORROWED IS:$$#####.##";
BN
3185 PRINT#-2,USING"REMAINING RE
AY-CASH  IS:$$#####.##";(TS-(VX+
FX+SV))
3190 PRINT#-2,CHR$(12)
3195 CLS
3200 PRINT"PRESS Y AND <ENTER> F
OR MENU."
3205 INPUT E$:IF E$="Y" THEN GOT
O 2500
3210 PRINT"WHAT???":PRINT:GOTO 3
200
```

■■■

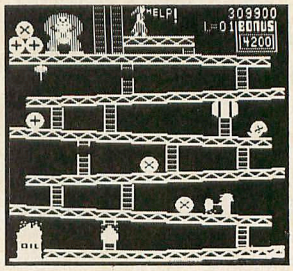
☎ Enter 47 on TeleResponse page 159

THE TOP 4 COCO GAMES...



ZAKSUND

From Elite Software comes this fantastic arcade style space action game with 3 different stages of moving 3-D graphics. You've never seen anything like this on your CoCo! Great sound too! 32K Tape: $24.95

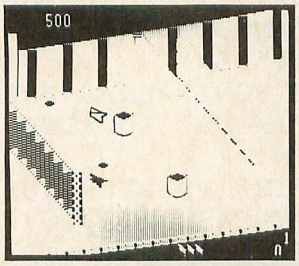


GHOST GOBBLER

From Spectral Assoc. This "PAC" theme game has been improved several times. It is definitely the best of its type. Brilliant color, action and sound, just like an arcade. 16K Tape: $24.95

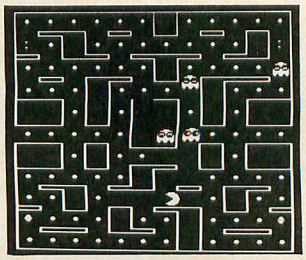
CUBIX

By Spectral Associates. Very much like the arcade smash! Jump little Cubix around the 3D maze trying to change the color of all the squares. With Death Globes, Discs, Snakes, etc. 32K Tape: $24.95



THE KING

Previously called 'Donkey King', you simply cannot buy a more impressive game for your CoCo. With 4 different screens and loads of fun! From Tom Mix Software. 32K Tape: $25.95



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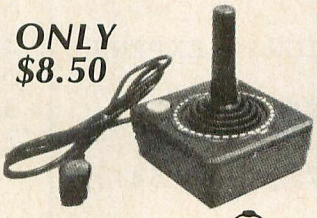

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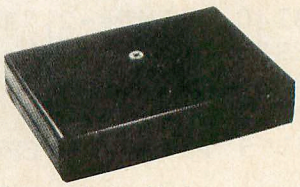

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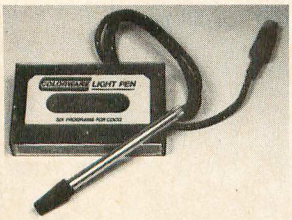

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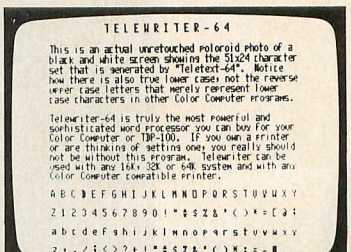
TELEWRITER-64



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Colorware researched the word processors available for the Color Computer. This is the best. Telewriter-64 is a truly sophisticated system that is marvelously easy to use. It works with any 16K, 32K or 64K system and any CoCo compatible printer.

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'REAL TALKER'

HARDWARE Voice Synthesizer

NEW from COLORWARE.. only...$59.95

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READ THIS....

Making your computer talk couldn't be any easier! 'Real Talker' is a full featured, ready to use, HARDWARE voice synthesizer system in a cartridge pak. It uses the Votrax SC-01 phoneme synthesizer chip to produce a clear, crisp voice.

FREE TEXT-TO-SPEECH

Included free with 'Real Talker' is Colorware's remarkable Text-to-Speech program. This is a truly powerful machine language utility. What it does is automatically convert plain English to speech. And it has an unlimited vocabulary! For example, use it in the direct mode: Type in a sentence or a paragraph, even mix in numbers, dollar signs, etc., then press enter. The text is spoken. At the same time a phoneme string is generated which can be saved to cassette or disk, modified or used in a Basic program.

We originally planned to sell this major piece of programming for about $40.00 but decided it was so useful that no 'Real Talker' user should be without it. Besides, it really shows off the capability of 'Real Talker'.

Also included with 'Real Talker' is our unique Phoneme Editor program. It allows you to explore and create artificial speech at the phoneme level. Phonemes are the fundimental sounds or building blocks of word pronunciation. There are 64 different phonemes, as well as 4 inflection levels at your disposal. Creating and modifying speech at the phoneme level is both fascinating and educational. The Phoneme Editor may also be used to customize the pronunciation of speech produced by the Text-to-Speech program.

You don't have to use any of our utility programs though. If you write your own Basic Programs, you will find the pocket sized Votrax Dictionary (included free) is all you need to make your own Basic programs talk. This dictionary gives you quick access to the phoneme sequences used to create approximately 1400 of the most used words in the English language.

How about compatibility? 'Real Talker' is compatible with any 16K, 32K, 64K, Extended or non-extended Color Computer. It works with any cassette or disk based system, with or without the Radio Shack Multi-slot expander. No other synthesizer under $100 can make this claim. Most other CoCo voice synthesizers require an expensive Multi-slot expander in order to work with the disk system. 'Real Talker' requires only an inexpensive Y-adapter. This is an important consideration if you plan on adding a disk or have one already.

'Real Talker' comes completely assembled, tested and ready to use. It is powered by the CoCo and talks through your T.V. speaker so there is nothing else to add. Price includes Text-to-Speech and other programs on cassette (may be transferred to disk), User Manual and Votrax Dictionary. ONLY $59.95

'Y-BRANCHING CABLE' For disk systems. This 40-pin, 3 connector cable allows 'Real Talker' to be used with any disk system $29.95

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Telewriter-64™

the Color Computer Word Processor

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

THE ORIGINAL

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

The standard Color Computer display of 32 characters by 16 lines without lower case is simply inadequate for serious word processing. The checkerboard letters and tiny lines give you no feel for how your writing looks or reads. Telewriter gives the Color Computer a 51 column by 24 line screen display with *true lower case characters*. So a Telewriter screen looks like a printed page, with a good chunk of text on screen at one time. In fact, more on screen text than you'd get with Apple II, Atari, TI, Vic or TRS-80 Model III.

On top of that, the sophisticated Telewriter full-screen editor is so simple to use, it makes writing fun. With single-letter mnemonic commands, and menu-driven I/O and formatting, Telewriter surpasses all others for user friendliness and pure power.

Telewriter's chain printing feature means that the size of your text is never limited by the amount of memory you have, and Telewriter's advanced cassette handler gives you a powerful word processor without the major additional cost of a disk.

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

TELEWRITER-64

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

64K COMPATIBLE

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

64 COLUMNS (AND 85!)

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

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

RIGHT JUSTIFICATION & HYPHENATION

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

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

FEATURES & SPECIFICATIONS:

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

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

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

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

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

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

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

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

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

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

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

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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Or check your local software store. If you have questions, or would like to order by Visa or Mastercard, call us at (619) 755-1258 (weekdays, 8AM-4PM PST). Dealer inquiries invited.

(Add $2 for shipping. Californians add 6% state tax. Allow 2 weeks for personal checks. Send self-addressed stamped envelope for Telewriter reviews from CCN, RAINBOW, 80-Micro, 80-U.S. Telewriter owners: send SASE or call for information on upgrading to Telewriter-64. Telewriter-compatible spelling checker (Spell 'n Fix) and Smart Terminal program (Colorcom/E) also available. Call or write for more information.)

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Dissecting Your ROM

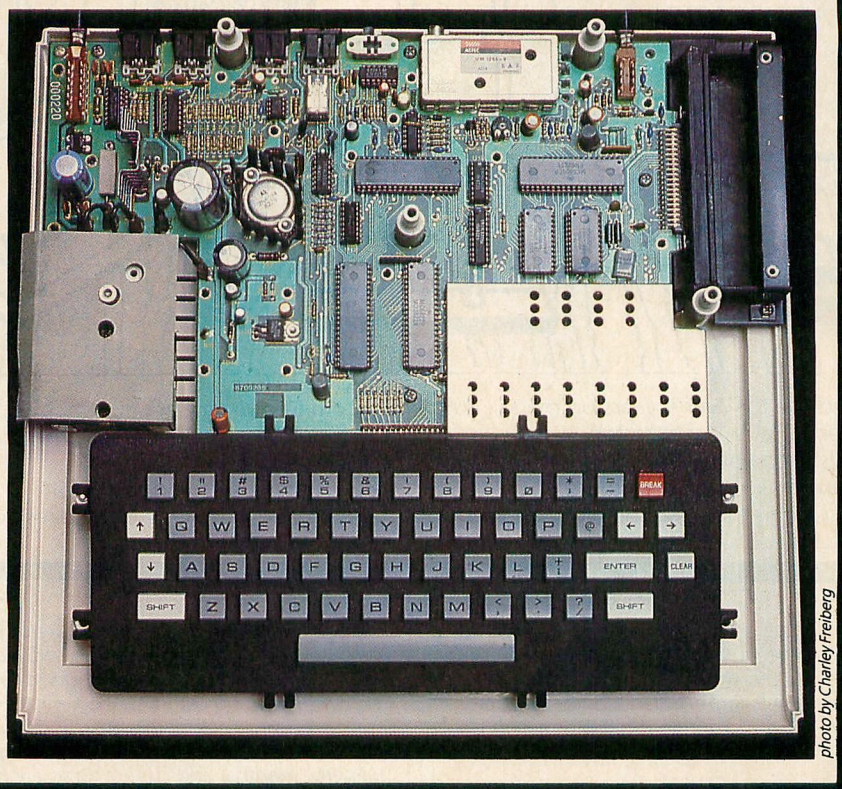

photo by Charley Freiberg

Extended Basic begins. The eighth of 14 articles

by Jake Commander

Now we've passed the milestone at the end of Color Basic we can get on with some of the fun stuff — like sound and graphics. Maybe the fun aspect is why I enjoyed this half of the disassembly task more than the first. With any disassembly, the further you go, the easier it gets, as the knowledge tends to "avalanche." As you unravel more routines, more become obvious by virtue of which other routines they call. Consequently, I was a lot more comfortable working on this half.

Extended Basic starts with EX. And so it does in the ROM,

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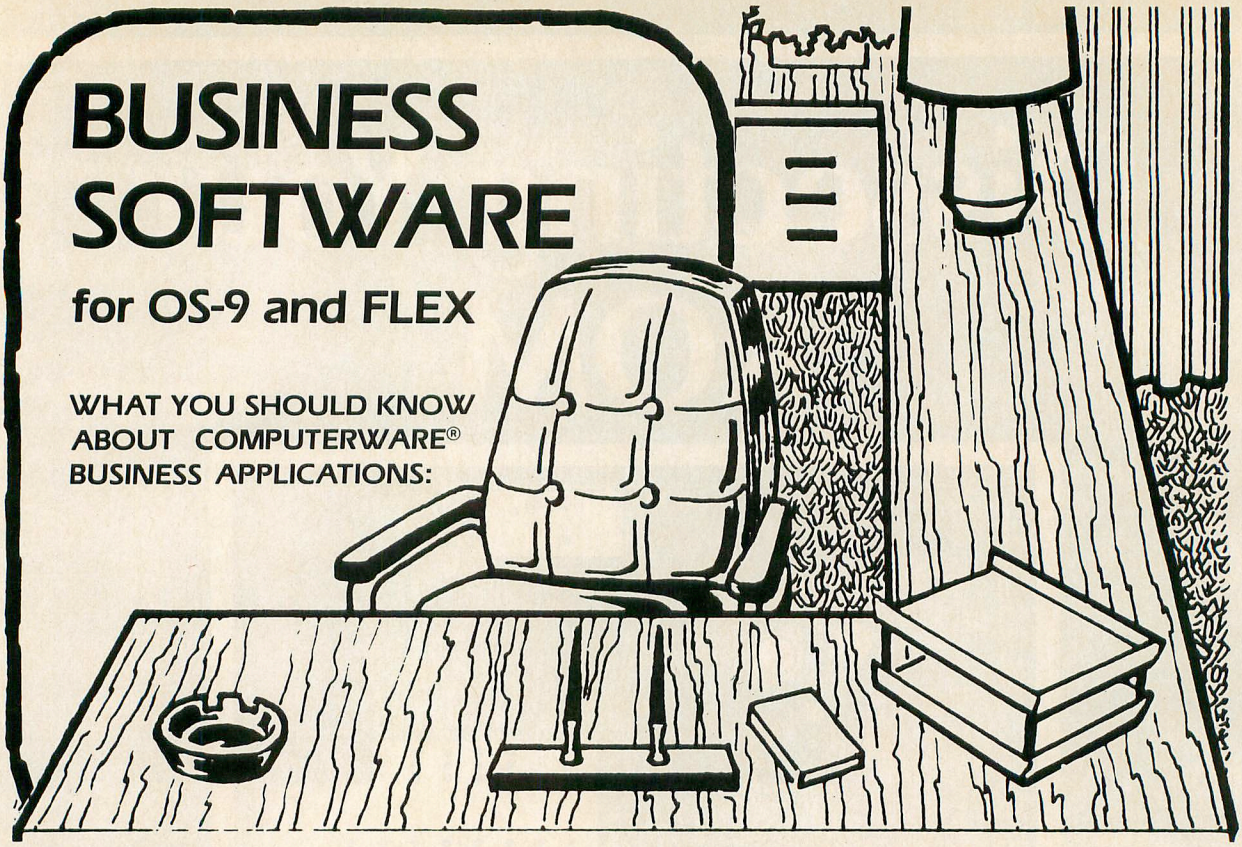

- They have been in use for over 4 years on many 6809 systems. This means they are well tested.
- Complete manuals accompany the systems.
- User-friendly menus make them easy to use.
- They are not accounting tutorials. They assume you know and use sound accounting principles.

System Requirements
- FLEX or OS-9 operating system
- 64K memory
- Computerware® Random BASIC
- Dual Disk Drives (Payroll requires double-sided drives)
- O-PAK for OS-9 systems

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This is a comprehensive double entry accounting system with complete audit trails, closing procedures, and full reporting. The chart of accounts is flexible and the system easy to use. Reports include the General Ledger, Trial Balance, Balance Sheet, Income Statement, and Transaction Register. Your financial information is at your fingertips!

CHECK LEDGER $195

This is a single entry bookkeeping system which allows the users to define a chart of income and expense accounts. Year-to-date totals are maintained for each account as well as complete checking account history. By just entering your checking account information, you can have always-current visibility over your income and expense ledgers. Financial statements and taxes are a snap!

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We call this the People Manager. It is a very sophisticated people data base system. The system collects name and address information, provides mailing labels or reports of the entire list or any subset upon request. The power of the system lies in the 17 character special code field that is used to identify special characteristics of each person and then can be used to select subgroups for reports and labels used in special marketing or contracts. Tested with data bases of 15 to 9,000 entries this system has been in use with retailers, clubs, churches and professionals for years.

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INVENTORY CONTROL $195

This system is designed to help the retailer, distributor, or businessman to keep control of this important factor. It stores your cost and quantity information, updates it immediately, and offers you key management reports with useful summaries at any time. With four costs, four locations, selling history, and vendor information for each item, you will always have the facts!

ACCOUNTS PAYABLE $195

This system can give you the tools to plan your business' growth by controlling expenditures and forecasting cash requirements. It helps a small business manage and track its cash liabilities by collecting vendor invoice information and reporting the business' cash commitments and payment history. Along with standard payables reports it also includes a check writer and payment forecast reports.

ACCOUNTS RECEIVABLE $149

All businesses need to know who owes them money! This system provides reliable and timely information regarding the status of all customer accounts. You can know instantly which accounts are past due, forecast how much money to expect to receive for cash flow planning, and keep on top of your customers' credit positions. Customer name, address, credit limit, invoice, and payment information is recorded and reports of all information including customer statements are available upon your request.

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too. EX is the signature which ordinary Color Basic looks for to tell it to pass control to the second ROM at address $8002. From here on, the second ROM really does become an extension of the first, continuing various initialization procedures which are not required under plain vanilla Color Basic. If a ROM beginning with DK is placed in the cartridge slot, the initialization will continue one stage further again to what is assumed will be Disk Basic.

The most important procedure carried out in the extended initialization process is the linking of Extended Basic via the *hooks*. These are strategic calls from ROM to RAM which are there especially to enable extensions to various commands. These hooks are extremely useful for customizing Basic by simply replacing the three-byte hook with a jump to your own address.

This first portion of Extended Basic also contains the vocabulary for the new commands plus the jump tables required for their execution. All this has been plodded through by the disassembler, which has produced the opcodes represented by these bytes. As you'd expect, this doesn't make any sense while in these tables.

Included up to address $84C3 is the code to perform a trace of the resident program via TRON and TROFF. Also accommodated are a few more transcendental functions, such as COS, LOG, ATN and SQR. Apart from the intervention of the initialization routines, these continue on logically from the functions at the end of the first ROM. ■ ■ ■

Program Listing. ROM Disassembly

```
Line                  Object
Number   Address      Code        Mnemonic  Operand     Jake's Comment

00001    8000 45                                        ;"E"  Extended Basic
00002    8001 58                  ASLB                  ;"X"  signature
00003    8002 8E 80DE             LDX       #$80DE      ;Source
00004    8005 CE 012A             LDU       #$012A      ;Destination
00005    8008 C6 0A               LDB       #$0A        ;# bytes
00006    800A BD A59A             JSR       $A59A       ;Copy addrs tble@$80DE to $012A
00007    800D 8E B277             LDX       #$B277      ;SN Error pointer
00008    8010 AF 43               STX       3,U         ;to $0137 (token > $CD vector)
00009    8012 AF 48               STX       8,U         ;to $013C (fnction > $A1 vectr)
00010    8014 8E 894C             LDX       #$894C      ;IRQ vector address
00011    8017 BF 010D             STX       $010D
00012    801A 9E 8A               LDX       <$8A        ;Zero constant
00013    801C BF 0112             STX       $0112       ;Set timer to zero
00014    801F BD 829C             JSR       $829C       ;Reset PLAY and DRAW variables
00015    8022 CC 2C05             LDD       #$2C05      ;Input baud rate = 1200
00016    8025 DD E6               STD       <$E6        ;Timeout counter = 5
00017    8027 8E 013E             LDX       #$013E      ;USR table pointer
00018    802A 9F B0               STX       <$B0
00019    802C CE B44A             LDU       #$B44A      ;Point unDEFd USRs @ ?FC Error
00020    802F C6 0A               LDB       #$0A        ;Set tally for 10 vectors
00021    8031 EF 81               STU       ,X++        ;$013E - $0150
00022    8033 5A                  DECB                  ;Decrement tally,
00023    8034 26 FB               BNE       $8031       ;until all USR vectors set
00024    8036 86 7E               LDA       #$7E        ;JMP opcode

Setup RAM vector jump addresses
00025    8038 B7 019A             STA       $019A       ;JMP $82B9
00026    803B 8E 82B9             LDX       #$82B9      ;Called between statements
00027    803E BF 019B             STX       $019B       ;@ $AD9E
00028    8041 B7 018B             STA       $018B       ;JMP $8846
00029    8044 8E 8846             LDX       #$8846      ;Called before operand check
00030    8047 BF 018C             STX       $018C       ;@ $B223
00031    804A B7 0197             STA       $0197       ;JMP $87E5
00032    804D 8E 87E5             LDX       #$87E5      ;Called during ASCII # convrsn
00033    8050 BF 0198             STX       $0198       ;@ $BD22
```

There are, after all, better ways to spend a day.

I can think of half a dozen things I'd rather do than type all day. Please send me the tapes for the months I've listed below.

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*March & April are combined. CC Space Trek and Banner Program not included.


```
Line                Object
Number  Address     Code        Mnemonic  Operand     Jake's Comment
00034   8053 B7 0179            STA       $0179       ;JMP $8E90
00035   8056 8E 8E90            LDX       #$8E90      ;Called during PRINT
00036   8059 BF 017A            STX       $017A       ;@ $B918
00037   805C B7 0191            STA       $0191       ;JMP $88F0
00038   805F 8E 88F0            LDX       #$88F0      ;Called during error
00039   8062 BF 0192            STX       $0192       ;@ $AC49
00040   8065 B7 016A            STA       $016A       ;JMP $8CF1
00041   8068 8E 8CF1            LDX       #$8CF1      ;Called before getting I/P chr
00042   806B BF 016B            STX       $016B       ;@ $A176
00043   806E B7 0167            STA       $0167       ;JMP $8273
00044   8071 8E 8273            LDX       #$8273      ;Called before putting O/P chr
00045   8074 BF 0168            STX       $0168       ;@ $A282
00046   8077 B7 0176            STA       $0176       ;JMP $8286

Line                Object
Number  Address     Code        Mnemonic  Operand     Jake's Comment
00108   80FE 2E 30              BGT       $8130       ;.0
00109   8100 0D 43              TST       <$43        ;C
00110   8102 4F                 CLRA                  ;O
00111   8103 50                 NEGB                  ;P
00112   8104 59                 ROLB                  ;Y
00113   8105 52                                       ;R
00114   8106 49                 ROLA                  ;I
00115   8107 47                 ASRA                  ;G
00116   8108 48                 ASLA                  ;H
00117   8109 54                 LSRB                  ;T
00118   810A 20 28              BRA       $8134       ; (
00119   810C 43                 COMA                  ;C
00120   810D 29 20              BVS       $812F       ;)
```


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```
00047  807A 8E 8286       LDX   #$8286     ;Called during CLOSE
00048  807D BF 0177       STX   $0177      ;@ $A42D
00049  8080 B7 01A3       STA   $01A3      ;JMP $8304
00050  8083 8E 8304       LDX   #$8304     ;Called before encoding Basic
00051  8086 BF 01A4       STX   $01A4      ;@ $B821
00052  8089 B7 0194       STA   $0194      ;JMP $829C
00053  808C 8E 829C       LDX   #$829C     ;Called before RUN
00054  808F BF 0195       STX   $0195      ;@ $AE75
00055  8092 B7 011D       STA   $011D      ;JMP $8489
00056  8095 8E 8489       LDX   #$8489     ;Exponential vector
00057  8098 BF 011E       STX   $011E
00058  809B BD 96E6       JSR   $96E6      ;Cold initialize Extended Basic
00059  809E B6 FF03       LDA   $FF03      ;* Field sync
00060  80A1 8A 01         ORA   #1         ;* clock
00061  80A3 B7 FF03       STA   $FF03      ;* IRQ enable
00062  80A6 8E 444B       LDX   #$444B     ;"DK"
00063  80A9 BC C000       CMPX  $C000      ;Disk Basic installed?
00064  80AC 1027 3F52     LBEQ  $C002      ;Go to it if so
00065  80B0 1C AF         ANDCC #$AF       ;Disable interrupts
00066  80B2 8E 80E7       LDX   #$80E7     ;=> extended Basic title
00067  80B5 BD B99C       JSR   $B99C      ;Print it
00068  80B8 8E 80C0       LDX   #$80C0     ;=> reset vector
00069  80BB 9F 72         STX   <$72       ;Setup reset vector
00070  80BD 7E A0E2       JMP   $A0E2      ;Flag startup, go to "OK"
Reset
00071  80C0 12            NOP              ;Reset must start with NOP
00072  80C1 0F E3         CLR   <$E3       ;Clear note length
00073  80C3 0F E4         CLR   <$E4       ;to prevent IRQ note play
00074  80C5 B6 FF03       LDA   $FF03      ;* Field sync
00075  80C8 8A 01         ORA   #1         ;* clock
00076  80CA B7 FF03       STA   $FF03      ;* IRQ enable
00077  80CD 7E A0E8       JMP   $A0E8      ;Continue normal reset

00078  80D0 B6 FF22       LDA   $FF22      ;RAM size
00079  80D3 85 02         BITA  #2         ;= 16K?
00080  80D5 26 03         BNE   $80DA      ;yes
00081  80D7 B7 FFDD       STA   $FFDD      ;Else reset M1 on SAM
00082  80DA 6E 84         JMP   ,X
00083  80DC 00 00         NEG   <0

Extended Basic RAM information
00084  80DE 19            DAA              ;Extended vocab table length
00085  80DF 81 83         CMPA  #$83       ;=> vocabulary @ $8183
00086  80E1 81 3C         CMPA  #$3C       ;=> ext'd vocab procssng @$813C
00087  80E3 0E 82         JMP   <$82       ;Extd func tbl lngth Adr @$821E
00088  80E5 1E 81         EXG   A,X        ;>$93 function interpret @$8168
00089  80E7 68 45         ASL   5,U        ;E
00090  80E9 58            ASLB             ;X
00091  80EA 54            LSRB             ;T
00092  80EB 45                             ;E
00093  80EC 4E                             ;N
00094  80ED 44            LSRA             ;D
00095  80EE 45                             ;E
00096  80EF 44            LSRA             ;D
00097  80F0 20 43         BRA   $8135      ; C
00098  80F2 4F            CLRA             ;O
00099  80F3 4C            INCA             ;L
00100  80F4 4F            CLRA             ;O
00101  80F5 52                             ;R
00102  80F6 20 42         BRA   $813A      ; B
00103  80F8 41                             ;A
00104  80F9 53            COMB             ;S
00105  80FA 49            ROLA             ;I
00106  80FB 43            COMA             ;C
00107  80FC 20 31         BRA   $812F      ; 1

00121  810F 31 39         LEAY  -7,Y       ;19
00122  8111 38                            ;8
00123  8112 30 20         LEAX  0,Y        ;0
00124  8114 42                            ;B
00125  8115 59            ROLB             ;Y
00126  8116 20 54         BRA   $816C      ; T
00127  8118 41                            ;A
00128  8119 4E                            ;N
00129  811A 44            LSRA             ;D
00130  811B 59            ROLB             ;Y
00131  811C 0D 55         TST   <$55       ;U
00132  811E 4E                            ;N
00133  811F 44            LSRA             ;D
00134  8120 45                            ;E
00135  8121 52                            ;R
00136  8122 20 4C         BRA   $8170      ; L
00137  8124 49            ROLA             ;I
00138  8125 43            COMA             ;C
00139  8126 45                            ;E
00140  8127 4E                            ;N
00141  8128 53            COMB             ;S
00142  8129 45                            ;E
00143  812A 20 46         BRA   $8172      ; F
00144  812C 52                            ;R
00145  812D 4F            CLRA             ;O
00146  812E 4D            TSTA             ;M
00147  812F 20 4D         BRA   $817E      ; M
00148  8131 49            ROLA             ;I
00149  8132 43            COMA             ;C
00150  8133 52                            ;R
00151  8134 4F            CLRA             ;O
00152  8135 53            COMB             ;S
00153  8136 4F            CLRA             ;O
00154  8137 46            RORA             ;F
00155  8138 54            LSRB             ;T
00156  8139 0D 0D         TST   <$0D       ;c/r c/r
00157  813B 00 81         NEG   <$81       ;Disassembler out of sync
00158  813D CB 22         ADDB  #$22       ;Ditto
00159  813F 08 8E         ASL   <$8E       ;Ditto
00160  8141 81 F0         CMPA  #$F0       ;Ditto

Extended vocabulary processing
-----  813C 81 CB         CMPA  #$CB       ;Token >$CB?
-----  813E 22 08         BHI   $8148      ;If so
-----  8140 8E 81F0       LDX   #$81F0     ;=> ext'd cmd JMP tbl
00161  8143 80 B5         SUBA  #$B5       ;Adjust offset to extended tble
00162  8145 7E ADD4       JMP   $ADD4      ;Extract addrss & JMP to routin
00163  8148 81 FF         CMPA  #$FF       ;Token = $FF?
00164  814A 27 08         BEQ   $8154      ;Yes
00165  814C 81 CD         CMPA  #$CD       ;Token = $CC or $CD?
00166  814E 23 15         BLS   $8165      ;SN Error if so
00167  8150 6E 9F0137     JMP   (0137)     ;If token > $CD
00168  8154 9D 9F         JSR   <$9F       ;Parse next character
00169  8156 81 90         CMPA  #$90       ;MID$= ?
00170  8158 1027 057A     LBEQ  $86D6      ;If Extd's MID$= on left of =
00171  815C 81 9F         CMPA  #$9F       ;TIMER= ?
00172  815E 1027 07FE     LBEQ  $8960      ;If TIMER= on left hand side
00173  8162 BD 01A0       JSR   $01A0      ;RAM vector
00174  8165 7E B277       JMP   $B277      ;SN Error

Functions > $93
00175  8168 C1 42         CMPB  #$42       ;Right hand side function >$A1?
00176  816A 23 04         BLS   $8170      ;No, OK
00177  816C 6E 9F013C     JMP   (013C)     ;If token > $A1
00178  8170 C0 28         SUBB  #$28       ;Offset token*2 to table start
```

```
Line                    Object
Number  Address         Code        Mnemonic  Operand     Jake's Comment

00179   8172 C1 10          CMPB    #$10        ;> SQR ?
00180   8174 22 07          BHI     $817D       ;Straight to function if so
00181   8176 34 04          PSHS    B           ;Save table offset
00182   8178 BD B262        JSR     $B262       ;Compute expression after "("
00183   817B 35 04          PULS    B           ;Restore offset
00184   817D 8E 8257        LDX     #$8257      ;=> Extended fnctions JMP table
00185   8180 7E B2CE        JMP     $B2CE       ;Add offset,do tbl adr as sbrtn

00186   8183 44             LSRA                ;D
00187   8184 45                                 ;E
00188   8185 CC 4544        LDD     #$4544      ;L/ ED
00189   8188 49             ROLA                ;I
00190   8189 D4 54          ANDB    <$54        ;T/ T
00191   818B 52                                 ;R
00192   818C 4F             CLRA                ;O
00193   818D CE 5452        LDU     #$5452      ;N/ TR
00194   8190 4F             CLRA                ;O
00195   8191 46             RORA                ;F
00196   8192 C6 44          LDB     #$44        ;F/ D
00197   8194 45                                 ;E
00198   8195 C6 4C          LDB     #$4C        ;F/ L
00199   8197 45                                 ;E
00200   8198 D4 4C          ANDB    <$4C        ;T/ L
00201   819A 49             ROLA                ;I
00202   819B 4E                                 ;N
00203   819C C5 50          BITB    #$50        ;E/ P
00204   819E 43             COMA                ;C
00205   819F 4C             INCA                ;L
00206   81A0 D3 50          ADDD    <$50        ;S/ P
00207   81A2 53             COMB                ;S
00208   81A3 45                                 ;E
00209   81A4 D4 50          ANDB    <$50        ;T/P
00210   81A6 52                                 ;R
00211   81A7 45                                 ;E
00212   81A8 53             COMB                ;S
00213   81A9 45                                 ;E
00214   81AA D4 53          ANDB    <$53        ;T/ S
00215   81AC 43             COMA                ;C
00216   81AD 52                                 ;R
00217   81AE 45                                 ;E
00218   81AF 45                                 ;E
00219   81B0 CE 5043        LDU     #$5043      ;N/ PC
00220   81B3 4C             INCA                ;L
00221   81B4 45                                 ;E
00222   81B5 41                                 ;A
00223   81B6 D2 43          SBCB    <$43        ;R/ C
00224   81B8 4F             CLRA                ;O
00225   81B9 4C             INCA                ;L
00226   81BA 4F             CLRA                ;O
00227   81BB D2 43          SBCB    <$43        ;R/ C
00228   81BD 49             ROLA                ;I
00229   81BE 52                                 ;R
00230   81BF 43             COMA                ;C
00231   81C0 4C             INCA                ;L
00232   81C1 C5 50          BITB    #$50        ;E/ P
00233   81C3 41                                 ;A
00234   81C4 49             ROLA                ;I
00235   81C5 4E                                 ;N
00236   81C6 D4 47          ANDB    <$47        ;T/ G
00237   81C8 45                                 ;E
00238   81C9 D4 50          ANDB    <$50        ;T/ P

Line                    Object
Number  Address         Code        Mnemonic  Operand     Jake's Comment

00239   81CB 55                                 ;U
00240   81CC D4 44          ANDB    <$44        ;T/ D
00241   81CE 52                                 ;R
00242   81CF 41                                 ;A
00243   81D0 D7 50          STB     <$50        ;W/ P
00244   81D2 43             COMA                ;C
00245   81D3 4F             CLRA                ;O
00246   81D4 50             NEGB                ;P
00247   81D5 D9 50          ADCB    <$50        ;Y/ P
00248   81D7 4D             TSTA                ;M
00249   81D8 4F             CLRA                ;O
00250   81D9 44             LSRA                ;D
00251   81DA C5 50          BITB    #$50        ;E/ P
00252   81DC 4C             INCA                ;L
00253   81DD 41                                 ;A
00254   81DE D9 44          ADCB    <$44        ;Y/ D
00255   81E0 4C             INCA                ;L
00256   81E1 4F             CLRA                ;O
00257   81E2 41                                 ;A
00258   81E3 C4 52          ANDB    #$52        ;D/ R
00259   81E5 45                                 ;E
00260   81E6 4E                                 ;N
00261   81E7 55                                 ;U
00262   81E8 CD                                 ;M/
00263   81E9 46             RORA                ;F
00264   81EA CE 5553        LDU     #$5553      ;N/ US
00265   81ED 49             ROLA                ;I
00266   81EE 4E                                 ;N
00267   81EF C7                                 ;G/
Extended commands jump table
00268   81F0 89 70          ADCA    #$70        ;DEL  = $8970
00269   81F2 85 33          BITA    #$33        ;EDIT = $8533
00270   81F4 86 A7          LDA     #$A7        ;TRON = $86A7
00271   81F6 86 A8          LDA     #$A8        ;TROFF= $86A8
00272   81F8 88 71          EORA    #$71        ;DEF  = $8871
00273   81FA AF 8993BB      STX     -$6C45,X    ;LET  = $AF89, LINE=$93BB
00274   81FE 95 32          BITA    <$32        ;PCLS = $9532
00275   8200 93 61          SUBD    <$61        ;PSET = $9361
00276   8202 93 65          SUBD    <$65        ;PRESET=$9365
00277   8204 96 70          LDA     <$70        ;SCREEN=$9670
00278   8206 96 8B          LDA     <$8B        ;PCLEAR=$968B
00279   8208 95 46          BITA    <$46        ;COLOR= $9546
00280   820A 9E 9D          LDX     <$9D        ;CIRCLE=$9E9D
00281   820C 98 EC          EORA    <$EC        ;PAINT= $98EC
00282   820E 97 55          STA     <$55        ;GET  = $9755
00283   8210 97 58          STA     <$58        ;PUT  = $9758
00284   8212 9C B6          CMPX    <$B6        ;DRAW = $9CB6
00285   8214 97 23          STA     <$23        ;PCOPY= $9723
00286   8216 96 21          LDA     <$21        ;PMODE= $9621
00287   8218 9A 22          ORA     <$22        ;PLAY = $9A22
00288   821A 8C 188A        CMPX    #$188A      ;DLOAD= $8C18, RENUM=$8A09
00289   821D 09 41          ROL     <$41        ;A
00290   821F 54             LSRB                ;T
00291   8220 CE 434F        LDU     #$434F      ;N/ CO
00292   8223 D3 54          ADDD    <$54        ;S/ T
00293   8225 41                                 ;A
00294   8226 CE 4558        LDU     #$4558      ;N/ EX
00295   8229 D0 46          SUBB    <$46        ;P/ F
00296   822B 49             ROLA                ;I
00297   822C D8 4C          EORB    <$4C        ;X/ L
00298   822E 4F             CLRA                ;O
```

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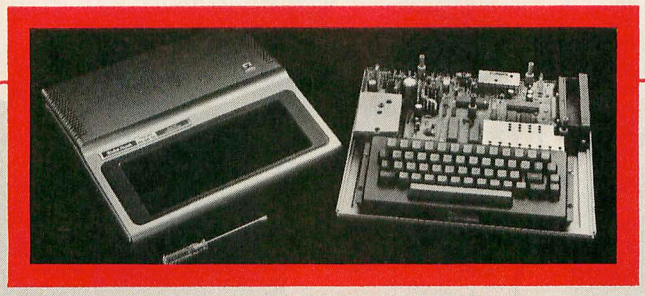

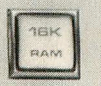

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```
Line                    Object
Number  Address  Code           Mnemonic  Operand      Jake's Comment
00299   822F C7                           ;G/
00300   8230 50                 NEGB      ;P
00301   8231 4F                 CLRA      ;O
00302   8232 D3 53              ADDD  <$53  ;S/ S
00303   8234 51                           ;Q
00304   8235 D2 48              SBCB  <$48  ;R/ H
00305   8237 45                           ;E
00306   8238 58                 ASLB      ;X
00307   8239 A4 56              ANDA  -$0A,U ;$/ V
00308   823B 41                           ;A
00309   823C 52                           ;R
00310   823D 50                 NEGB      ;P
00311   823E 54                 LSRB      ;T
00312   823F D2 49              SBCB  <$49  ;R/ I
00313   8241 4E                           ;N
00314   8242 53                 COMB      ;S
00315   8243 54                 LSRB      ;T
00316   8244 D2 54              SBCB  <$54  ;R/ T
00317   8246 49                 ROLA      ;I
00318   8247 4D                 TSTA      ;M
00319   8248 45                           ;E
00320   8249 D2 50              SBCB  <$50  ;R/ P
00321   824B 50                 NEGB      ;P
00322   824C 4F                 CLRA      ;O
00323   824D 49                 ROLA      ;I
00324   824E 4E                           ;N
00325   824F D4 53              ANDB  <$53  ;T/ S
00326   8251 54                 LSRB      ;T
00327   8252 52                           ;R
00328   8253 49                 ROLA      ;I
00329   8254 4E                           ;N
00330   8255 47                 ASRA      ;G
00331   8256 A4 83              ANDA  ,--X  ;$/

Extended functions jump table
00332   8258 B0 8378            SUBA  $8378 ; ATN = $83B0, COS= $8378
00333   825B 83 8184            SUBD  #$8184 ; TAN = $8381, EXP= $84F2
00334   825E F2 8524            SBCB  $8524 ; FIX = $8524
00335   8261 84 46              ANDA  #$46  ; LOG = $8446
00336   8263 86 AC              LDA   #$AC  ; POS = $86AC
00337   8265 84 80              ANDA  #$80  ; SQR = $8480
00338   8267 8B DD              ADDA  #$DD  ; HEX$= $8BDD
00339   8269 86 BE              LDA   #$BE  ;VARPTR=$86BE
00340   826B 87                           ;INSTR= $877E
00341   826C 7E 8968            JMP   $8968 ;TIMER= $8968
00342   826F 93 39              SUBD  <$39  ;PPOINT=$9339
00343   8271 87                           ;STRING$=$874E
00344   8272 4E

Before PRINT from $A282
00345   8273 0D 6F              TST   <$6F  ;Device number
00346   8275 1027 1333          LBEQ  $95AC ;If video, reset A/G mode
00347   8279 34 04              PSHS  B
00348   827B D6 6F              LDB   <$6F  ;Device number
00349   827D C1 FD              CMPB  #$FD  ;-3?
00350   827F 35 04              PULS  B
00351   8281 26 02              BNE   $8285 ;RTS if not
00352   8283 32 62              LEAS  2,S   ;Else pull return address
00353   8285 39                 RTS

During CLOSE from $A42D
00354   8286 96 6F              LDA   <$6F  ;Device number
00355   8288 4C                 INCA        ;-1 (cassette)?
00356   8289 26 FA              BNE   $8285 ;RTS if not
00357   828B 96 78              LDA   <$78  ;File mode
00358   828D 81 02              CMPA  #2    ;Output?
00359   828F 26 F4              BNE   $8285 ;RTS if not
00360   8291 96 79              LDA   <$79  ;# bytes in cassette block
00361   8293 26 F0              BNE   $8285 ;RTS if more
00362   8295 0F 6F              CLR   <$6F  ;Else set device number = video
00363   8297 32 62              LEAS  2,S   ;Pull return address
00364   8299 7E A444            JMP   $A444 ;Output end block

Before RUN from $AE75. Reset PLAY/DRAW
00365   829C CC BA42            LDD   #$BA42 ;Current play amplitude
00366   829F DD DF              STD   <$DF  ;Set to mid
00367   82A1 86 02              LDA   #2    ;Default value for...
00368   82A3 97 E2              STA   <$E2  ;...current tempo
00369   82A5 97 DE              STA   <$DE  ;...current octave
00370   82A7 48                 ASLA        ;=4
00371   82A8 97 E1              STA   <$E1  ;Reset current note length
00372   82AA 0F E5              CLR   <$E5  ;Reset # dots after length
00373   82AC DC 8A              LDD   <$8A  ;Zero constant
00374   82AE DD E8              STD   <$E8  ;Reset DRAW angle and scale
00375   82B0 C6 80              LDB   #$80  ;=128
00376   82B2 DD C7              STD   <$C7  ;Default previous X end coord
00377   82B4 C6 60              LDB   #$60  ;=96
00378   82B6 DD C9              STD   <$C9  ;Default previous Y end coord
00379   82B8 39                 RTS

Between statements from $AD9E
00380   82B9 32 62              LEAS  2,S   ;Pull return address
00381   82BB 1C AF              ANDCC #$AF  ;Enable interrupts
00382   82BD BD ADEB            JSR   $ADEB ;Scan for break/shift @
00383   82C0 9E A6              LDX   <$A6  ;Next interpret address
00384   82C2 9F 2F              STX   <$2F  ;Into next statement
00385   82C4 A6 80              LDA   ,X+   ;End of line?
00386   82C6 27 07              BEQ   $82CF ;If so
00387   82C8 81 3A              CMPA  #$3A  ;End of statement?
00388   82CA 27 25              BEQ   $82F1 ;If so
00389   82CC 7E B277            JMP   $B277 ;Otherwise,SN Error
00390   82CF A6 81              LDA   ,X++  ;Link pointer MSB
00391   82D1 97 00              STA   <0    ;Save it
00392   82D3 26 03              BNE   $82D8 ;If not end of program
00393   82D5 7E AE15            JMP   $AE15 ;If end of program, STOP
00394   82D8 EC 80              LDD   ,X+   ;Line number
00395   82DA DD 68              STD   <$68  ;Save as current line number
00396   82DC 9F A6              STX   <$A6  ;Current parse pointer
00397   82DE 96 AF              LDA   <$AF  ;Trace on?
00398   82E0 27 0F              BEQ   $82F1 ;If not
00399   82E2 86 5B              LDA   #$5B  ;Left bracket
00400   82E4 BD A282            JSR   $A282 ;Print it
00401   82E7 96 68              LDA   <$68  ;Line number MSB
00402   82E9 BD BDCC            JSR   $BDCC ;Integer to ASCII and print
00403   82EC 86 5D              LDA   #$5D  ;Right bracket
00404   82EE BD A282            JSR   $A282 ;Print it
00405   82F1 9D 9F              JSR   <$9F  ;Parse next character
00406   82F3 1F A9              TFR   CCR,B ;Flags to B
00407   82F5 81 98              CMPA  #$98  ;CSAVE ?
00408   82F7 27 1D              BEQ   $8316 ;If so
00409   82F9 81 97              CMPA  #$97  ;CLOAD ?
00410   82FB 27 14              BEQ   $8311 ;If so
00411   82FD 1F 9A              TFR   B,CCR ;Restore flags
00412   82FF BD ADC6            JSR   $ADC6 ;Interpret
```

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Line                Object
Number  Address     Code        Mnemonic  Operand   Jake's Comment

00413   8302 20 B7              BRA       $82BB     ;Cont scan between statements

Before encoding Basic from $B821
00414   8304 AE 62              LDX       2,S       ;Next-but-one return address
00415   8306 8C AC9D            CMPX      #$AC9D    ;After direct interpret?
00416   8309 26 05              BNE       $8310     ;RTS if not
00417   830B 8E 82F1            LDX       #$82F1    ;Else repush return after this
00418   830E AF 62              STX       2,S       ;To stack
00419   8310 39                 RTS

Extended CLOAD
00420   8311 BD 8C62            JSR       $8C62     ;Do CLOADM or CLOAD
00421   8314 20 A5              BRA       $82BB     ;Continue between statemnts chk

00422   8316 8D 02              BSR       $831A     ;Do CSAVEM or CSAVE
00423   8318 20 A1              BRA       $82BB     ;Continue between statemnts chk

00424   831A 9D 9F              JSR       <$9F      ;Parse next character
00425   831C 81 4D              CMPA      #$4D      ;"M"?
00426   831E 1026 212A          LBNE      $A44C     ;No, normal CSAVE
00427   8322 9D 9F              JSR       <$9F      ;Else parse next character
00428   8324 BD A578            JSR       $A578     ;Get specified filename
00429   8327 8D 43              BSR       $836C     ;Get start address of CSAVEM
00430   8329 BF 01E7            STX       $01E7     ;Save start address
00431   832C 8D 3E              BSR       $836C     ;Get end address
00432   832E AC 62              CMPX      2,S       ;End < start ?
00433   8330 1025 3116          LBLO      $B44A     ;FC Error if so
00434   8334 8D 36              BSR       $836C     ;Get entry point
00435   8336 BF 01E5            STX       $01E5     ;Save entry point
00436   8339 9D A5              JSR       <$A5      ;Parse current chr
00437   833B 26 D3              BNE       $8310     ;If not end of line
00438   833D 86 02              LDA       #2        ;File type = binary
00439   833F 9E 8A              LDX       <$8A      ;Zero constant
00440   8341 BD A65F            JSR       $A65F     ;Output filename header
00441   8344 0F 78              CLR       <$78      ;Set file mode = header
00442   8346 0C 7C              INC       <$7C      ;# bytes in cassette block
00443   8348 BD A7D8            JSR       $A7D8     ;Start tape, output hdr pulses
00444   834B AE 64              LDX       4,S       ;Start address
00445   834D 9F 7E              STX       <$7E      ;To I/O pointer
00446   834F 86 FF              LDA       #$FF      ;=255
00447   8351 97 7D              STA       <$7D      ;# bytes of I/O
00448   8353 EC 62              LDD       2,S       ;End address
00449   8355 93 7E              SUBD      <$7E      ;Subtract current I/O from end
00450   8357 24 05              BHS       $835E     ;If still more to do
00451   8359 32 66              LEAS      6,S       ;Else de-stack start,end,e.p.
00452   835B 7E A491            JMP       $A491     ;Ouput end null block
00453   835E 108300FF           CMPD      #$00FF    ;# bytes to O/P >= 255 ?
00454   8362 24 03              BHS       $8367     ;Yes alrdy got # blk byts setup
00455   8364 5C                 INCB                ;Else adjst # byts for last blk
00456   8365 D7 7D              STB       <$7D      ;# bytes to O/P
00457   8367 BD A7F4            JSR       $A7F4     ;Output cassette block
00458   836A 20 E1              BRA       $834D     ;Continue dump

Get # < 65536 to X and stack
00459   836C BD B26D            JSR       $B26D     ;Syntax check for ","
00460   836F BD B73D            JSR       $B73D     ;Get # < 65536 to X
00461   8372 EE E4              LDU       ,S        ;Hold return address
00462   8374 AF E4              STX       ,S        ;Replace return w/ CSAVEM addr
00463   8376 1F 35              TFR       U,PC      ;Go to return

COS
00464   8378 8E 83AB            LDX       #$83AB    ;=> pi/2
00465   837B BD B9C2            JSR       $B9C2     ;Add pi/2
00466   837E 7E BF78            JMP       $BF78     ;Do SIN

TAN(n)
00467   8381 BD BC2F            JSR       $BC2F     ;Get n frm FPAC1 to scrtch1@$40
00468   8384 0F 0A              CLR       <$0A
00469   8386 8D F6              BSR       $837E     ;SIN(n) to FPAC1
00470   8388 8E 004A            LDX       #$004A    ;=> temp locn for SIN(n)
00471   838B BD BC35            JSR       $BC35     ;Cpy SIN(n) frm FPA1 to tmp loc
00472   838E 8E 0040            LDX       #$0040    ;=> original n
00473   8391 BD BC14            JSR       $BC14     ;Copy n to FPAC1
00474   8394 0F 54              CLR       <$54      ;Set FPAC1 positive
00475   8396 96 0A              LDA       <$0A
00476   8398 8D 0C              BSR       $83A6     ;Get COS(n)
00477   839A 0D 4F              TST       <$4F      ;FPAC1=0 ?
00478   839C 1027 36F2          LBEQ      $BA92     ;OV Error if so
00479   83A0 8E 004A            LDX       #$004A    ;=> temp locn of SIN(n)
00480   83A3 7E BB8F            JMP       $BB8F     ;Do SIN(n)/COS(n)
00481   83A6 34 02              PSHS      A         ;For PULS @ $BFAF
00482   83A8 7E BFA6            JMP       $BFA6     ;0.25-FPAC1
00483   83AB 81 49              CMPA      #$49      ;Literal 1.57079633
00484   83AD 0F DA              CLR       <$DA      ;  (pi/2)
00485   83AF A2 96              SBCA      (A,X)     ;disassembly out of sync
00486   83B1 54                 LSRB                ;disassembly out of sync

ATN(n)
-----   83B0 96 54              LDA       <$54      ;Sign FPAC1
00487   83B2 34 02              PSHS      A         ;Save sign of n
00488   83B4 2A 02              BPL       $83B8     ;If positive
00489   83B6 8D 24              BSR       $83DC     ;Else make FPAC1 positive
00490   83B8 96 4F              LDA       <$4F      ;FPAC1 exponent
00491   83BA 34 02              PSHS      A         ;Save exponent
00492   83BC 81 81              CMPA      #$81      ;>1 ?
00493   83BE 25 05              BLO       $83C5     ;If not
00494   83C0 8E BAC5            LDX       #$BAC5    ;=> 1.0
00495   83C3 8D DE              BSR       $83A3     ;Get reciprocal FPAC1
00496   83C5 8E 83E0            LDX       #$83E0    ;=> ATN series
00497   83C8 BD BEF0            JSR       $BEF0     ;Do series summation
00498   83CB 35 02              PULS      A         ;Original exponent
00499   83CD 81 81              CMPA      #$81      ;>1 ?
00500   83CF 25 06              BLO       $83D7     ;If not
00501   83D1 8E 83AB            LDX       #$83AB    ;=> pi/2
00502   83D4 BD B9B9            JSR       $B9B9     ;Summed series minus pi/2
00503   83D7 35 02              PULS      A
00501   83D1 8E 83AB            LDX       #$83AB    ;=> pi/2
00502   83D4 BD B9B9            JSR       $B9B9     ;Summed series minus pi/2
00503   83D7 35 02              PULS      A         ;Original sign of n
00504   83D9 4D                 TSTA                ;positive?
```

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Line                    Object
Number  Address         Code        Mnemonic  Operand     Jake's Comment

00505   83DA 2A 03              BPL   $83DF     ;RTS if so
00506   83DC 7E BEE9            JMP   $BEE9     ;Else negate FPAC1
00507   83DF 39                 RTS

ATN series table
00508   83E0 0B                           ;# entries in table
00509   83E1 76 B383            ROR   $B383
00510   83E4 BD D379            JSR   $D379
00511   83E7 1E F4
00512   83E9 A6 F5              LDA   (B,S)
00513   83EB 7B
00514   83EC 83 FCB0            SUBD  #$FCB0
00515   83EF 107C
00516   83F1 0C 1F              INC   <$1F
00517   83F3 67 CA
00518   83F5 7C DE53            INC   $DE53
00519   83F8 CB C1              ADDB  #$C1
00520   83FA 7D 1464            TST   $1464
00521   83FD 70 4C7D            NEG   $4C7D
00522   8400 B7 EA51            STA   $EA51
00523   8403 7A 7D63            DEC   $7D63
00524   8406 30 887E            LEAX  $7E,X
00525   8409 7E 9244            JMP   $9244
00526   840C 99 3A              ADCA  <$3A
00527   840E 7E 4CCC            JMP   $4CCC
00528   8411 91 C7              CMPA  <$C7
00529   8413 7F AAAA            CLR   $AAAA
00530   8416 AA 13              ORA   -$0D,X
00531   8418 81 00              CMPA  #0
00532   841A 00 00              NEG   <0
00533   841C 00 03              NEG   <3

LOG series table @ $841D
00534   841E 7F 5E56            CLR   $5E56
00535   8421 CB 79              ADDB  #$79
00536   8423 80 13              SUBA  #$13
00537   8425 9B 0B              ADDA  <$0B
00538   8427 64 80              LSR   ,X+
00539   8429 76 3893            ROR   $3893
00540   842C 16 8238            LBRA  -$7DC8    ;0667
00541   842F AA 3B              ORA   -5,Y
00542   8431 20 80              BRA   $83B3
00543   8433 35 04              PULS  B
00544   8435 F3 3481            ADDD  $3481
00545   8438 35 04              PULS  B
00546   843A F3 3480            ADDD  $3480
00547   843D 80 00              SUBA  #0
00548   843F 00 00              NEG   <0
00549   8441 80 31              SUBA  #$31
00550   8443 72
00551   8444 17 F8BD            LBSR  -$0743    ;7D04
00552   8447 BC 6D10            CMPX  $6D10     ;Disassm out of sync
00553   844A 2F 2F              BLE   $847B     ; until $8452
00554   844C FD 8E84            STD   $8E84     ;   .
00555   844F 32 96              LEAS  (A,X)     ;   .
```

```
Line                    Object
Number  Address         Code        Mnemonic  Operand     Jake's Comment

00556   8451 4F                 CLRA            ;   .

LOG(n)
-----   8446 BD BC6D            JSR   $BC6D     ;Get sign of (n)
-----   8449 102F 2FFD          LBLE  $B44A     ;FC Error if <= 0
-----   844D 8E 8432            LDX   #$8432    ;=> .207106781
-----   8450 96 4F              LDA   <$4F      ;Exponent n
00557   8452 80 80              SUBA  #$80      ;Save integer of exponent
00558   8454 34 02              PSHS  A         ;To stack
00559   8456 86 80              LDA   #$80      ;Force normalized exponent
00560   8458 97 4F              STA   <$4F      ;To FPAC1
00561   845A BD B9C2            JSR   $B9C2     ;FPAC1 + .207106781
00562   845D 8E 8437            LDX   #$8437    ;=> .414213562
00563   8460 BD BB8F            JSR   $BB8F     ;Divide .414213562/FPAC1
00564   8463 8E BAC5            LDX   #$BAC5    ;=> 1.0
00565   8466 BD B9B9            JSR   $B9B9     ;1.0 minus FPAC1
00566   8469 8E 841D            LDX   #$841D    ;=> LOG table
00567   846C BD BEF0            JSR   $BEF0     ;Sum coefficient
00568   846F 8E 843C            LDX   #$843C    ;=> 0.5
00569   8472 BD B9C2            JSR   $B9C2     ;FPAC1 + 0.5
00570   8475 35 04              PULS  B         ;Original n exponent integer
00571   8477 BD BD99            JSR   $BD99     ;Add to FPAC1
00572   847A 8E 8441            LDX   #$8441    ;=> .193147181
00573   847D 7E BACA            JMP   $BACA     ;FPAC1 * .193147181

SQR(n)
00574   8480 BD BC5F            JSR   $BC5F     ;Copy FPAC1 to FPAC2
00575   8483 8E BEC0            LDX   #$BEC0    ;=> 0.5
00576   8486 BD BC14            JSR   $BC14     ;0.5 to FPAC1
00577   8489 27 67              BEQ   $84F2
00578   848B 4D                 TSTA            ;n = 0?
00579   848C 26 03              BNE   $8491     ;If no
00580   848E 7E BA3A            JMP   $BA3A     ;Else return sqr = 0
00581   8491 8E 004A            LDX   #$004A    ;Floating point destination
00582   8494 BD BC35            JSR   $BC35     ;Copy 0.5 to $4A
00583   8497 5F                 CLRB
00584   8498 96 61              LDA   <$61      ;Sign of n
00585   849A 2A 10              BPL   $84AC     ;If n positive
00586   849C BD BCEE            JSR   $BCEE     ;Get INT of FPAC1
00587   849F 8E 004A            LDX   #$004A    ;=> 0.5
00588   84A2 96 61              LDA   <$61      ;Sign of n
00589   84A4 BD BCA0            JSR   $BCA0     ;Compare FPAC1 to ($4A)
00590   84A7 26 03              BNE   $84AC
00591   84A9 43                 COMA
00592   84AA D6 01              LDB   <1        ;Result of integer
00593   84AC BD BC4C            JSR   $BC4C     ;Copy FPAC2 to FPAC1
00594   84AF 34 04              PSHS  B
00595   84B1 BD 8446            JSR   $8446     ;LOG
00596   84B4 8E 004A            LDX   #$004A    ;=> 0.5
00597   84B7 BD BACA            JSR   $BACA     ;Floating Point Multiply
00598   84BA 8D 36              BSR   $84F2     ;Exponent
00599   84BC 35 02              PULS  A
00600   84BE 46                 RORA
00601   84BF 1025 3A26          LBLO  $BEE9     ;Negate FPAC1
00602   84C3 39                 RTS
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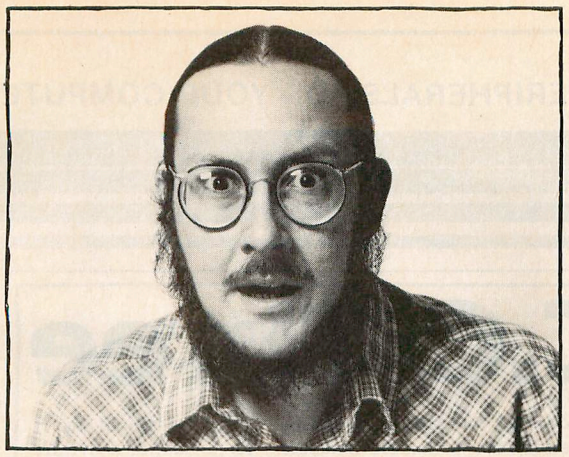

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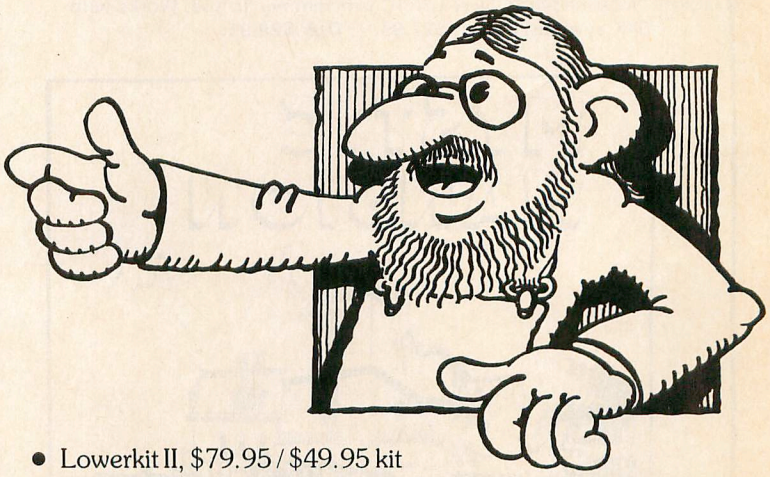

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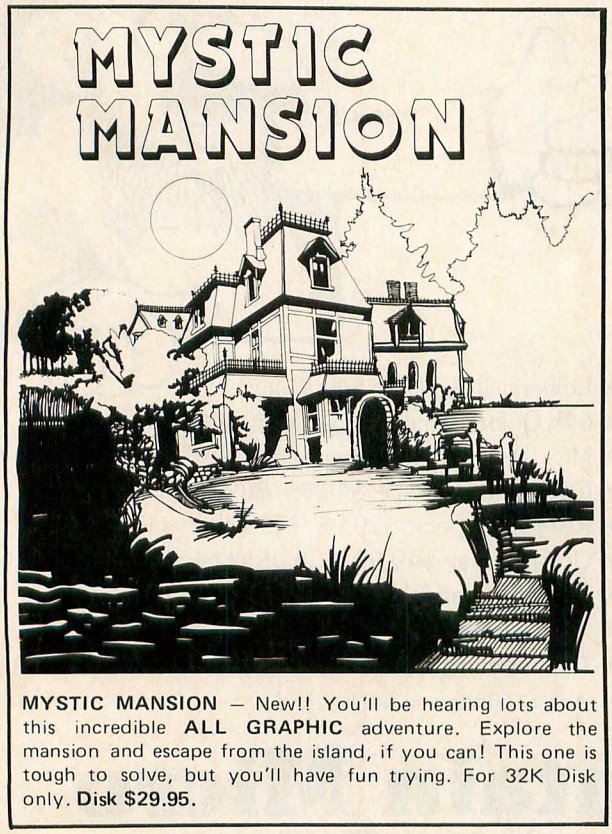

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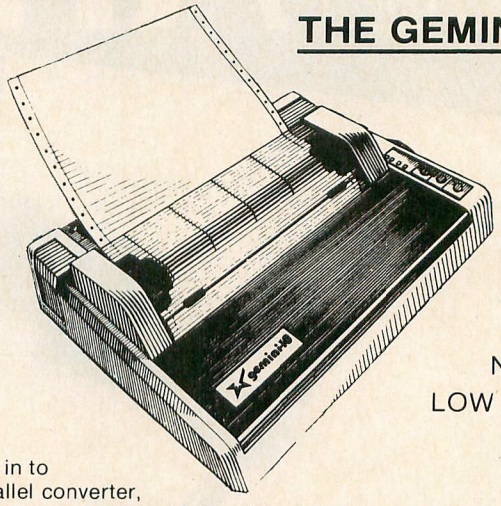

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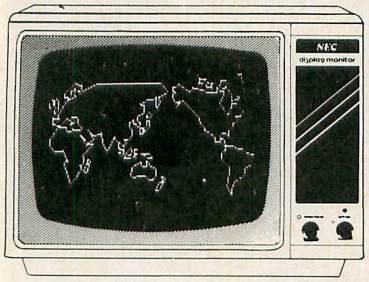

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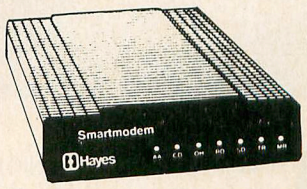

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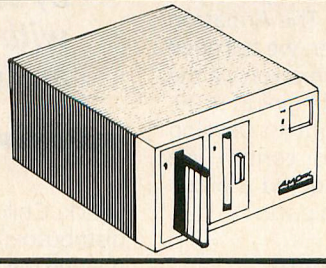

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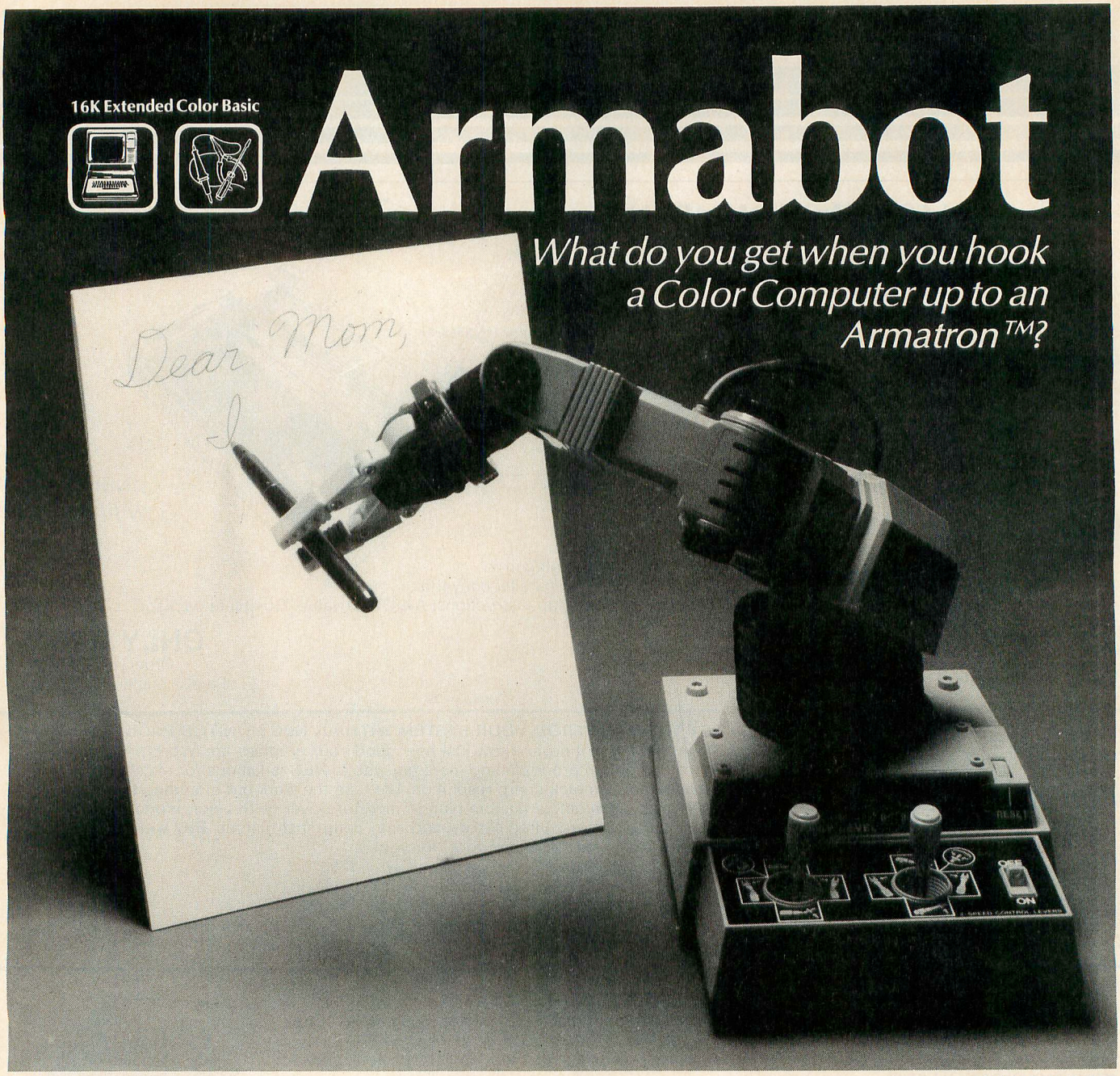

photo by Charley Freiberg

by Steve Cox, with Steve McMaster and Carlos Escobar

IT IS 11:00 P.M. THE NIGHT before the Engineering Week contest, and the motor control circuitry has just been finished and tested. The Armatron is now functional. However, we still need software to control the Armatron via the Color Computer. Judging begins at 9:00, so we have most the night to develop some simple algorithms for control. We made a pot of coffee, ordered a pizza, and forged ahead at a mad pace.

How It all Began

Carlos and other students at Oklahoma State University had organized a group to modify an Armatron robot arm (manufactured by Tomy, sold by Radio Shack, Child World, Toys R Us and other distributors) for a senior design class. He needed me to design an interface to control the Armatron using a microcomputer. I could not pass up this challenge. I promptly called one of my electronics cronies, Steve McMaster, and asked him to work on the project with me. We also decided to use this project for the annual Engineering Week project competition. (Each year during Engineering Week at Oklahoma State, different engineering interest groups enter low-cost — less than $150 — projects designed and built during the semester.) Our engineering group had decided to try to design and build an Armatron-based system with computer control. An article published in *Robotics Age* used solenoids to control the Armatron's joysticks. We believed fitting the Armatron with individual motors for each joint was a better way to go.

Carlos' group worked on the mechanical modifications and Steve and I concentrated on the interface, motor control circuitry, and the necessary software drivers.

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We had some very specific goals for the working system: the total cost (not including computer and power supplies) must be less than $100; computer control would be manual and automatic; some type of positional feedback must be available for each joint; and we'd like some type of limited vision (photocell).

The first point was to prove that robotics did not have to be as expensive as many people believe. We also wished to demonstrate that another use of the home computer is as a powerful real-time controller. The Color Computer was chosen because of ease of interfacing (all bus lines come out to the game cartridge port) and also because I happened to own one.

We used a 32K Color Computer with Extended Color Basic, although Extended Basic is not necessary. We did not use a disk-based system because we were using the game port for our 6522 interface and the 6522's chip-select is derived from the disk's motor control line — pin 36 of the Color Computer.

Hardware

We had the following hardware criteria:

- Each motor (at each joint) must be able to be switched by software to move in forward or reverse directions.
- Each motor must be able to be turned on or off under software control.
- The speed of each motor should be individually controlled by hardware (as simple as using a speed control potentiometer).
- The transistor switches used for the motors must have a low resistance when on and be capable of sinking at least one ampere.
- The motor control circuitry (steering logic and transistors) must be TTL compatible and as simple as possible (to reduce device count and point-to-point connections).
- Transistors should cost approximately $1 each.
- Flexibility must be designed into the motor controller in case circuit modifications become necessary.

We needed a transistor/logic arrangement which emulated a double-pole, double-throw (dpdt) switch. With the switch in the up position, current flows in one direction (the motor moves in the corresponding direction). The current and motor direction are reversed when the switch is changed to the down position. (As will be seen, Q1 through Q4 and the CMOS NAND gates U11 and U12, Figure 1, provide the dpdt forward/reverse function outlined in goal number one.)

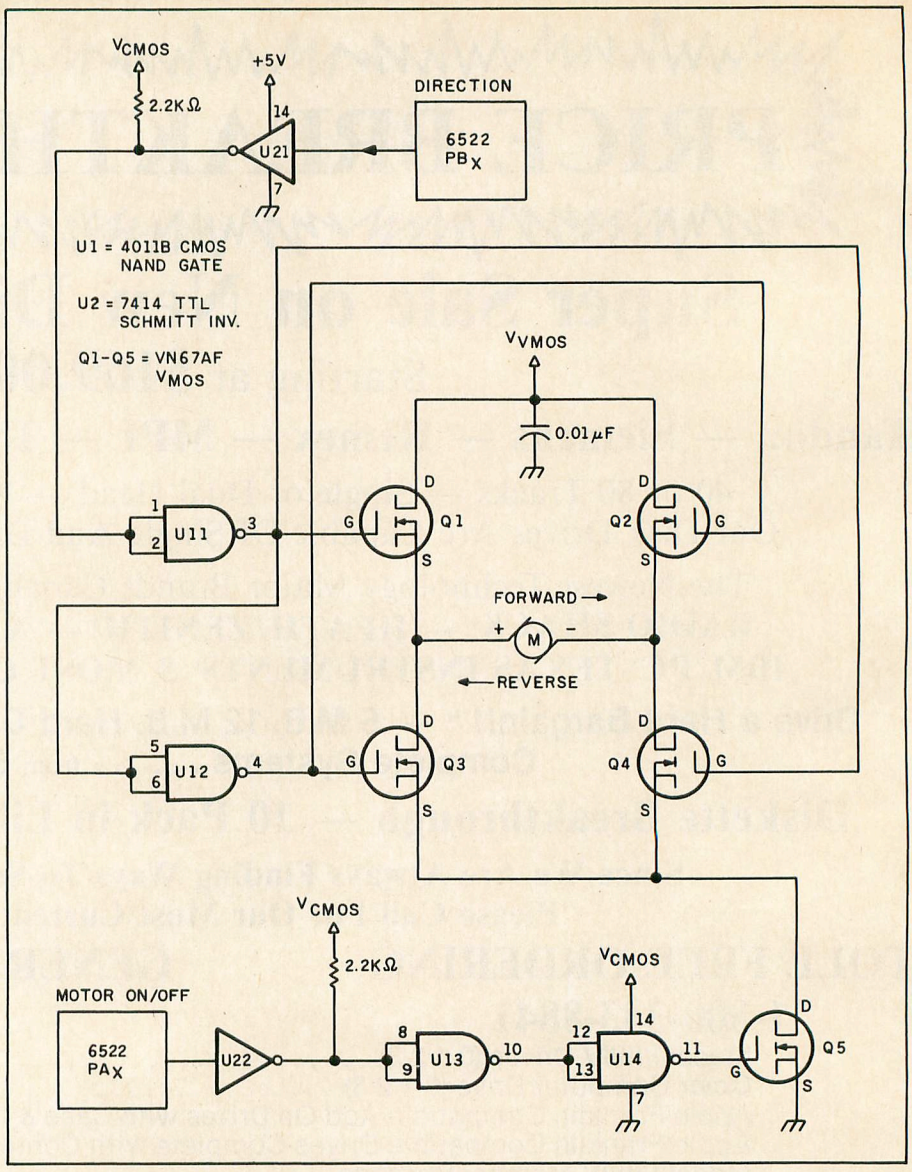


Figure 1. Motor Control Circuit

Transistor Q5 provided the on/off function outlined in goal two. When Q5 was turned on, current began to flow through the motor (M) in Figure 1.

To achieve individual speed control in each motor we had planned to use U13 and U14 as an adjustable astable multivibrator (oscillator) which would Pulse Width Modulate (PWM) the gate of transistor Q5. After bread-boarding a prototype motor controller, we discovered the PWM feature was unnecessary and was not implemented. Also, only one of the CMOS gates (U13 or U14) was necessary, but we continued with both.

Hardware goals four and five were met by using VMOS power transistors. Unlike Bipolar Junction Transistors (BJT) which are current driven, VMOS are voltage controlled. Since they draw negligible gate current (voltage driven), they are readily interfaced with TTL and CMOS logic. Using VMOS will greatly simplify the controller circuitry, since CMOS and TTL cannot directly drive high-current BJT power transistors. The 4000B series CMOS gates were used for their wide operating voltage. The VN67AF VMOS transistor made by Siliconix was used in the motor controller because it is economical ($1.05), it has a relatively low resistance when on, and it can handle over one ampere. There are now much better devices than the VN67AF available at a lower cost.

To semi-isolate the output of the 6522 from the CMOS gates, 7414 Schmitt-Trigger inverters were used; however, a high voltage open collector device such as the 7416 or 7417 should have been used.

To pull the TTL logic levels up to CMOS logic levels a 2.2 kilohm resistor was used. The 2.2 kilohm gave us good switch-

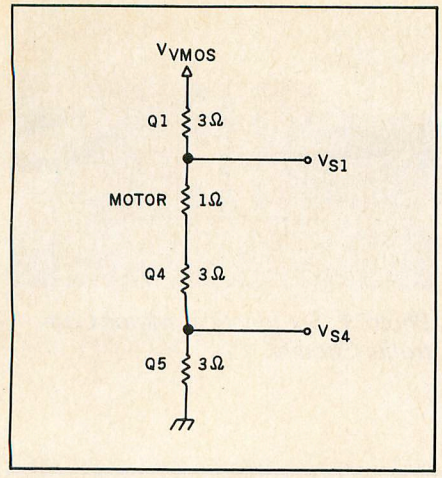


Figure 2. VMOS 3-ohm Series Resistor

ing performance and ensured that the 7414 would never sink more than seven milliamps (its maximum is 16 milliamps).

Please note the three separate power supplies used in Figure 1. Vvmos, Vcmos, and +5V. Vcmos > Vvmos > +5V, with Vcmos=15V, and Vvmos=10V. The Vvmos supply should be capable of at least four amperes due to the heavy current draw if several motors are on at once. Four amperes should allow at least three motors to be on at the same time. The power supplies were turned on in the following order: CMOS; VMOS; and TTL (+5 volt supply). CMOS was turned on first to ensure its input never received a voltage greater than Vcmos. Failure to follow this turn-on procedure produced ruined CMOS gates and strange capacitive storage characteristics from the VMOS transistors.

A Functional Description

We'll look first at the motor control circuitry in Figure 1; the 6522 will be described later.

A logic 1 input to U21 causes the output of U11 to go to +Vcmos turning both Q1 and Q4 on. The output of U12 will be 0V, turning off Q2 and Q3. A logic 0 (0 volts) at the input of U22 makes its output go high (+Vcmos), so U13's output goes low and U14's output will be at +Vcmos. Q5 will turn on as its gate-to-source voltage (Vgs) will be +Vcmos, more than sufficient to be fully saturated. Essentially, the VMOS transistors act as voltage controlled switches with a low series resistance (when on). When the motor is running, each VMOS device appears as a 3-ohm series resistor. This is illustrated in Figure 2.

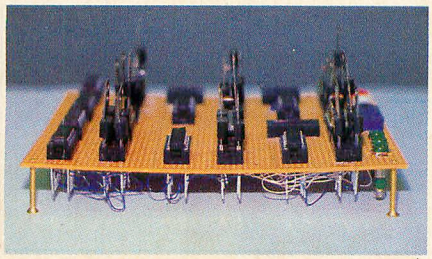


Photo 1. Motor Controller Board

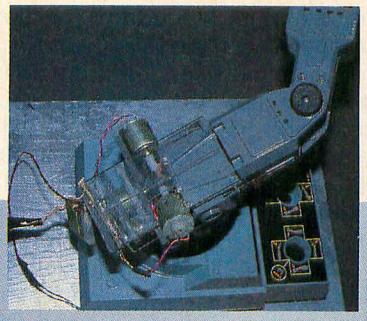
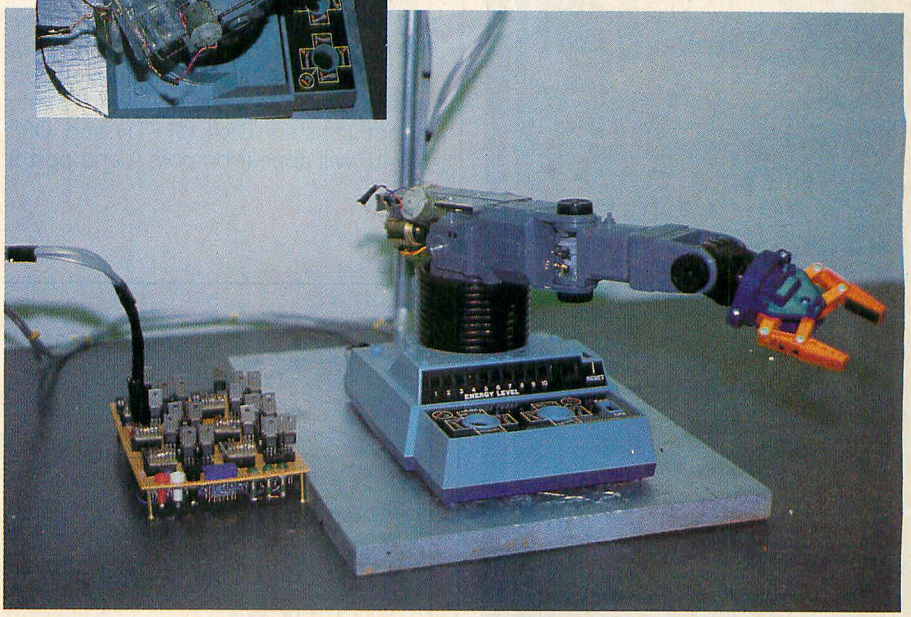


Photo 2. Modified Armatron, with Two Motors Showing

Photo 4. Functioning Arm System, Less Power Supplies, Color Computer and Connecting Cables



Motor Controller

The motor controller (Photo 1) was constructed to accommodate anticipated circuit changes. The VMOS transistors were plugged into 14-pin DIP wire-wrap sockets. This technique made the circuit changes a snap. When a VMOS device is introduced that is pin compatible with the VN67AF, we can upgrade by plugging in the new device. A drawback is the lack of adequate heat-sinking, but this can be overcome with a little ingenuity. (Paper clips work well in a pinch.)

Motors

To implement our plan to use six motors on the arm, one for each axis of rotation, these motors would have to be very inexpensive (dirt-cheap) hobbyist-type dc motors, such as those available at Radio Shack or through hobbyist magazines, if we were to remain in our final price range. The motors on the Armatron were connected to the motor controller via ordinary telephone cord, a special male-female connector (Photo 2, left) and a 16-pin DIP male-female combination (Photo 3, gray cord in the foreground).

6522 VIA

A 6522 VIA (versatile interface adaptor) was used to enable the Color Computer to communicate with the motor controller board. The 6522 has two 8-bit programmable bidirectional (input/output) parallel ports. This gave us 16 independent motor control lines. As the motor controller requires only two control lines for each motor, we needed only twelve control lines, leaving four lines (PA0, PA7, PB0, and PB7) unused. The 6522 was connected to the Color Computer bus as shown in Figure 3. Since I had a 6522 interface built prior to this project, the connections from the 6522 to the motor controller board were made using a 16-pin DIP ribbon cable (gray cable in the background of Photo 3).

Six identical motor controllers are located on the motor controller board (Photo 3). Each motor controller is the equivalent of Figure 1. If we connect the elbow motor controller to the 6522, then PAx in Figure 1 would be connected to PA1 of Figure 3 and PBx of Figure 1 would be connected to PA1 of Figure 3. These connections were made for each

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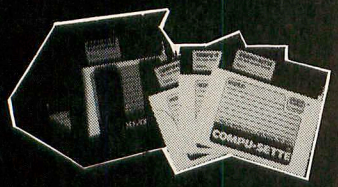

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of the six motors, producing a functioning computer controlled arm (Photo 4).

The 6522 must first be properly initialized so it may "talk" with the motor controller. The 6522 is a bidirectional device; the data direction registers (DDRA and DDRB, see Figure 4) for port A and for port B must be programmed as outputs. POKEing 255 ($FF) into DDRA ($FF43) and DDRB ($FF42) will configure all port lines as output. A value now written into output registers ORA ($FF41) and ORB ($FF40) will appear on port A and port B

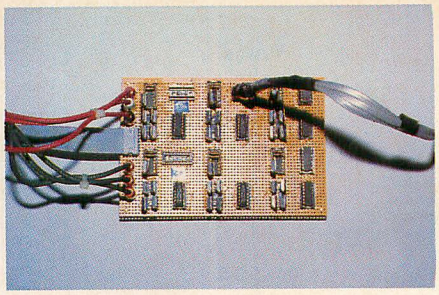

Photo 3. Six Identical Motor Controller Circuits

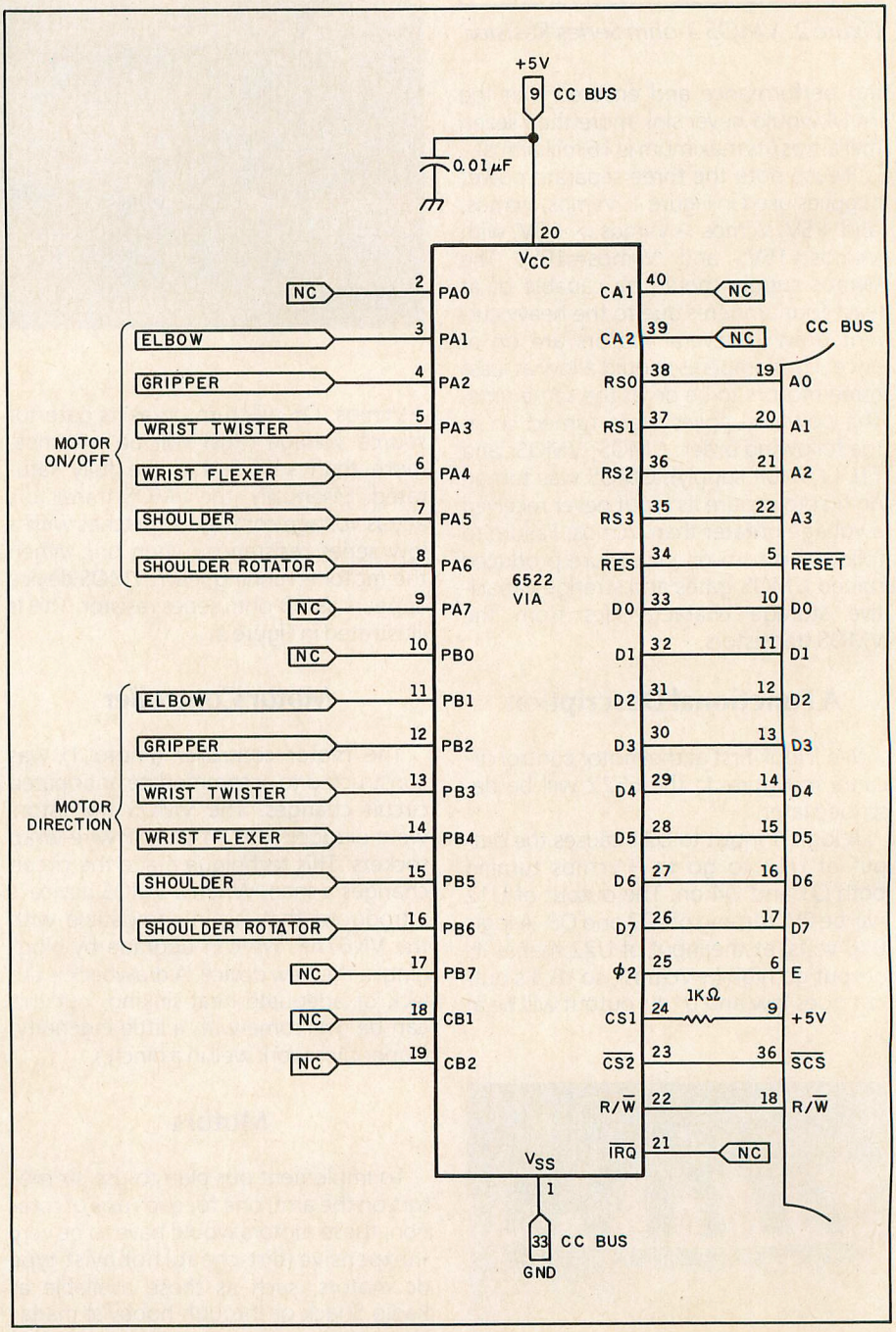

Figure 3. Color Computer to 6522 Connection

Register Number	RS Coding RS3	RS2	RS1	RS0	Register Desig.	Description Write	Read
0	0	0	0	0	ORB/IRB	Output Register "B"	Input Register "B"
1	0	0	0	1	ORA/IRA	Output Register "A"	Input Register "A"
2	0	0	1	0	DDRB	Data Direction Register "B"	
3	0	0	1	1	DDRA	Data Direction Register "A"	
4	0	1	0	0	T1C-L	T1 Low-Order Latches	T1 Low-Order Counter
5	0	1	0	1	T1C-H	T1 High-Order Counter	
6	0	1	1	0	T1L-L	T1 Low-Order Latches	
7	0	1	1	1	T1L-H	T1 High-Order Latches	
8	1	0	0	0	T2C-L	T2 Low-Order Latches	T2 Low-Order Counter
9	1	0	0	1	T2C-H	T2 High-Order Counter	
10	1	0	1	0	SR	Shift Register	
11	1	0	1	1	ACR	Auxiliary Control Register	
12	1	1	0	0	PCR	Peripheral Control Register	
13	1	1	0	1	IFR	Interrupt Flag Register	
14	1	1	1	0	IER	Interrupt Enable Register	
15	1	1	1	1	ORA/IRA	Same as Reg 1 Except No "Handshake"	

Figure 4. 6522 Information (Reprinted with permission of Synertek Inc, 3001 Stender Way, Santa Clara, CA 95052, copyright 1978.)

Program Listing. Armatron Drive

```
10 'This is the Armatron Drive p
rogram, for communication by 652
2 VIA with the Armatron Motor Co
ntroller
20 '6522 base address is $FF40.
Port A of the 6522 turns the mot
ors on and off. Port B controls
the motors' direction.
25 'References to Left, Right,
Up or Down relative to operator
50 'by Steve Cox, Steve McMaster
 03/29/83     Rev 1: 11/26/83
100 'Initialize DDRB ($FF42) and
 DDRA ($FF43) as outputs
110 POKE &HFF42,255 :POKE &HFF43
,255
130 'All references to (+ to -)
or (- to +) refer to direction o
f current through motor, Fig. 2
140 'Set port B ($FF40) to all m
otors Off
150 'Set port A ($FF41) to all m
otors Forward (+ to -, Fig 2)
160 POKE &HFF40,255 :POKE &HFF41
,255
170 CLS
180 SOUND 5,5
190 PRINT"DO YOU WANT TO OPERATE
 IN THE   MANUAL OR AUTOMATIC MO
DE (M OR A)?"
```


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output lines. For example, POKE &HFF40,2 (ORB) will result in PB1=1 (+5 volts) and PB0,PB2–PB7=0 (0 volts). If bit 3 of ORB is set by POKE &HFF40,8, PB3 will equal logic one (+5 volts); however, if bit 3 is cleared (0), PB3 will be logic low (0 volts). The port output lines logic levels (0 or +5 volts) follow their corresponding bits logic values (0 or 1) in ORA and ORB.

Software Development

We decided we would at least need full keyboard control of the Armatron. If we were still awake and had time before the contest, some automatic routines would also be nice.

A rough flowchart for the manual mode is presented in Figure 5. Between the flowchart and the Program Listing, we can fully describe the manual mode.

After initializing the 6522 data direction registers (DDRA and DDRB) as outputs in Line 110, the output port registers (ORA and ORB) are initialized in Line 160 for all motors off and in the forward direction. This direction is in reference to the current flow through the motor in Figure 1 and not a physical direction of the Armatron. In this description, forward indicates motor current flow from plus to minus, with reverse indicating current flow from minus to plus. Physical direction (such as left, right, up or down) is referenced to my position at the Color

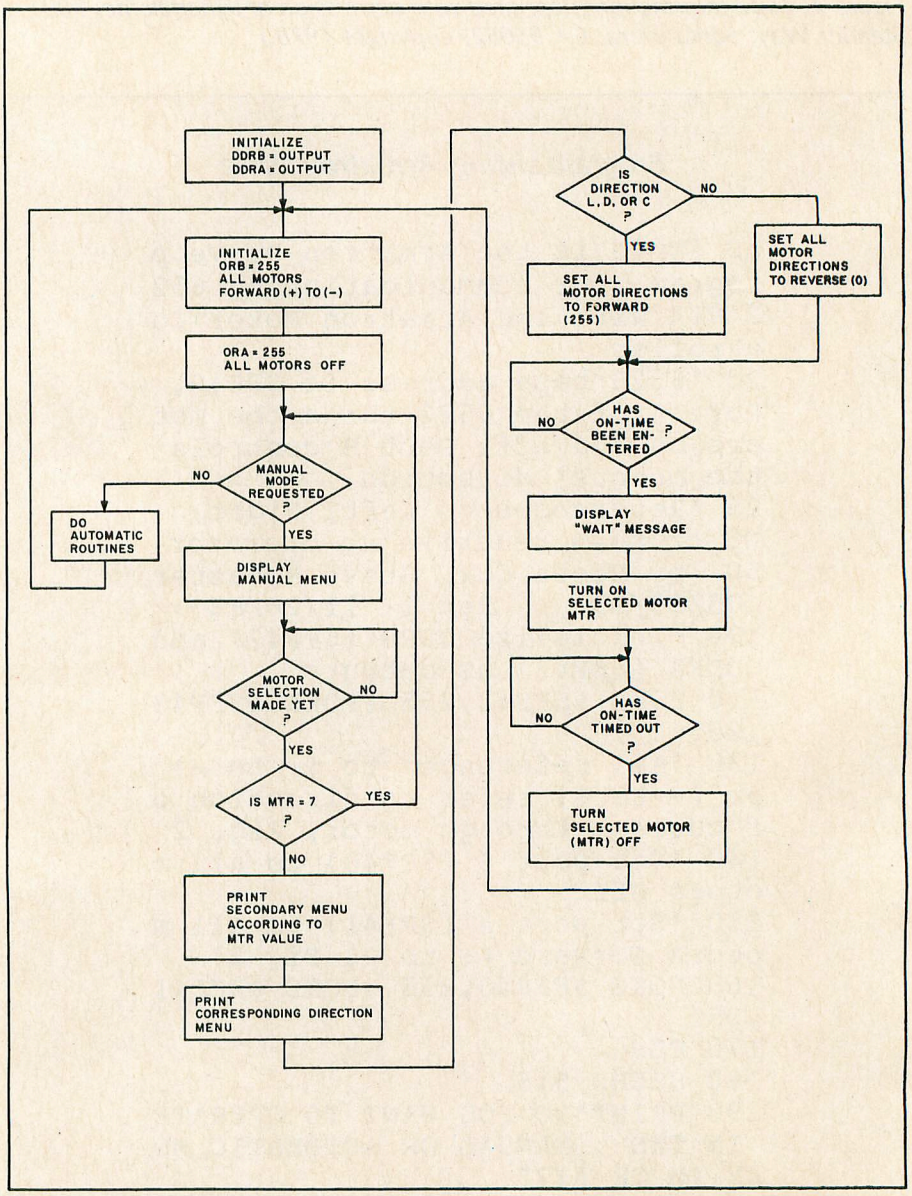

Figure 5. Flowchart For Manual Mode

Computer keyboard. Picture yourself sitting at the keyboard which is situated at a right angle to the rear of the Armatron. As you look around to the Armatron, which faces away from you, your right would also be the Armatron's right. Following the 6522's initialization, the user is queried for the automatic or manual mode (Line 190). Choosing the manual mode displays the manual menu in Lines 300 – 370. This menu describes the various motorized joints of the Armatron. Making a selection will display a secondary menu (Lines 450 – 590) according to the joint chosen. For example, if you choose number one, the elbow, the screen will display:

ELBOW
ENTER DIRECTION
(L OR R)

Entering a direction brings a prompt:

ENTER ON TIME (SECONDS)?

Once the motor direction has been entered, Line 630 checks to see if the directions L (left), D (down), or C (close) have been entered. If so, it sets all motors to forward (relative to Figure 1) even though only one motor is actually going to be turned on. If L, D, or C has not been entered, all motors are set for reverse. The actual direction setting is accomplished in Lines 650 – 690. After entering the motor on time, the Motor On subroutine (1390 – 1440) is called, turning on the selected motor (MTR). A timing loop in Line 750 will wait the number of seconds specified until the Motor Off subroutine (1470 – 1510) is called, disabling the motor's current flow. After the motor is turned off the program returns to the manual menu.

Subroutines

The Motor On and Motor Off subroutines are very important to the manual and automatic modes.

Motor On: Line 1410 reads output register A (ORA) to get the current status of the motors — which motors are on or off. Lines 1420 – 1430 then clear (logic 0) the bit in ORA associated with the motor (MTR variable) to be turned on, but leaves the other bits in ORA unaltered. Only the selected motor (MTR) is turned on while the other motors are unaffected. If motor 1 (MTR=1 is the elbow) is chosen, bit 1 of ORA will be cleared to logic 0, turning on the elbow motor.

Motor Off: This routine is similar to Motor On, except that Lines 1490 – 1500 will set (logic 1) the bit in ORA associated with the variable MTR. Only the selected motor (MTR) will be turned off, leaving the other motors unaffected.

Set Bit For Direction: This subroutine will set the direction bit in ORB as-

```
200 A$=""
210 A$=INKEY$ :IF A$="" THEN210
220 IF A$="A" THEN 1810
230 CLS
250 'Initialize 6522 parameters
ever Manual mode loop.
260 POKE &HFF41,255 :POKE &HFF40
,255
270 'Port A Output ($FF41) Motor
 On/Off, 0=On, 1=Off
280 'Port B Output ($FF40) Motor
 Direction, 1=Forward (+ to -),
0=Reverse (- to +), see Fig 2
290 '***** Manual Menu *****
300 PRINT"ENTER MOTOR KEY NEEDED
"
310 PRINT"1)  ELBOW"
320 PRINT"2)  GRIPPER"
330 PRINT"3)  WRIST-SPIN"
340 PRINT"4)  WRIST"
350 PRINT"5)  SHOULDER"
360 PRINT"6)  SHOULDER-ROTATION"

370 PRINT"7)  RETURN TO MENU"
380 PRINT
390 A$=""
400 A$=INKEY$ :IF A$="" THEN400
410 IF A$="7" THEN 170
420 MTR=VAL(A$)
430 ON MTR GOTO 450, 460, 470, 4
80, 490, 500
440 'Label Secondary Menues
450 PRINT"ELBOW" :GOTO 510
460 PRINT"GRIPPER" :GOTO 510
470 PRINT"WRIST-SPIN" :GOTO 510
480 PRINT"WRIST" :GOTO 510
490 PRINT"SHOULDER" :GOTO 510
500 PRINT"SHOULDER"
510 PRINT"ENTER DIRECTION"
530 ON MTR GOTO 540,550,560,570,
580,590
540 PRINT"(L OR R)" :GOTO 600
550 PRINT"(C OR O)" :GOTO 600
560 PRINT"(S)":GOTO600
570 PRINT"(U OR D)":GOTO600
580 PRINT"(U OR D)":GOTO600
590 PRINT"(L OR R)"
600 C$=""
620 C$=INKEY$ :IF C$="" THEN620
630 A$=C$:IF C$="L" OR C$="D" OR
 C$="C" THEN C$="F" ELSE C$="R"
640 PRINT A$ :PRINT
650 IF C$="F" THEN 690
660 'All motors Reverse
670 POKE &HFF40,0 :GOTO 700
680 'All motors Forward
690 POKE &HFF40,255
```

sociated with MTR. That is, MTR=1 affects ORB bit 1. Setting the direction bit will cause the selected motor's (MTR) current to travel positive and minus (forward) relative to Figure 1.

Clear Bit For Direction: This routine is the same as the Set Bit routine, but the selected motor's direction bit is cleared (logic 0), forcing the motor to turn in reverse (current minus to plus).

Change Direction: This subroutine was written for use in the automatic routines. Lines 1570 – 1580 read ORB and determine which direction the motor (MTR) is turning. If the direction is forward, the direction is changed to reverse, and vice versa. Only the direction bit associated with MTR is affected. This subroutine made moving joints left and then right or up and then down very easy.

Automatic Mode

Since we were running out of time, we decided to try to create a simple routine to demonstrate the movement of each Armatron joint in both directions, with more than one motor on during some points of the routine.

The first automatic routine resides from 870 – 1240. It was developed in panic mode, so it is not very refined. The

```
700 INPUT"ENTER ON-TIME (SECONDS
)";T
710 PRINT:PRINT:PRINT:PRINT"PLEA
SE WAIT WHILE I EXECUTE THE COMM
AND"
720 'Turn MTR motor On
730 GOSUB 1390
740 'Wait w/ motor On T seconds
750 FOR X=1 TO 460*T :NEXT X
760 'Turn MTR motor Off
770 GOSUB 1460
780 'Back to Manual Menu
790 GOTO 230'*End Manual Menu**
820 '1st auto routine developed
3/30/83 @ 5:00 AM by Steve Cox,
Steve McMaster, Carlos Escobar
840 POKE &HFF43,255 :POKE &HFF42
,255
850 I=0
860 ' Delay times for motors
870 T1=.2 :T4=.7 :T5=.15 :T6=.25
 :MTR=2
930 GOSUB 1390
940 MTR=3 :GOSUB 1330
960 GOSUB 1390
970 MTR=1 :GOSUB 1390
980 FOR X=1 TO 460*T1 :NEXT X
```


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```
990 GOSUB 1560 :FOR X=1 TO 460*T
1 :NEXT X
1000 MTR=3 :GOSUB 1460
1010 MTR=2 :GOSUB 1460
1020 MTR=1 :GOSUB 1460
1030 MTR=5 :GOSUB 1390
1040 FOR X=1 TO 460*T5 :NEXT X
1050 GOSUB 1560 :FOR X=1 TO 460*
T5*2 :NEXT X
1060 GOSUB 1560
1070 FOR X=1 TO 460*T5 :NEXT X
1080 GOSUB 1460
1090 MTR=4 :GOSUB 1390
1100 MTR=6 :GOSUB 1390
1110 MTR=4 :GOSUB 1560
1120 FOR X=1 TO 460*T6 :NEXT X
1130 GOSUB 1460
1140 MTR=6 :GOSUB 1460
1150 MTR=6 :GOSUB 1560
1160 MTR=6 :GOSUB 1390
1170 FOR X=1 TO 460*T6*2.4 :NEXT X
1180 GOSUB 1560
1190 FOR X=1 TO 460*T6 :NEXT X
1200 GOSUB 1460
1210 MTR=6 :GOSUB1560
1220 GOSUB 1390 :FOR I=1TO460*T6
 :NEXT I :GOSUB 1460
```

more

routines Demo 2 (Line 2540) and Demo-Auto 2 (Line 1810) were developed later. These two routines let the Armatron strut its stuff in the Automatic mode. In the Program Listing, Demo-Auto has been well commented, so the reader may follow each movement.

Since this project did not incorporate any type of positional feedback due to time constraints during development, software timing loops were used throughout the automatic routines. To make the Armatron's joints move to specific positions from an initialized state we used the manual routine and experimented with the motor on times. With these experimentally derived on times for each joint, we knew approximately how long it took each joint to go through a movement from its initial position.

Here is the logic flow for an automatic routine: decide the movements for each joint; initialize the Armatron in a standard position; derive the motor on time for each movement of each joint, using the manual mode; note the on times for the various joints and movements; write an automatic routine using these derived motor on times in conjunction with the three Basic subroutines.

Since the automatic routines rely so heavily on timing loops, they also rely on the Vvmos supply voltage. These auto-

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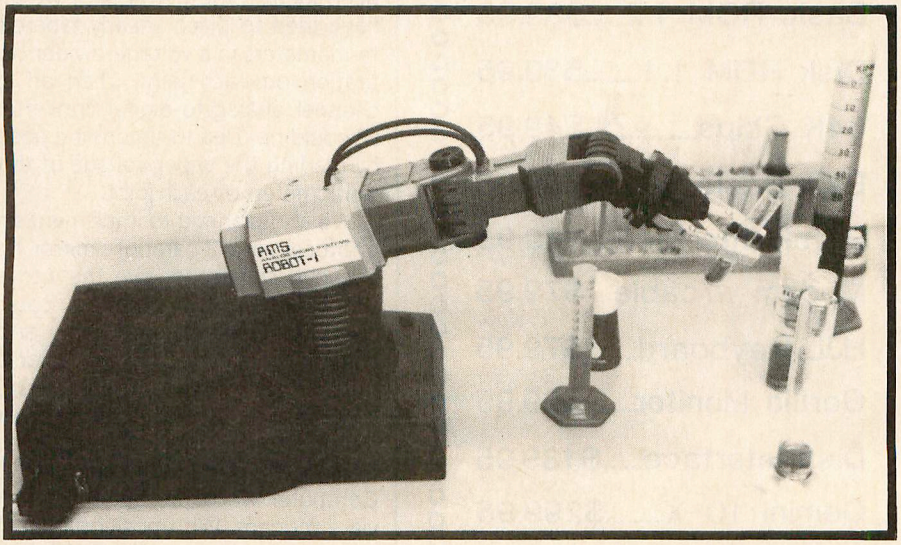

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matic routines were written at a Vvmos =10 volts. Changing the Vvmos supply voltage would alter the response of the Armatron during the automatic routines because the Vvmos supply governs the motor current. Altering Vcmos could also affect the timing loops.

Some type of positional feedback for each joint would have been ideal. With feedback we could tell a joint to move a specific number of degrees independent of timing loops, supply voltage, and joint stiffness.

Hardware Improvements

Although the circuit in Figure 1 worked very well, hindsight always reaps circuit improvements. Six of the circuits in Figure 1 were designed and built in two weeks. The motor controller in Photo 1 was the finished result. As expected, problems did arise.

Occasionally, our motor controller would blow out a CMOS NAND gate. I believe this was due to the fact that CMOS logic gates, operating with high supply voltages (around 15 volts), can latch up on switching transients. A latched up gate will draw excessive current from the Vcmos supply through its internal MOS transistors, effectively ruining the logic gate. To counteract this problem, generous use of decoupling capacitors (.01 microFarad) on the Vcmos and Vvmos supply lines should help. More importantly, the Vcmos supply current should be limited by inserting a series resistor of 3 kilohms to 4 kilohms between pin 14 of the CMOS and Vcmos. To slow down switching transients, series damping resistors (5 – 10 kilohm) could be placed between the CMOS gates output and the VMOS transistors' gate. A better idea is to replace the CMOS NAND gates with TTL high-voltage open-collector 7426 NAND gates, with their output pulled up to the voltage necessary to drive the VMOS into saturation.

To protect the VMOS from back-emf generated by turning off the motors, 15-volt zener diodes should be placed on the drains of Q3 and Q4. Transistor Q5 can be eliminated by using a configuration such as Figure 6; however, all four transistors should not be allowed on at the same time (see truth table in Figure 6.)

New Power MOS

Advances in MOS power devices have brought lower prices and lower conducting resistances. A new device which I would highly recommend (although I have not tried it) is the BUZ71 EconoFET by Siemens. It boasts an on resistance of 100 milliohms, drain-to-source breakdown (Vds) of 50 volts, and drain-to-source current (Ids) of 12 amperes, at a cost of 65¢ to $1. Using these devices instead of the VN67AFs, the Vvmos supply can be lowered by a factor of ten because of their extremely low on resistance. By lowering the Vvmos supply voltage, the voltage applied to the gate of the VMOS devices could also be substantially lowered. The following should explain why.

When Q1-Q4-Q5 were on (see model in Figure 2) the voltage at Vs1 (Q1's source) is approximately 7 volts if Vvmos=10 volts. Recall that VMOS transistors are turned on according to their Vgs. When Q1 is turned on, its gate voltage referenced to ground is at Vcmos (or 15 volts). This gives Q1 a net Vgs of 15V−7V=8 volts. Vgs=8 volts is probably just enough to saturate (fully turn on) Q1. The Vgs of Q4 will be 15V−Vs4 or 15−3V=12 volts: more than enough to saturate Q4.

The Vcmos supply voltage needed to be greater than the Vvmos supply , so the net Vgs was enough to saturate all transistors. However, using devices such as the BUZ71, the voltage drops across each transistor dramatically decreases, lowering the needed gate voltage. This condition holds as long as the current through the devices is low enough to avoid a substantial voltage drop across them.

Some type of positional feedback for each joint of the Armatron would have been ideal. Time permitting, we would have tried to place linearly tapered potentiometers in a voltage-divider configuration on each joint. Then an eight-channel analog-to-digital converter (A/D) could be used to determine positions by reading the wiper voltage of the potentiometers on each joint.

We also planned to implement simple photocells and a parabolic mirror from a cheap flashlight to give the Armatron simple vision. The photocell could be configured in a voltage divider and the voltage could be read by the Color Computer's joystick ports. The joystick ports could also be used to read the potentiometers. Another novel approach to controlling the Armatron using the Color Computer would be by remote control via a modem. With positional feedback this could easily be realized. Using a software package such as REMOTERM — a remote terminal program — and a modem, the Armatron could be controlled from any remote location with another computer/modem or terminal/modem combination. I have used REMOTERM this way with excellent results. Another

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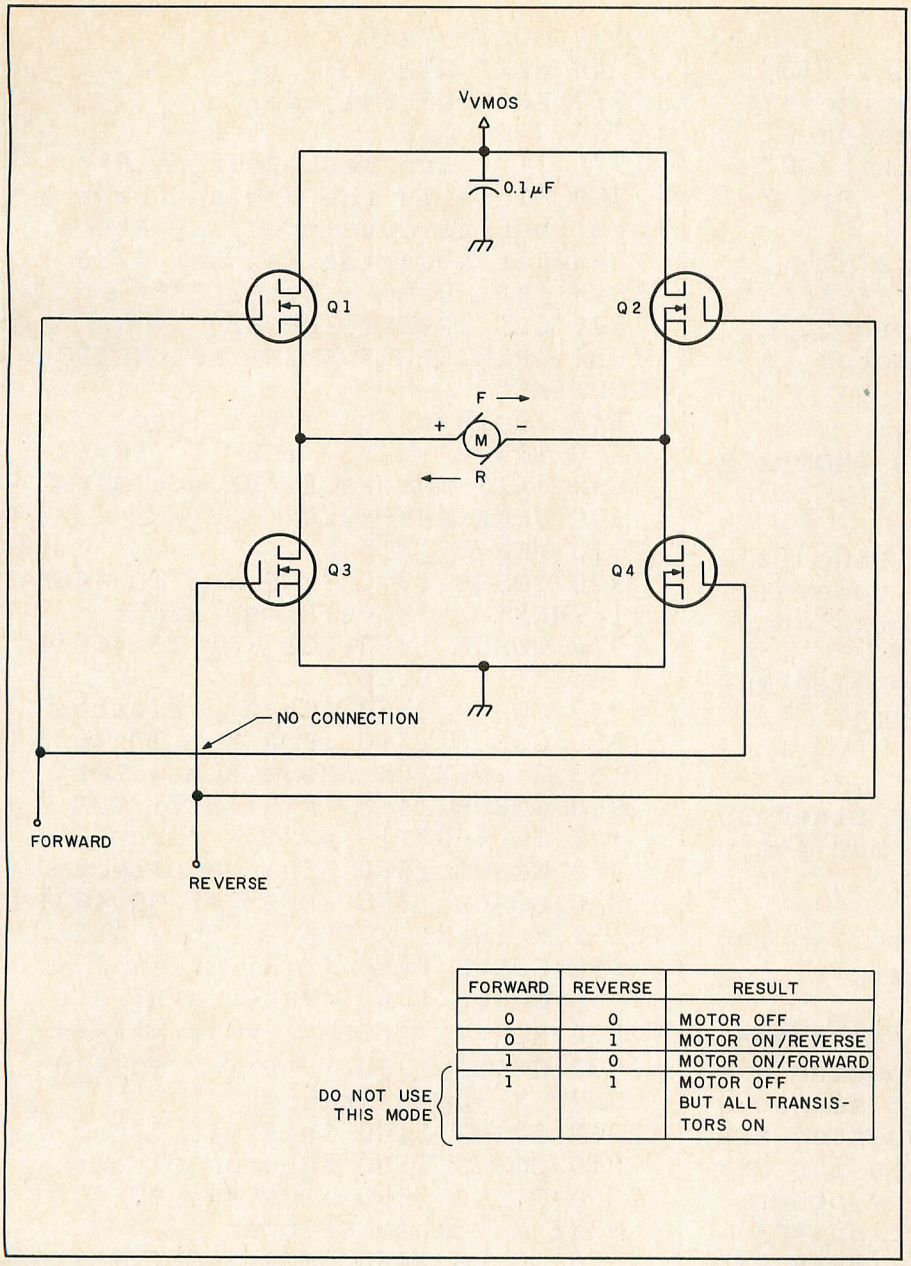

FORWARD	REVERSE	RESULT
0	0	MOTOR OFF
0	1	MOTOR ON/REVERSE
1	0	MOTOR ON/FORWARD
1	1	MOTOR OFF BUT ALL TRANSISTORS ON

DO NOT USE THIS MODE

Figure 6. Alternate Motor Control Circuit

possibility is using the joysticks to control the Armatron. By including a Learn mode, the Armatron's movements could be programmed via the joysticks. These movements could then be saved as data on a tape, disk, or EPROM for later execution. The possibilities seem endless.

Our total hardware cost was approximately $96, including the 6522 VIA chip. Our project won second place, missing first place by one point.

This project was not intended to be fully understood by a beginner in electronics and the Color Computer. Nor is this article intended to be a cookbook "how to" article. Robotics using home computers is virtually virgin territory. This field is begging for your skill and insight.

So what are you waiting for? Go for it!

■ ■ ■

Contributors

Dr. Joe Cleveland
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On Motors

by Carlos Escobar

THE IDEA OF INTERFACING an inexpensive toy to a computer to produce a working robot came after studying an Armatron. We found many problems after studying the complexity of the mechanisms used to operate the Armatron's six functions; many hours were dedicated to find a way to interface the Color Computer to the model. The solution we hit on was to use independent actuated motors to perform each of the functions.

We then had to find the best location for each motor, the speed at which the motor should run, and finally, the torque required to perform each individual function. Lack of physical space in the arm, and difficulty in getting to the drive shafts and gears, made this one of the most delicate tasks.

The location of the motors was found by determining the place on the mechanism where high speed of rotation (RPM) and low torque were available to perform each operation. Our findings presented some problems: space and accessibility to the specified shafts and gears were limited to these locations. Also, the inaccessibility of small high-torque motors was a set-back.

Deciding to use inexpensive, low torque, high RPM motors was inevitable. The motors used were similar to the one originally located in the Armatron — 300 mAmps, 3 Vdc, 8000 RPM: and cost $2.50 each.

The first motor was mounted inside the base. This motor activates the gearing system which rotates the arm. Motor number two was located inside the shoulder. The function of this motor is to move the arm up or down. The four remaining motors were placed at the back of the arm. These last four motors actuate the hand rotation, the gripper, the wrist, and the elbow.

Many modifications were made to accommodate these last four motors: existing shafts were replaced with longer shafts; and new gears were added to reduce the RPM and increase the torque of these motors.

■ ■ ■

```
1230 I=I+1
1240 IF I<6 THEN 870 ELSE 170
1250 '*End 1st auto routine****
1270 'Set Bit for Direction...
This causes selected motor (MTR)
 to run Forward (+ to -, Fig 2)
1290 P= PEEK( &HFF40 )
1300 POKE &HFF40, P OR 2^MTR
1310 RETURN'*******************
1330 ' Clear Bit for Direction..
 This causes selected motor to r
un Reverse (- to +, Fig 2)
1350 PP= PEEK( &HFF40 )
1360 POKE &HFF40,PP AND (NOT(2^M
TR))
1370 RETURN
1390 '*** Motor On *** Line 1420
 was used, works fine; however,
A=A AND (NOT(2^MTR)) works, too
1410 A= PEEK( &HFF41 )
1420 IF (A AND INT(2^MTR))=0 THE
N 1430 ELSE A=A-INT(2^MTR)
1430 POKE &HFF41,A
1440 RETURN
1460 '*** Motor Off *** Line1490
 was used, works fine; but A=A O
R (2^MTR) work, too
1480 A= PEEK( &HFF41 )
1490 IF (A AND INT(2^MTR))>0 THE
N 1500 ELSE A=A+INT(2^MTR)
1500 POKE &HFF41,A
1510 RETURN'*******************
1530 'This direction routine use
d by automatic mode. It senses w
hich direction the requested MTR
 is going, then reverses its dir
ection w/o affecting any other.
1560 '*** Change Direction ***
1570 B= PEEK( &HFF40 ) :BB=B AND
 (INT(2^MTR)) :IF BB=0 THEN B=B+
INT(2^MTR) ELSE B=B-INT(2^MTR)
1580 POKE &HFF40,B :RETURN'****
1600 '@@Test Routine. Used durin
g hardware debug. Sequences each
 motor On, waits .4 secs., turns
 Off, changes direction, turns O
n, waits, turns off, next motor
1630 T=.4
1640 FOR MTR=1 TO 6
1650 PRINT"MOTOR NUM=";MTR
1660 INPUT DUM
1670 GOSUB 1390
1680 FOR I=1 TO 460*T :NEXT I
1690 GOSUB 1460
1700 GOSUB 1560
1710 GOSUB 1390
1720 FOR I=1 TO 460*T :NEXT I
1730 GOSUB 1460
1740 NEXT MTR
1750 POKE &HFF41,255
1760 GOTO 1600
1770 '*** End Test Routine ***
1790 'This is the 3rd and best a
uto routine developed. By Steve
McMaster & Carlos Escobar 4/83
1810 '*** Demo - Auto2 ***
1820 CLS :PRINT :PRINT
1830 PRINT"PERFORMING AUTOMATIC
ROUTINE"
1840 'Delays for Motor loop
1850 T1=.2 :T4=.7 :T5=.1 :T6=.2
1890 'All motors first set Rvrs
1900 POKE &HFF40,0
1910 MTR=1 'Elbow
1920 GOSUB 1390 :FOR X=1 TO 460*
T1 :NEXT X 'Move Elbow Right
1930 GOSUB 1460:FOR X=1 TO 460*T
1 :NEXT X 'Stop
1940 GOSUB 1560 'Change Directn
1950 GOSUB 1390 :FOR X=1 TO 460*
T1*3.3 :NEXT X 'Move Elbow Left
1960 GOSUB 1460 'MTR1 Off: FOR X
 = 1 TO 460*T1 :NEXT X 'Stop
1970 GOSUB 1560 'Change Directn
1980 GOSUB 1390 :FOR X=1 TO 460*
T1*1.5 :NEXT X 'Move Elbow Left
1990 GOSUB 1460 'MTR1 Off ***
2000 GOSUB 1560 'Reset MTR1 Dir
2020 MTR=2 'Gripper ***********
2030 GOSUB 1390 :FOR X=1 TO 460
:NEXT X 'Open Gripper
2040 GOSUB 1460 'MTR Off 'Stop
2050 GOSUB 1560 'Change Directn
2060 GOSUB 1390 :FOR X=1 TO 800
:NEXT X 'Close Gripper
2070 GOSUB 1460 'MTR 2 Off ***
2090 MTR=3 'Wrist (Twist) *****
2100 GOSUB 1390 :FOR X=1 TO 460
:NEXT X 'Twist Wrist
2110 GOSUB 1460 'MTR 3 Off'Stop
2120 FOR X= 1 TO 460 :NEXT X
2140 MTR=4 'Wrist (Up/Down) ***
2150 GOSUB 1390 :FOR X=1 TO 460*
T4 :NEXT X 'Move Wrist Up
2160 GOSUB 1460 'MTR 4 Off'Stop
2170 FOR X= 1 TO 460 :NEXT X
2180 GOSUB 1560 'Change Directn
2190 GOSUB 1390 :FOR X=1 TO 460*
T4*2.0 :NEXT X 'Move Wrist Down
2200 GOSUB 1460 'MTR 4 Off'Stop
2210 FOR X= 1 TO 460 :NEXT X
2220 GOSUB 1560 'Change Directn
2230 GOSUB 1390 :FOR X=1 TO 460*
T4 :NEXT X 'Move Wrist Up
```

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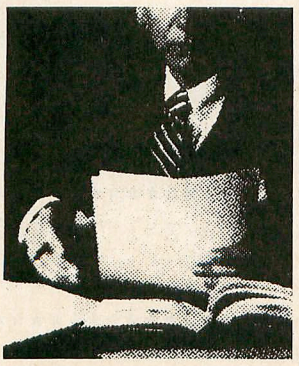

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```
2240 GOSUB 1460 'MTR 4 Off'Stop
2250 FOR X= 1 TO 460 :NEXT X
2270 MTR=5 'Shldr (Up/Dn) *****
2280 GOSUB 1390 :FOR X=1 TO 460*
T5*.75 :NEXT X 'Move Shouldr Up
2290 GOSUB 1460 'MTR 5 Off'Stop
2300 FOR X= 1 TO 460 :NEXT X
2310 GOSUB 1560 'Change Directn
2320 GOSUB 1390 :FOR X=1 TO 460*
T5*1.3 :NEXT X 'Move Shlder Dwn
2330 GOSUB 1460 'MTR 5 Off'Stop
2340 FOR X= 1 TO 460 :NEXT X
2350 GOSUB 1560 'Change Directn
2360 GOSUB 1390 :FOR X=1 TO 460*
T5*.0 :NEXT X 'Move Shoulder Up
2370 GOSUB 1460 'MTR 5 Off'Stop
2380 FOR X= 1 TO 460 :NEXT X
2400 MTR=6 'Shoulder (Rot) ****
2410 GOSUB 1390 :FOR X=1 TO 460*
T6*.5 :NEXT X 'Rot Shldr Right
2420 GOSUB 1460 'MTR 6 Off'Stop
2430 FOR X= 1 TO 460 :NEXT X
2440 GOSUB 1560 'Change Directn
2450 GOSUB 1390 FOR X=1 TO 460*T
6*1.1*2 :NEXT X 'Rot Shldr Left
2460 GOSUB 1460 'MTR 6 Off'Stop
2470 FOR X= 1 TO 460 :NEXT X
2480 GOSUB 1560 :FOR X=1 TO 460
:NEXT X 'Change Direction
2490 GOSUB 1390 :FOR X=1 TO 460*
T6*.45 :NEXT X 'Rot Shldr Right
2500 GOSUB 1460 :FOR X=1 TO 460
'MTR 6 Off'Stop
2510 FOR X= 1 TO 460 :NEXT X
2520 'This is the 2nd auto routi
ne developed by Steve McMaster,
Steve Cox, and Carlos Escobar
2540 ' Demo 2 *****************
2550 POKE &HFF40,0
2560 CLS :PRINT@133,"POSITION GR
IPPER" :PRINT"       HIT ANY KEY
 WHEN READY" :SOUND 5,5 :A$="" :
A$=INKEY$ :IF A$="" THEN 2560
2570 '************************
2580 MTR=2 :GOSUB 1390
2590 FOR X=1 TO 460*.15 :NEXT X
2600 GOSUB 1460 :FOR X=1 TO 460
:NEXT X
2620 MTR=4'*********************
2630 GOSUB 1560 'Change Directn
2640 GOSUB 1390 :FOR X=1 TO 460*
T4*.7 :NEXT X
2650 GOSUB 1460 :FOR X=1 TO 460
:NEXT X
2670 MTR=2'*********************
2680 GOSUB 1560 'Close Grip
2690 GOSUB 1390 :FOR X=1 TO 500
:NEXT X
2700 GOSUB 1460 :FOR X=1 TO 460
:NEXT X
2720 MTR=5'*********************
2730 GOSUB 1390 :FOR X=1 TO 460*
0 :NEXT X
2740 GOSUB 1460 :FOR X=1 TO 460
:NEXT X
2760 MTR=4'*********************
2770 GOSUB 1560
2780 GOSUB 1390 :FOR X=1 TO 460*
T4 :NEXT X
2790 GOSUB 1460 :FOR X=1 TO 460
:NEXT X
2810 MTR=2'*********************
2820 GOSUB 1390
2840 MTR=3'*********************
2850 GOSUB 1390 :FOR X=1 TO 460*
5 :NEXT X
2860 GOSUB 1460 :MTR=2 :GOSUB 14
60 :FOR X=1 TO 460 :NEXT X
2880 MTR=5'*********************
2890 GOSUB 1560
2900 GOSUB 1390 :FOR X=1 TO 460*
0 :NEXT X
2910 GOSUB 1460 :FOR X=1 TO 460
:NEXT X
2920 GOSUB 1560
2930 GOSUB 1390 :FOR X=1 TO 460*
.3 :NEXT X
2940 GOSUB 1460 :FOR X=1 TO 460
:NEXT X
2960 MTR=6'*********************
2970 GOSUB 1560
2980 GOSUB 1390 :FOR X=1 TO 460*
.3 :NEXT X
2990 GOSUB1460 :FOR X=1 TO 1000
:NEXT X
3010 MTR=2'*********************
3020 GOSUB 1560
3030 MTR=5
3040 GOSUB 1560
3050 MTR=6
3060 GOSUB 1560
3070 GOSUB 1390
3090 MTR=5'*********************
3100 GOSUB 1390 :FOR X=1 TO 460*
.1 :NEXT X
3110 GOSUB 1560
3130 MTR=2'*********************
3140 GOSUB 1390
3150 FOR X= 1 TO 460*.2 :NEXT X
3160 'Turn all motors Off
3170 POKE &HFF41,255
3180 SOUND 25,5
3190 GOTO 160
```

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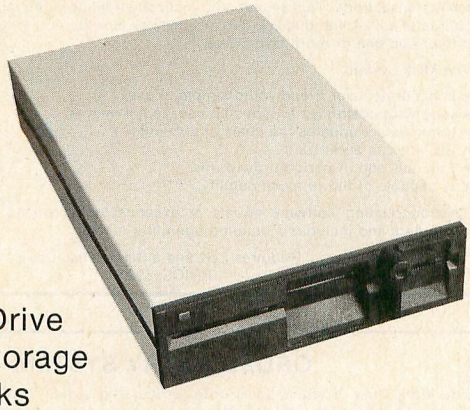

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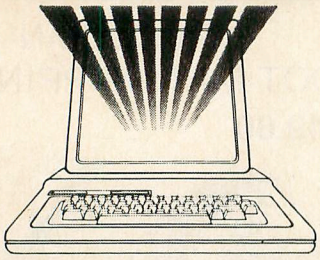
SUPER SCREEN



- **A big 51 character by 24 line screen.**
- **Full upper and lower case characters.**
- **Easily combine text with hi-res graphics.**
- **PRINT @ is completely functional on the big screen.**
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- **Control codes for additional functions.**
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COMBINE TEXT WITH HI-RES GRAPHICS

You can now write truly professional looking programs that combine text with hi-res graphics. Super Screen allows you to create graphics displays with the Basic LINE, DRAW and CIRCLE statements and then notate the graphics with descriptive text. You can even use PRINT @ if you wish for greater programming convenience. Super Screen's versatility will amaze you.

PRINT @ IS FULLY IMPLEMENTED

The PRINT @ statement is a valuable asset to the programmer when formatting text on the screen. The standard Color Computer will report an error if you specify a location higher than 511 but Super Screen allows locations all the way to 1223! You get a big screen and a powerful formatting tool as well. Of course, Super Screen also supports the CLS command allowing you to clear the big screen using standard Basic syntax.

ON ERROR GOTO

That's right! Super Screen gives you a full implementation of ON ERROR GOTO including the ERR and ERL functions. Now you can trap errors and take corrective action to prevent crashed programs and lost data using the same standard syntax as other computers. The ON ERROR GOTO capability overcomes a serious deficiency of Color Computer Basic and greatly improves your capability to handle sophisticated tasks. All well written, 'user friendly' programs use error trapping techniques and yours can too! Now that's power!

AUTO KEY REPEAT

No more frustration as you edit a long line in your Basic program; just hold the space bar down and automatically step to the desired position in the line. Need a line of asterisks? Hold the key down and auto repeat will give them to you. Those of you who spend many hours at your keyboard will appreciate this outstanding addition to Super Screen's long list of impressive capabilities.

CONTROL CODES FOR ADDITIONAL FUNCTIONS

Super Screen recognizes several special control code characters that allow selection of block or underline, solid or blinking cursor and other functions. You can 'Home Up' the cursor or you may erase from the cursor to the end of a line or to the end of the screen just like many other computers. These special codes give you an extra dimension of versatility and convenience that put Super Screen in a class by itself.

AND MORE GOOD NEWS...

Super Screen comes with complete, well detailed instructions and is available on cassette or disc. It adjusts automatically to any 16K or greater, Extended or Disc Basic Color Computer or TDP-100 and uses only 2K of memory in addition to the screen memory reserved during power up. Guaranteed to be the most frequently used program in your software library...once you use it, you won't be without it! Super Screen's low price will really please you; only $29.95 on cassette or $32.95 on disc!

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The Mark Data Products accounting system is ideal for the small businessman needing a fast, efficient means to process income and expenses, prepare detailed reports and maintain most of the information required at tax time. The system is a family of programs which operate by means of a "menu" selection scheme. When the operator selects a task to perform, the computer loads a program designed to handle that task from the system disc. The system disc contains all of the programs required to create, update and maintain data files and prepare the necessary accounting reports including a transaction journal, a P&L or income report, an interim or trial balance and a balance sheet.

Up to 255 separate accounts may be defined and a single disc system can hold over 1,400 transactions. This system automatically enhances the monitor screen to a 51 character by 24 line display. 32K of memory is required along with an 80-column printer and one or more disc drives.

The MDP system:

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The Mark Data Products sales order processing system provides a fast, efficient means to enter orders, print shipping papers and invoices, prepare sales reports, and monitor receivables. The system automatically enhances the monitor screen to a 51 character by 24 line display. 32K of memory is required along with an 80-column printer, and one or more disc drives.

The MDP order entry system is a family or programs which operate interactively by means of a "menu" selection scheme. Up to 900 products may be defined and a single disc system can hold over 600 transactions. When the operator selects a task to be performed, the computer loads a program designed to handle that task from the system disc. The system disc contains all of the programs required to create, update and maintain data files and prepare the necessary paperwork including shipping and invoice forms, daily sales reports, a monthly (or other period) sales report and a receivables report.

The MDP system:

- Is accurate, user friendly and simple to use.
- Is easy to customize for specific user requirements.
- Produces a traceable invoice.
- Handles receivables as well as closed orders.
- Is capable of future expandability.

This order entry software equals or exceeds higher priced packages for other computers and includes a detailed operating manual.

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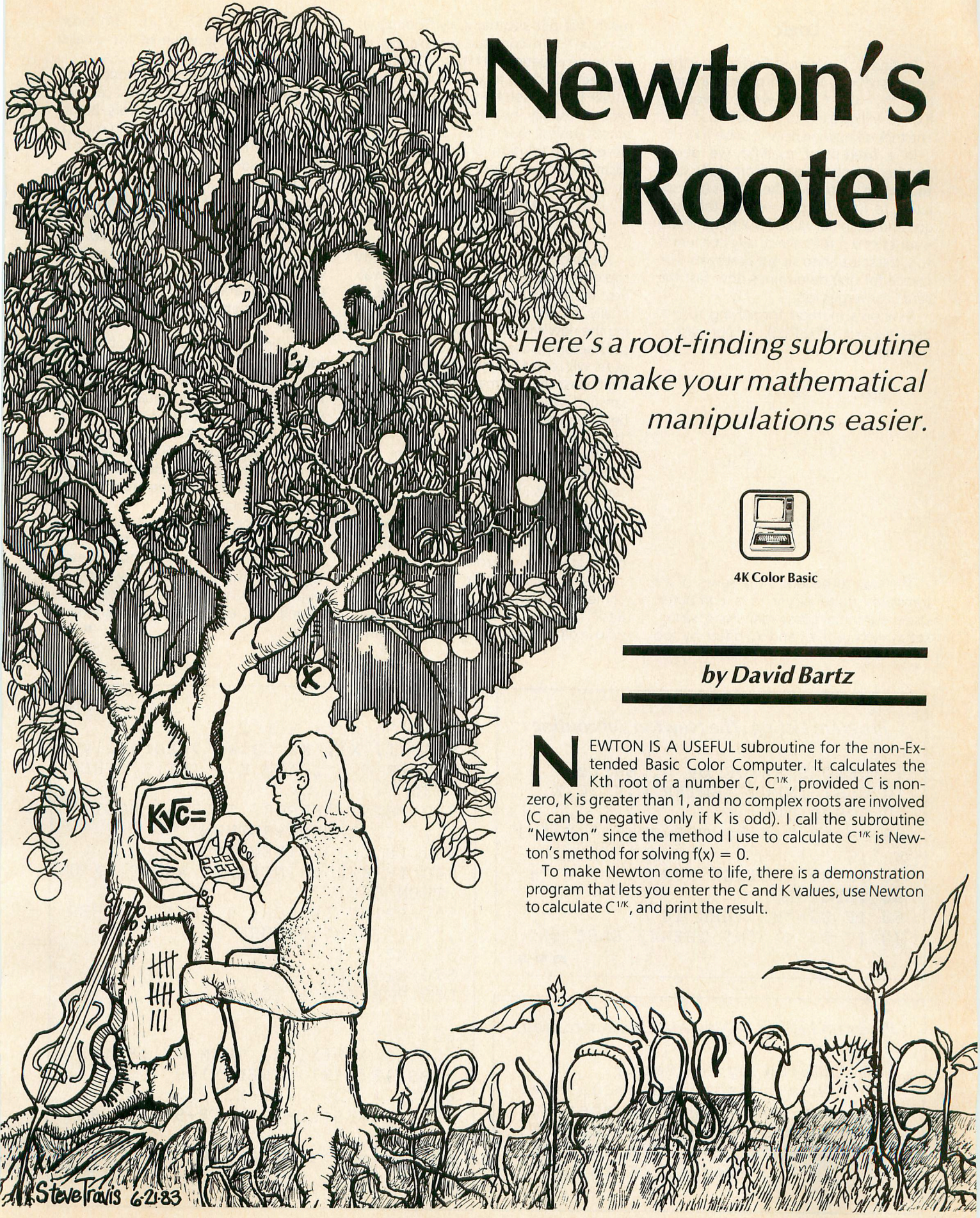
Newton's Rooter

Here's a root-finding subroutine to make your mathematical manipulations easier.



4K Color Basic

by David Bartz

NEWTON IS A USEFUL subroutine for the non-Extended Basic Color Computer. It calculates the Kth root of a number C, $C^{1/K}$, provided C is nonzero, K is greater than 1, and no complex roots are involved (C can be negative only if K is odd). I call the subroutine "Newton" since the method I use to calculate $C^{1/K}$ is Newton's method for solving $f(x) = 0$.

To make Newton come to life, there is a demonstration program that lets you enter the C and K values, use Newton to calculate $C^{1/K}$, and print the result.

Logic

To find $C^{1/K}$, we must find some x that satisfies $x^K = C$. We can denote a function, $f(x) = x^K - C$, that when solved for $f(x) = 0$ will give us our solution to $x^K = C$. The trick is knowing how to solve $f(x) = 0$.

In a fixed-point method we derive another function, g(x), from f(x), such that when we plug in the value s (the solution to $f(x) = 0$), $g(s) = s$. We then use g(x) and an initial value for x to generate a series of x's that eventually converges to s, the solution to all our problems. The choice for g(x) determines how fast the series converges to s.

Newton's method for solving $f(x) = 0$ uses $g(x) = x - (f(x)/f'(x))$, in our case it becomes:

$$g(x) = x - \frac{(x^K - C)}{[K * x^{(K-1)}]}$$

$$= (K-1)*x - \frac{\frac{C}{x^{(K-1)}}}{K}$$

$$= x + \frac{[(C/x^{K-1}) - x]}{K}$$

The way to generate the series of x's translates quite nicely to a computer. Using our initial guess value for x, say x_0, set $x_1 = g(x_0)$. If x_0 and x_1 differ by too much, we get another x, x_2 from $g(x_1)$: $x2 = g(x_1)$. We continue generating x's using the equation $x_i 1 = g(x_{i-1})$, until x_i is satisfactorily close to x_{i-1}, at which time x_i will be the solution to $g(x) = x$. This process usually involves many x_i generations (unless our initial guess is very close to the solution) and is an ideal application for the tireless Color Computer.

Algorithms vs. Bugs

The algorithm for Newton is pretty straightforward: First, check input values; then, calculate new x from g(old x); finally, repeat the calculation, substituting the new x for the old x, until they are satisfactorily close (since the Color Computer will round a printed fraction to nine digits past the decimal point, we will be satisfied when the absolute difference between the new and old x's is less than 1E−9).

When converting the algorithm to a Color Computer subroutine there were certain things I had to keep in mind. For instance, there is no exponentiation function in Radio Shack Color Basic, so numbers larger than 1E38 in magnitude cause overflow errors, and numbers smaller than 1E−38 in magnitude become zero. There is also a bug in Color Basic. Adding or subtracting numbers whose difference in magnitude is greater than *1E38* (*i.e.*, 1E5 + 1E−34) incorrectly returns the value of the smaller number.

I coded my exponentiation loop to calculate C/x^{K-1} as opposed to just calculating x^{K-1} to avoid overflow errors. Before I used the result of that loop in my g(x) evaluation I had to make sure that its value wouldn't cause the result of x = g(x) to be set to a very small number, instead of playing a very small part in the evaluation of g(x). I used a test to set the result of the C/x^{K-1} expression to zero (Line 605) to prevent a serious mistake when used in the evaluation of g(x). This test also guarantees the validity of the difference between the old x and the new x.

The line by line description of Newton follow: Lines 510–550 check C and K values for the limits specified for the routine. Line 560 sets the initial old X. Lines 570—600 calculate C/old X^{K-1}. Line 605 checks for a small X2 that would cause miscalculation. Line 610 calculates a new X, and Lines 620–630 determine if the desired accuracy has been reached and take appropriate action.

To use this subroutine, K must be set to a positive integer greater than 1, and C must be set to any number greater than zero (if K is even) or any non-zero number (if K is odd). The solution is contained in X; and I, X2, and X1 are modified. ■ ■ ■

Program Listing. The Newton Subroutine

```
5 'DEMONSTRATOR by D. Bartz
10 CLS: INPUT "ENTER C,K";C,K
20 GOSUB 500
30 PRINT X;" TO THE POWER",K;" I
S ";C
40 PRINT"ANOTHER RUN- Y or N ";
50 INPUT D$
60 IF D$="Y" THEN 10
70 IF D$ <> "N" THEN40 ELSE END
```

■ ■ ■

Program Listing. A Newton Demonstration

```
500 'NEWTON by D. Bartz
501 'This subroutine calculates
 the Kth root of the number C.
502 'Inputs: K -an integer > 1.
      C -positive if K is even,
         non-zero if K is odd.
503 'Output: X ( C ^ 1/K )
504 'I, X1, X2  used internally
510 IF K > 1 AND K = INT(K) THEN
 530
520 PRINT "ERROR: ILLEGAL ROOT,"
;K,"REQUESTED":RETURN
530 IF C > 0 THEN 560
540 IF K/2 > INT(K/2) AND C <> 0
 THEN 560
550 PRINT "ERROR: ILLEGAL NUMBER
,";C,"USED":RETURN
560 X2 = 1
570 X1 = C
580 FOR I = 1 TO K-1
590 X1 = X1/X2
600 NEXT
605 IF ABS(X1)<1 THEN IF ABS(X2)
>ABS(1E38*X1) THEN X1=0
610 X = X2 + (X1-X2)/K
620 IF ABS(X2-X) < 1E-9 THEN RET
URN
630 X2 = X : GOTO 570
```

■ ■ ■

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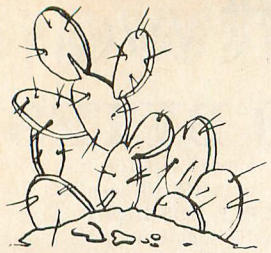

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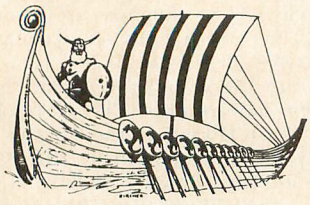

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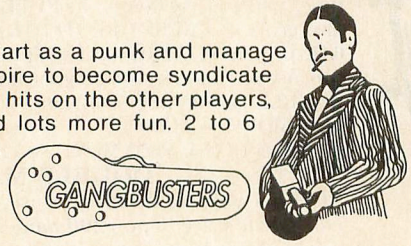

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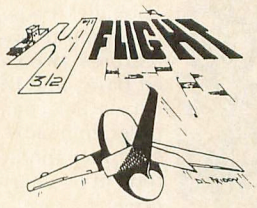

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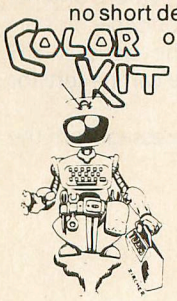

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EXPLANATION OF CODES

BASIC: This program is 100% BASIC. That means it is easy to examine and easy to modify. BASIC is the best language for some applications.

B & ML This program is written mostly in BASIC, but some routines are in machine language for more speed. May be harder to examine or modify than an all BASIC program.

100% ML This program is all machine language for fastest possible execution. Examination or modification will require a high skill level.

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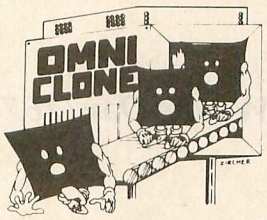
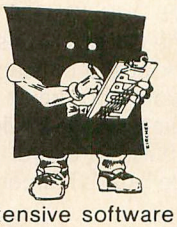
DISK UTILITIES



OMNI CLONE: This program even amazes us. It backs up every color computer disk we have seen, and has even backed up disks for the Model 3 and IBM PC. Protect your valuable collection against loss with this super power backup utility. Easy to use. Needs 32K and at least one disk drive, but works with two drives if you have them. 100% ML. **$39.95**



DISK ZAPPER: A neat utility that lets you easily examine and change data right on the disk! Rebuild directories, format to 40 tracks, change programs, store backup directories, and more. Needs two drives and 64K for some functions. B & ML. **$34.95**

DISK MANAGER: If you have an extensive software collection, this program will create an alphabetical listing so you can find what you want. It also prints a super directory with ML addresses and gives you three ways to recover a crashed disk! Needs 32K and 1 disk drive. B & ML. **$29.95**

DISK MASTER: Eight functions, including drive speed check and adjust, moving DATA files to and from disk and tape, a directory which includes ML addresses, two different disk maps, and an easy mass copy utility. Needs one disk drive and 32K. B & ML. **$24.95**

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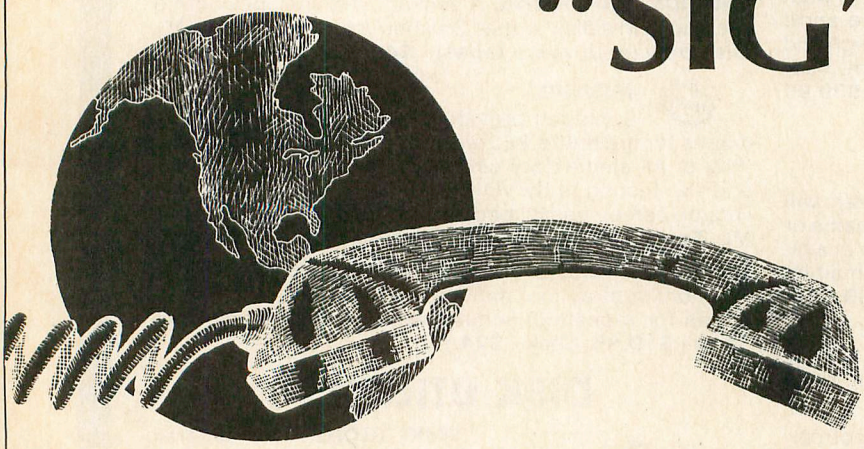

by R. Wayne Day (76703,376)

LET'S BEGIN OUR JOURNEY NOW through the Color SIG this month with a look at the message database. Those of you who aren't familiar with the electronic message services usually found on bulletin board systems (BBS) can visualize what's happening this way:

Imagine a bulletin board in your local grocery store, where someone posts a message saying, "I want to sell my '56 Chevy." We'll call this message 1. Anyone entering the store can look up on the board and see that message. Since the store manager has thoughtfully provided pen and paper, the customer can also reply to the message by putting another message directly under the first. Let's say someone else comes in and leaves the message "How much?" as message 2.

Later in the day a third person comes in and sees the messages. He's interested, too, but only if the Chevy is blue. "I'll buy it if it's blue!" he writes as message 3.

The next day the original writer comes in and sees two replies to his message, and answers both of them. "I want $500," he writes as message 4, which is a reply to message 2. "Sorry, it's red," he answers as message 5, which is the reply to message 3.

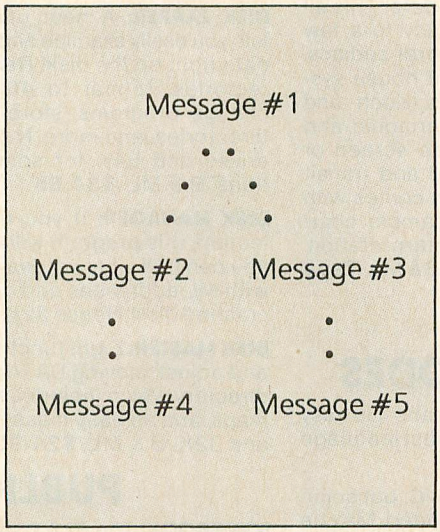

Figure 1. Message Graph

If you drew a graph showing how the messages were generated, it'd look like Figure 1.

Each message is left up on the board so everyone can see them. If any customer wishes to, he can reply to them. Message 6 could be a reply to the original message, for example.

The message database on the Color SIG works the same way, where original messages can be left for one specific person or addressed to the general SIG membership, and replies can be left for any of the messages.

After posting, each message on the SIG is formatted like this:

```
#: 83300    Sec. 6 -OS9/FLEX
Sb: #83275-#HELP
    5-Jun-88  17:22:41
Fm: Wayne Day 76703,376
To: Don Hutchison 70425,1225 (X)

Don,
  Thanks for the help.  It worked!
(C RE T):
```

In this case, message #83300 is a reply from me to another user. Don's earlier message to me was #83275. The # in front of the previous message number and the subject (HELP) indicate that both messages have been replied to. The (X) after Don's identification number means he has read the message, which makes it easy to find out if a message addressed to someone was received.

Notice how both the FROM line and the TO line included the user's account number. This lets the SIG notify you when you first log on of messages addressed to you, so you won't accidentally miss them.

The only thing we haven't covered in this message is up on the first line: Sec. 6 - OS9/FLEX. We have divided the message database into seven categories of messages, depending upon their subject content. A person solely interested in OS-9, for example, can read only the messages in Section 6 if he wishes.

Think of these sections as seven separate bulletin boards up on the grocer's wall: you can read all of them, or just check the boards that interest you most.

The message database is divided as shown in Table 1.

Messages can be read in many ways on the SIG, thanks to the flexibility of the SIG program. Using the basic READ MESSAGE command (R) we can use the following instructions to the SIG:

Section	Subject
0	General messages
1	Color Computer hardware
2	Color Computer software
3	MC-10
4	Personal classifieds
5	Assembly language
6	OS-9 / FLEX

Table 1. Message Database Divisions

RN — Read all new messages posted since the last time we've been on.
RM — Read only those messages marked for our ID number.
RF — Read all messages in a forward direction. The program will ask you what message number to start with, and will continue to the end.
RR — Read all messages in a reverse direction, starting at the last message on the SIG.

Suppose you are primarily interested in all messages about a particular subject, i.e., OS-9. To read all messages on the SIG that have the string OS9 in them, use the following command: RS;S;OS9;xxxxx. RS commands the system to let you read by a selective search; S indicates that you want to search on the subject field of the message; OS9 indicates the string that will be searched for; and xxxxx is where you substitute the message number you want to start with. To read all messages from the beginning, enter the number zero.

Searching can also take place using the From field or the To field. For example, to read all messages to ALL, use the command: RS;T;ALL;xxxxx.

After a bit of trial and error you'll begin to find the way you are most comfortable with. Since the SIG offers so much flexibility in reading messages, you're sure to find some way that is efficient for you.

At the end of each message you'll be asked if you want to reply to the message, return to the main function prompt, or go on to the next message. When you receive the (C RE T) prompt, enter RE to reply to the message, T to get back to the main menu, or just Enter to go on. At this point you could enter several other options that are not displayed for you:

RT — takes you back to the top message in the thread (remember the example at the grocery store? Think of message 1 as the top of the thread, and each of the replies as a continuing portion of the thread).
RR — reads all replies to this particular message.
RP — reads all previous messages on this same message thread.

One other command is possible at this time, especially for those of you with smart terminal programs that let you save portions of your buffer for later use. The NS option (at the (C RE T) prompt) tells the CIS computers that you want to read messages without stopping between each one. This option, when combined with the RN command, zips you through the entire new message base very quickly. You can then save your buffer to disk or tape (if your terminal program supports that facility) and read the messages at your leisure (when off-line and not paying for the connect time).

This tutorial will keep you fairly busy learning the easiest way to read messages; the next column should help you through the other part of the message database: sending a message to someone else.

SIG Happenings

During November, Ken Kaplan, the president of Microware, was the guest of the SIG on a conference about OS-9. Quite a few folks checked into the system that night and were able to get answers to many of their questions about this new operating system, directly from the folks that wrote it for Tandy.

Due to popular demand, Ken has agreed to be the guest on another conference on OS-9, tentatively scheduled for mid-April. Watch for an announcement on the exact date on the SIG.

And, speaking of OS-9, one of the SIG members, Saul Bendersky, has come up with an easy way to dump OS-9 files onto the Color SIG without having to purchase an OS-9 terminal program. This actually could be used with any BBS.

You do this by getting to the point of submitting the file right before actually sending the file to the host computer. When you are told to send the data, get out of your terminal program (usually by hitting Reset or turning the power off and then back on) and boot OS-9. Once you have the OS9: prompt, type the following:

```
XMODE /T1 BAUD=1 -BSB -BSL -ECHO -
LF -PAUSE
LIST/DO/filename.extension >/T1
```

When the file has been typed out, get back into your terminal program.

On CompuServe, enter a CONTROL-Z to designate the end of the file. On other BBS systems, use their end of file designator.

As Saul mentions, you can create an OS-9 procedure file to take care of most of the work for you. It's easier to do than it sounds. Thanks for the idea, Saul!

A reminder: CompuServe does sell a comprehensive guide to SIG operations through the Feedback portion of CIS. It costs $3.95 and could be a worthwhile addition to your personal library.

If you're not part of the Color SIG family, drop by your nearest Radio Shack store and ask them to demonstrate CompuServe, and especially the SIG. ■ ■ ■

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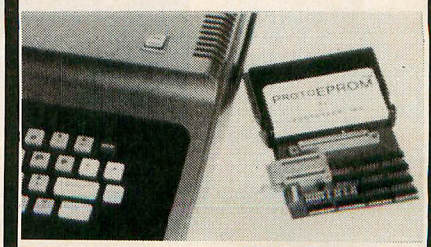

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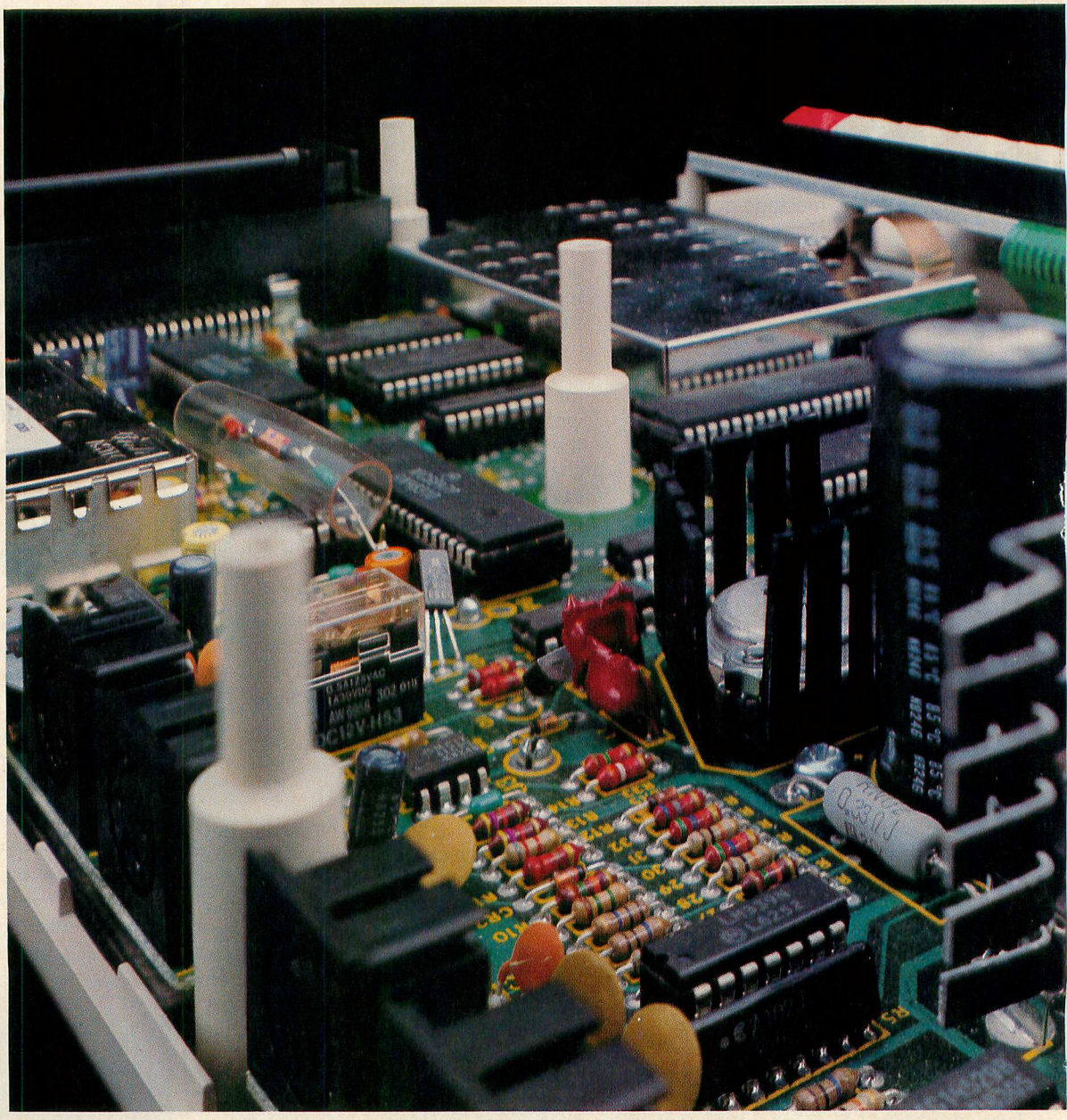
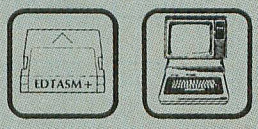


Color Basic ROM

Part II of an explanation that should help our readers who found Jake's disassembly too brief.



16K Extended Color Basic

by James A. Sanford

photo by Charley Freiberg

WITH A GOOD UNDERSTANDING of how the existing system works, it should be clear that you can write your own Basic commands. To do this, decide what functions you want and what keywords will be used to call these functions. Write down how many keywords there will be, and where you will put the keyword list. Refer to the memory map in the Radio Shack Basic manual to find out where it is safe to do this. Remember that the last character of each keyword must have 80 added to its ASCII code. Decide where the execution routine will be, and write down that address. Now insert all the numbers you just determined into memory immediately following the last block of system data. Use the following format:

number of new keywords (one byte)
address of keyword list (two bytes)
address of the execution routine (two bytes)

Remember to use hexadecimal values. Follow this with a block pointing to the error routine. This should look identical to the block you just replaced.

Your execution routine will first need to screen out any invalid tokens. If any are found, the best way to handle them is to jump to the normal error routine. Otherwise, transfer control to the appropriate subroutine.

The best way to show this in detail is by way of an example. To prove the method, I decided to add four commands.

The first command is called HOME. I read somewhere that somebody was unhappy that the Color Computer did not have this Apple function, so I decided to add it. It is essentially the same as Basic's CLS, so to actually accomplish clearing the screen I decided to use the existing ROM routine.

The second command I added was called PPRINT. This is the command which will send data out the parallel port.

The next command decided upon was LPRINT. This is a carry-over from Model I/III, and is useful because it is a lot easier to type than PRINT #−2, . . . It will use the existing serial port output routine.

more

Finally, I wanted a way to obtain a printout of the disk directory, so I created a new command, LDIR. This command places the number FB (signifying the serial printer) into DEVNUM (device number) and then calls the Disk ROM routine to obtain the directory.

To do all this, I created a system called SRBASIC. Listing 1 shows the additions to the data table and the relocated error routine address. Location 013E contains the number 04, which indicates that there are four keywords in the new list. The next two bytes contain 022C, the address of the new keyword list. Listing 2 shows this list. The next two bytes contain the address 0282, the address for the actual execution routine.

With the new keyword list in place, the new commands will be tokenized as E1 through E4. When they are executed, the program will direct control to the associated execution routine, located at 0282. Listing 3 shows this routine. When entered, it first preserves the condition code register. This is important, because flags are set prior to entry to this routine which must be retained. Then a check for invalid tokens is made, and an error routine is called if any are found. If the token is valid, the number E1 is subtracted from it. The result is multiplied by two, and this is used as an offset from the base address of the vector table. The vector table is located at 0252. Listing 4 shows this table. The program then jumps to the appropriate address. I chose to use this technique instead of a straight item-for-item comparison because it is faster, similar to what is done in the ROMs, and is very easy to expand.

Now let's look at the routines. The first new command is HOME, which is tokenized as E1. The vector table indicates that this routine is located at 0260 (listed in Listing 5). This routine restores the condition code register, goes to a subroutine which sets a flag according to the next data in the Basic statement, and then jumps to A910. This is the address for the routine which clears the screen and homes the cursor. A screen color can be specified, just as when using the CLS command. For example, HOME 5 will clear the screen to buff.

The next command is PPRINT, which is tokenized as E2. It is located at 0267, and is shown as Listing 6. The example shown here uses the serial port to let anyone try it without requiring the parallel printer port. If a parallel port exists in your system, this is where you will place the routine to take the character in A and send it to the parallel port. This routine puts FB in DEVNUM, restores the condition code register, and sets the flags. Then it jumps to the Basic print routine (B8F7). Note

Listing 1. SRBASIC

```
                        00490
                        00500 *TELL THE MACHINE ABOUT THE NEW ADDITIONS
013E                    00510          ORG     $013E
013E    04              00520          FCB     $04     4 NEW KEYWORDS
013F    022C            00530          FDB     $022C   LIST LOCATED AT $022C
0141    0282            00540          FDB     $0282   EXECUTION AT $0282
0143    00              00550          FCB     0       NOMORE
0144    4AB4            00560          FDB     $4AB4   LIKE IT WAS
0146    B277            00570          FDB     $B277   POINT TO ERROR HANDLER
0148    00              00580          FCB     0       DO IT ONE MORE TIME
0149    4AB4            00590          FDB     $4AB4
014B    B277            00600          FDB     $B277
                        00610
                        00620
```

Listing 2. New Keyword List

```
                        00630
                        00640 * SRBASIC KEYWORD LIST
                        00650
022C                    00660          ORG     $022C
022C    48              00670          FCC     /HOM/   HOME
        4F
        4D
022F    C5              00680          FCB     $C5     TERMINATOR
0230    50              00690          FCC     /PPRIN/ PPRINT
        50
        52
        49
        4E
0235    D4              00700          FCB     $D4     TERMINATOR
0236    4C              00710          FCC     /LPRIN/ LPRINT
        50
        52
        49
        4E
023B    D4              00720          FCB     $D4     TERMINATOR
023C    4C              00730          FCC     /LDI/   LDIR
        44
        49
023F    D2              00740          FCB     $D2     TERMINATOR
                        00750
                        00760
                        00770
                        00780
```

Listing 3. Execution Routine

```
                        00790
                        00800
                        00810 *EXECTUTION ROUTINE
                        00820
0282                    00830          ORG     $0282
0282 34   01            00840          PSHS    CC      SAVE CONDITION CODES
0284 81   E5            00850          CMPA    #$E5    LOOK FOR BAD TOKENS
0286 24   08            00860          BHS     ERR     IF BAD, REPORT ERROR
0288 80   51            00870          SUBA    #$51    OTHERWISE, NORMALIZE
028A 48                 00880          ASLA            AND SET UP AS OFFSET
028B CE   0252          00890          LDU     #$0252  FOR VECTOR TABLE
028E 6E   D6            00900          JMP     [A,U]   AND EXECUTE
0290 6E   9F 0146       00910 ERR      JMP     [$0146] GO REPORT ERROR
                        00920
```

that in order for this to work, you need to have made the modification to the print routine which I discussed earlier, forcing the system to accept device number −5 as the parallel port.

The next command is LPRINT. It is tokenized as E3 and is located at 0294 (see Listing 7). This is similar to PPRINT except that it is designed to always use the serial port, so the number placed in DEVNUM is FE (−2).

Finally, the command LDIR is tokenized as E4. It is at location 029F and is shown as Listing 8. It loads the number FE (−2) into DEVNUM to direct the output to the serial printer port. The condition code register is restored, the flags set, and then the program jumps to CBCF, the location of Disk Basic's directory command. This will cause the normal directory to be printed out via the serial port.

Limitations

Nothing comes free, and there are some trade-offs to be made in adding to Color Basic. First, the extra keywords to be checked will slow execution. I have not been able to notice any difference in speed, but some will exist. This would become more apparent with a longer list of added keywords. Second, there is a limit to the number of keywords which can be added. The last keyword which can be added to the first pass lists will have the token FE. This is a small number of additions, but is probably adequate. If not, a different list can be set up in the second pass (which contains the function lists), using tokens which are two bytes. The first byte will be FF, followed by a second byte to determine which routine to call. There is also an upper limit on available memory which will partially dictate how many additions you make. All these must be considered, but still allow plenty of room for some additions.

You may not use the user functions (USR(0),(1), and (2)) or the new system information will be lost. This is because Basic stores vectors for the USR functions where we have stored our block of data pointing to the new commands.

Finally, a Basic program which relies heavily on custom functions will not work on another system without those functions. This means you will lose portability. If this is a problem, data could be added to the beginning of the Basic program to POKE the necessary commands into system RAM during program initialization.

Expansion

All the examples discussed so far involve use or modification of routines already in the ROMs. It *is* possible to completely initiate your own routines. For example, if you do a lot of plotting, it might be nice to have a command which would plot a set of axes on the precision graphics screens. This could be called AXES. To add this, change the number of keywords (location 013E), add to the keyword list, add to the vector table, and write the routine to plot whatever axes you desire. (*Getting Started with Color Basic* has some good information on assembly language use of precision graphics.) That's all it takes to write your own new commands.

Location

I have used the low areas of RAM throughout this discussion for a very good reason. My personal philosophy is that the upper area of RAM should be reserved for USR functions, which can change from program to program. The system data or enhancements, however, should be placed low so they will be protected, but not subject to change by each Basic program. This places an upper limit on how much RAM is available. The memory map in the Radio Shack manuals shows that there really is a great deal of room available for assembly language routines in low RAM. If this really is not enough, there is an alternative.

Locations 00BA, 00BB, and 00BC contain information which points to the beginning of graphics memory. In a disk system you can change this pointer to put as much room as desired between the disk RAM and graphics. Then execute the PCLEAR command and the Basic program will be moved appropriately. In a non-disk system this will not work, but you can use the first page of graphics (starting at 0600) and start all your graphics displays on graphics page 2. This establishes more protected space for your system enhancements.

Another alternative is to use the upper 32K of RAM if you have 64K memory chips installed. You can clear location FFDF to select the upper RAM. Remember that the ROMs will no longer be available and that you must disable interrupts before doing this. When your routine is completed, jump back to the lower 32K, clear FFDE to restore the ROMs and reenable interrupts. Then return to Basic.

Glitches

I found two problems, neither of which is major.

The Radio Shack manuals don't really mention the subject of spaces in Basic text. You get the impression they are not

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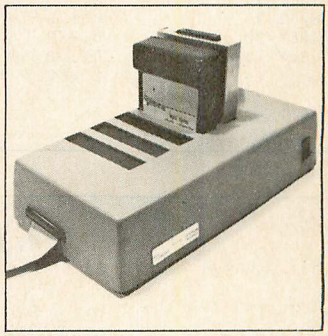

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Listing 4. Vector Table

```
                        00930
                        00940
                        00950 *VECTOR TABLE
0252                    00960         ORG     $0252   BASE ADDRES
0252        0260        00970         FDB     $0260   HOME
0254        0267        00980         FDB     $0267   PPRINT
0256        0294        00990         FDB     $0294   LPRINT
0258        029F        01000         FDB     $029F   LDIR
                        01010
```

Listing 5. NOME

```
                        01020
                        01030
                        01040 *HOME ROUTINE
0260                    01050         ORG     $0260
0260 35     01          01060         PULS    CC      RESTORE CONDITION CODE
0262 9D     9F          01070         JSR     $9F     GET NEXT CHARACTER
                        01080 *AND SET FLAGS
0264 7E     A910        01090         JMP     $A910   GO TO BASIC CLS ROUTINE
                        01100
```

Listing 6. PPRINT

```
                        01110
                        01120
                        01130 *PPRINT ROUTINE
0267                    01140         ORG     $0267
0267 86     FB          01150         LDA     #$FB    MAKE DEVNUM -5
0269 97     6F          01160         STA     $6F
026B 35     01          01170         PULS    CC      RESTORE FLAGS
026D 9D     9F          01180         JSR     $9F     GET NEXT CHARACTER
026F 7E     B8F7        01190         JMP     $B8F7   GO TO REST OF PRINT ROUTINE
                        01200
                        01210
```

Listing 7. LPRINT

```
                        01220
                        01230 *LPRINT ROUTINE
0294                    01240         ORG     $0294
0294 86     FE          01250         LDA     #$FE    MAKE DEVNUM -2
0296 97     6F          01260         STA     $6F
0298 35     01          01270         PULS    CC
029A 9D     9F          01280         JSR     $9F     GET NEXT CHARACTER
029C 7E     B8F7        01290         JMP     $B8F7   GO TO REST OF PRINT ROUTINE
                        01300
```

Listing 8. LDIR

```
                        01310
                        01320
                        01330 *LDIR ROUTINE
029F                    01340         ORG     $029F
029F 86     FE          01350         LDA     #$FE    MAKE DEVNUM -2
02A1 97     6F          01360         STA     $6F
02A3 35     01          01370         PULS    CC      RESTORE FLAGS
02A5 9D     9F          01380         JSR     $9F     GET NEXT CHARACTER
02A7 7E     CBCF        01390         JMP     $CBCF   GO PRINT DIRECTORY
                        01400
                        01410
```

always required, but some trial and error is necessary to confirm this. Disassembling the ROMs reveals that in general spaces are ignored, with one important exception: a space must separate a variable name and a subsequent keyword. For example: 10 IF X = NODE AND Y = . . . compares the variable X and the variable NODE and then compares something else with the variable Y. Meanwhile the statement: 20 IF X = NODEAND Y = . . . compares the variable X with the variable NODEAND. Statement 20 will generate at worst a logic error (often insidious and hard to find), or at best a syntax error.

The reason for this is in the way variables are recognized. In Model I Basic keywords cannot be embedded in a variable name. They are always recognized as keywords. In Color Basic, however, keywords *may* be embedded in variable names, and will not be treated as keywords. The interpreter tells the difference by the presence of a space after the keyword.

Another potential problem is the way in which variables are stored. The entire variable name is stored for listing purposes, but for purposes of execution only the first two letters count. When comparing variables, if the first two letters are the same, subsequent letters are ignored. For example the sequence:

```
10 ZA = 1
20 ZAI = 2
30 ZAR = 3
40 PRINT ZA
50 PRINT ZAI
60 PRINT ZAR
```

will produce the output:

```
3
3
3
```

instead of what you might expect. The output is 3 because the last value assigned to ZAR was three. The computer considers ZAI, ZAR, and ZA to all be the same, thus Line 30 sets all to be equal to three. So, some care is necessary in choosing variable names.

I would welcome any correspondence from users of these techniques. Please include a self addressed stamped envelope if a reply is desired.

Three people provided invaluable assistance in this project. Rocky Raher provided logical insight and a great deal of brute force help at 3 and 4 am. Mel Paris provided detailed criticism to keep me in touch with reality and the discussions understandable. Finally, my wife provided begrudging understanding and soda, beer, and iced tea to keep the creative fires fueled. Without them this would not have been written. Thanks to all.

■ ■ ■

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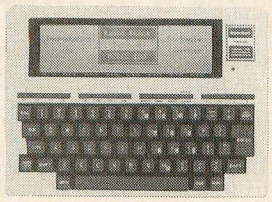

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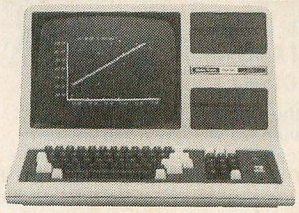

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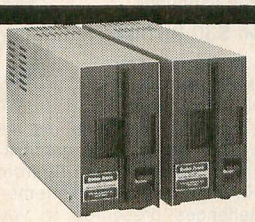

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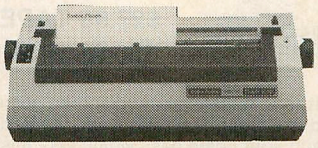

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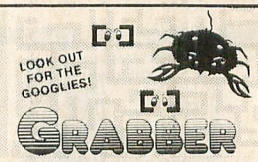

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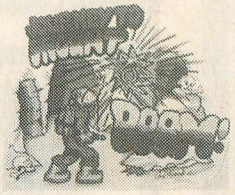

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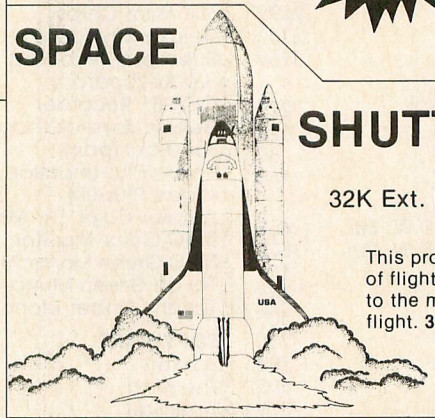

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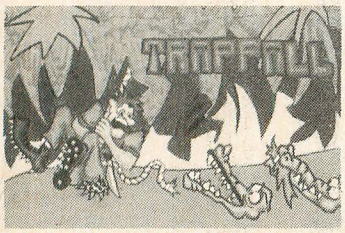

"TRAPFALL"

By KEN KALISH

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

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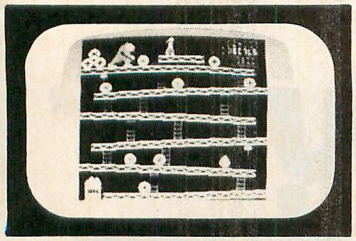

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About Robots

What they are, what they will be... and what it means.

by Jamie Tietjen

CHANCES ARE YOU TOUCH or otherwise directly interact with a robot regularly. Not me, you say? Your most complicated machine interaction (other than your Color Computer) is with the toaster? Think again, and see what around you fits this definition: **Robot** — *noun*, a machine or tool that does useful *work* under computer control.

Let's see...a computer is a programmable computation machine operating on data collected from the real world. A thermostat is a computer-controlled machine that can be programmed (setting the temperature) to open and close electrical circuits based on real world data (a bimetal strip that bends with temperature changes). This circuit can be a simple

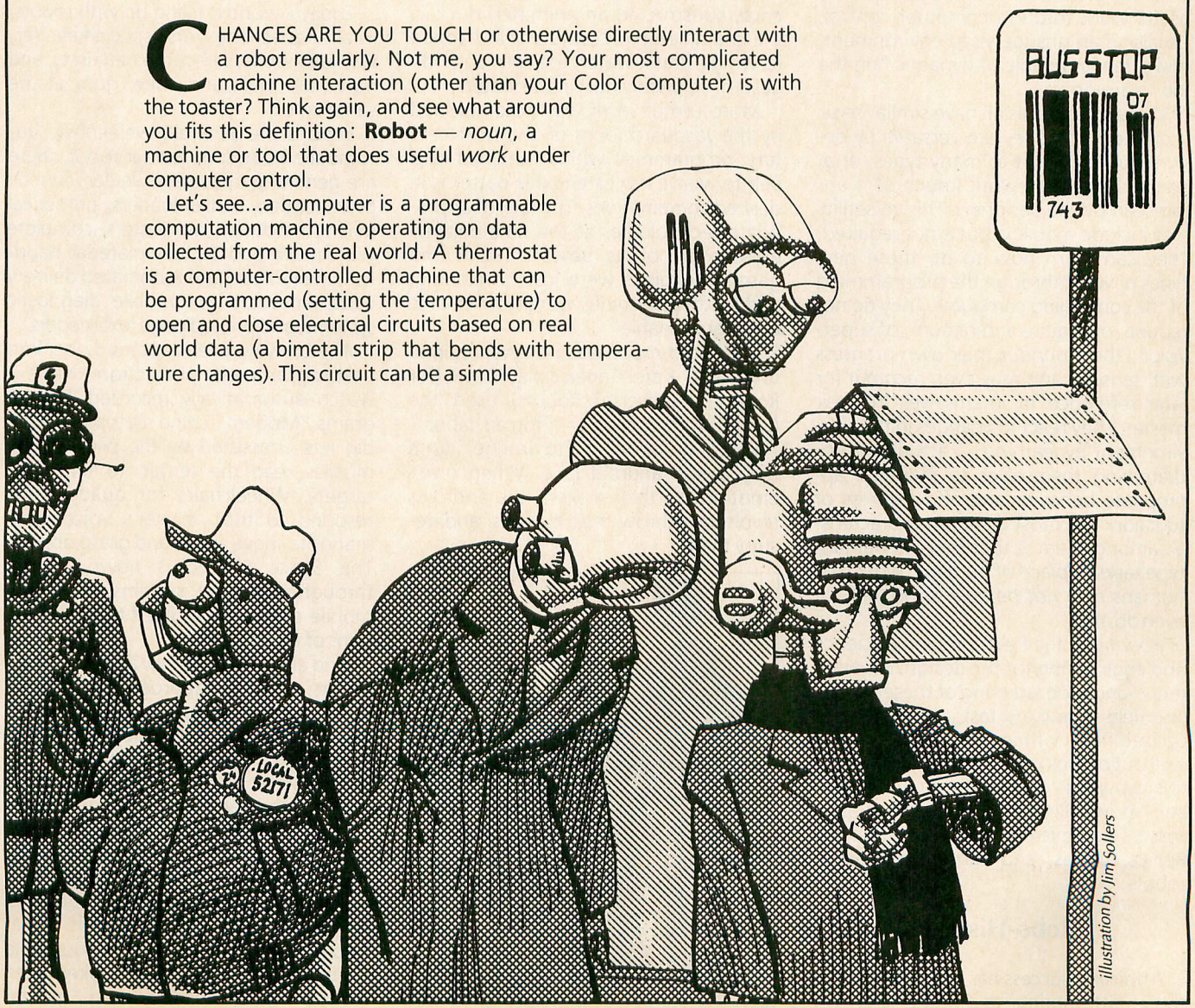


illustration by Jim Sollers

heating device (coils in a toaster) or a simple ejection device (spring catch releasing solenoid). Oops, it seems that your toaster really *is* a robot — if a simple and crude one — at least technically.

Actually, the word *robot* is rarely, if ever, used in such an all-encompassing way. The opposite extreme is the average movie-goer's image of a robot: a walking, talking, intelligent machine fully aware of its environment, and often in possession of a personality. Such a complete copy of a human is best referred to using the term **Anthrobot** — *noun*; an advanced robot, with the approximate physical and behavioral appearance of a human being, including manipulation ability, touch, vision, hearing, speech, mobility, learning, intelligence, awareness and self-direction, creativity, etc.

A more common and useful definition includes ideas that point us closer to the average movie anthrobot, but without going all the way: **Robot** — *noun*, a versatile machine or tool that accomplishes useful work through computer control, usually in an unsupervised environment, and often is capable of dynamic "on the job" learning.

These robot tools all have similar basic characteristics. They are *versatile* by design, able to adapt to many types, or at least subtypes, of work (much of it unforeseen by the designer). This versatility may include mobility, but is not required. They can *learn* how to do these new types of work through the programming of the controlling computer. They do not require, or require a minimum, of supervision: they *monitor* their own progress with sensors, and may even *record* it for later reference by themselves or their master. They react to changes in their environment by *learning* — actually reprogramming themselves to maintain appropriate behavior and effectiveness of function. The most common characteristic among them is that they do human-type tasks *in place of* humans, work that humans may *not be able* to do well, or even do at all.

Robotics is the field combining science and engineering for the design, development, and programming of these robots. The field is growing fast, and many specialized fields within robotics are already well out of their early childhood. Much of this growth is due to the shrinking size and snowballing power that microprocessors and microcomputers lend to the nerves, brains, and senses of modern robots.

Robo-History

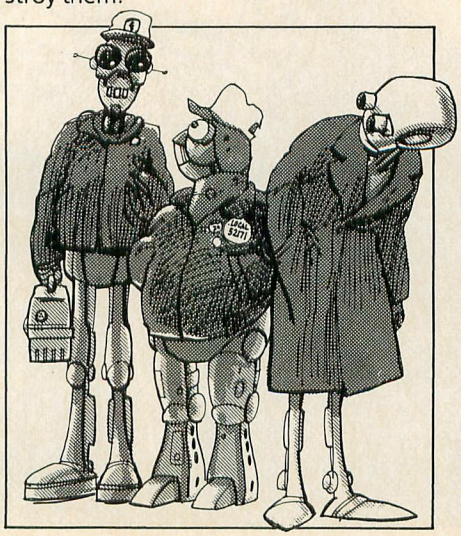
Attaining success has been difficult for those attempting to imitate life. Yet some reached amazing goals — even by today's standards — as long ago as 100 B.C, when Hero of Alexandria presented automated plays of weight-driven puppets, and supposedly made birds that chirped, drank, and even flew.

April Definitions
Character — adj., used to refer to authors, readers with questions, & freelance artists.

The mid-eighteenth century saw a number of clockwork automatons that could write on paper, draw, or even play musical instruments. Jacques de Vaucauson, of the French Academy of Science, constructed an animated duck in the late nineteenth century that flapped its wings, drank water, ate corn and "digested" it, dissolving it in the water.

More useful work was accomplished by the Jacquard loom of the next century, programmed with a punched card belt to weave intricate textile patterns in desired combinations. The lack of appropriate technologies at the time delayed exploitation of its power. Steam and gasoline engines were just developing, and factory machines were not versatile or programmable.

The word *robot* was not even coined until 1920. Karel Capek's play *R.U.R.* (for Rossum's Universal Robots) used the Czech word *robota* — "forced labor," "work"; or *robotit* — "to drudge," for a fully aware android race. When given emotions by their makers, the androids revolt, overthrow their masters, and destroy them.



Robot developments in the first half of this century are the simpler and more common devices we often take for granted: smart elevators, automatic doors, early airplane autopilots, and the like. The first general-purpose programmable tool wasn't born until the early 1960's.

These first programmable manipulators were slow, clumsy, and very dumb, despite the physical size of the computers required to operate them. Advances in structural materials, control subsystems, and mini- and microcomputers doubled and redoubled the capabilities of these laboring ancestors. Yet they were still so alien and out of place in the real world that robots have only recently made a significant contribution to the work force. Most of this contribution has been in areas of monotonous, highly precise or hazardous work.

A Robot in Every Room

Today's world is filling up with robots, in all shapes, sizes, and specialties. Very few are mobile, self-contained units; and none can walk and chew gum at the same time.

Besides the generally well-known automobile body spot welder robot, there are general purpose arc welders, punch press loaders and unloaders, numerical milling machines, die casters, complete warehouse and factory material handlers, mail sorters and automated delivery carts, on-board automobile diagnostic systems, and printed page text readers.

A microwave oven zaps my dinner into preprogrammed perfection while I watch automatically recorded TV programs. Modern airline autopilots land big jets unassisted by the pilot. Cruise missiles read the terrain to find their targets. Wheelchairs for quadriplegics respond to their master's voice commands to move about and grasp objects. The Space Shuttle is flown entirely through computer systems. My automobile engine tunes itself to the conditions of the moment.

And also available now are "personal" robots, ones that approach the appearance and basic function of the movie robot. They can move about on their own. They can listen, speak, fetch the paper, serve drinks or snacks, and respond to their environment in an ever-increasing number of ways. Yet their existence is dependant on large financial support for this high tech hobby (pet).

I suggest *pet* because the personal robots available bring trade-offs similar to ownership of the average household cat or dog. They need to be looked after, require regular "feeding" and "groom-

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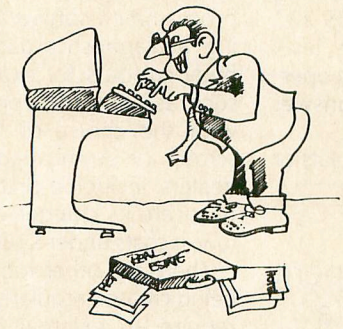

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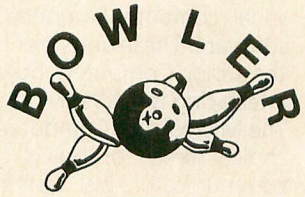

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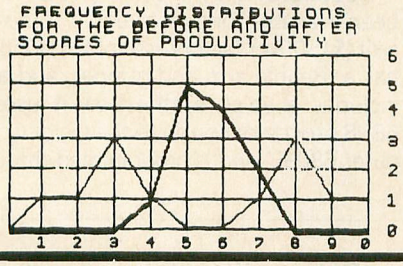

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ing" (recharging and service). They are limited in what they can do, where they can go, and what you can safely leave in their environment. They can have bad habits that often are impossible to correct, and often seem to be more costly and troublesome than they are worth.

I say *hobby* because even these personal units are not intended for the average person, or even the average personal *computerist*. They often require above-average knowledge of programming, either of the on-board processor, or of your personal computer tied to it like a doting parent. (Some new owners begin to feel like a parent, as the initial excitement of ownership wears off and is replaced with concern over this new mouth to feed.) Also handy for an owner to have is an above average knack for trouble-shooting and repairing complex systems, both mechanical and electrical. Fortunately, those doting over their 'bots with a Color Computer will find they have the advantages of an efficient and powerful processor to command, and a convenient and complete expansion port.

Nuts, Bolts, and Ribbon Cable

You must be wondering how the extra power hidden in your Color Computer can be tapped to provide the intelligence of *your* robot brainchild. In this issue you will find an article on modifying and interfacing an inexpensive toy robot arm to the Color Computer. This line of approach is probably beyond many Color Computer owners' skill, time, or desire for in-depth technical knowledge.

Many readers will be glad to know that life has been made much simpler (if more expensive doesn't bother you) by the recent introduction of several robots or robot kits with control computers on-board. They are fairly complete; with scratch memory, some type of robot oriented system monitor or language in ROM, and often an RS-232 interface for communication with — you guessed it — personal computers like the Color Computer.

Currently, the most affordable mobile peripheral available is the Smart Rabbit, from Hobby Robot Co., Inc. For under $400 you can buy a starter kit for a 22-inch tall, structurally complete robot enclosure and motorized base, with a parallel interface for control by the Timex 1000/ZX81 and Commodore computers and associated software. The manufacturer claims that most other popular personal computers can be easily interfaced (the Color Computer is one mentioned). Doubling your initial outlay gets you a more functional computer companion kit, with motorized head and arms with grippers, all required hardware, and an electronics expansion bus.

Rhino Robots, Inc.'s most recent introduction is the Scorpion, their least expensive model. For under $700 you get, in kit form, a mobile platform with on-board computer, audio generator, scanning style eye, bumper sensors, and RS-232 interface to accept simple base level commands to its ROM-based robot operating system and return data in answer to inquiries.

In the four-digit price range are kits or assembled units with fully programmable on-board computers, complete with keyboard and display, or complete personal computer interfaces and system software. These units aren't intended for the Color Computer; however, RS-232 interfacing is distinctly possible on each. The Micro Color Computer would be my choice for an on-board controller and communicator, but system and control software are still required before you could approach a functioning system.

Access Time — time spent waiting to speak to a technical editor.

Heathkit's well-known HER01 has been available for over a year. It comes as a kit ($1500) or factory assembled ($2500), has a useable arm and gripper, and also includes a voice synthesizer. It uses a 6808 processor cousin to the Color Computer 6809E, and is programmed through a hex keypad and LED display. Other manufacturers have already started supplying second-source expansion boards and modifications for it, including personal computer links. Perhaps there will soon be a general purpose RS-232 and radio/infrared communication board and software for this popular hobby horse.

Bit — Short for "but I thought..." Smallest unit of misconception.

Androbot, Inc. has a sleek looking 'droid called Topo, with a radio link for its host. You can pay less than $1000 for it, but with complete software and interfaces (at press time, only for the Apple computer) it is over $1500. There are some ambitious plans for Topo, and its innovative transport design makes it worth serious consideration.

Those readers who were captivated by the Star Wars 'droid R2D2 will find its domed ancestor exists and can be purchased from RB Robot Corp. Called the RB5X, it was recently enhanced with pre-programmed software modules, including a diagnostics package, and upper body cut-outs for expansion hardware, such as arms. This provides the owner with the choice of building on from scratch or buying upgrades from RB5X dealers. Including circuitry and software to locate its charger when batteries are low, it costs under $1800.

There are other robots and robot kits being created regularly and many do not require an external computer for developing intelligence. However, most can be easily interfaced or connected to personal computers. The biggest hurdle to overcome before your personal robot actually does real *work* is software. A fast runner won't win if he starts his final kick too soon, and a well-built robot won't scramble an egg if it lets it drop to the floor instead of the pan.

How Does a Ro Bot?

The nuts and bolts side of robotics is developing along predictable lines, and eventually should mature into a relatively plain and straightforward application of engineering, manufacturing, and craftsmanship. The exciting aspect of robotics is that, in time, nothing appears to be impossible concerning the intelligence with which we will be able to endow our creations. All it takes is a simple study of ourselves and a spark of creativity in duplicating what we find.

The first approach to bringing a robot to life usually uses one computer for the entire machine. By adding motor control hardware and sensory interfaces, this single processor can coordinate movement, sense, and purpose using a large and complex set of software.

This software must coordinate the entire body of the beast, including such detailed tasks as positioning each stepper motor to particular angles at particular rates, checking sensory data for dangerous or erroneous conditions, and forming the individual sounds of words to be spoken. It often results in a very narrow-minded being that can literally do only one thing at a time — move an arm, turn a corner, say a phrase, or react to unexpected events with reflexes.

Current trends are towards distributing intelligence throughout the "nervous" system of the robot, in a way analogous to the distribution of function in

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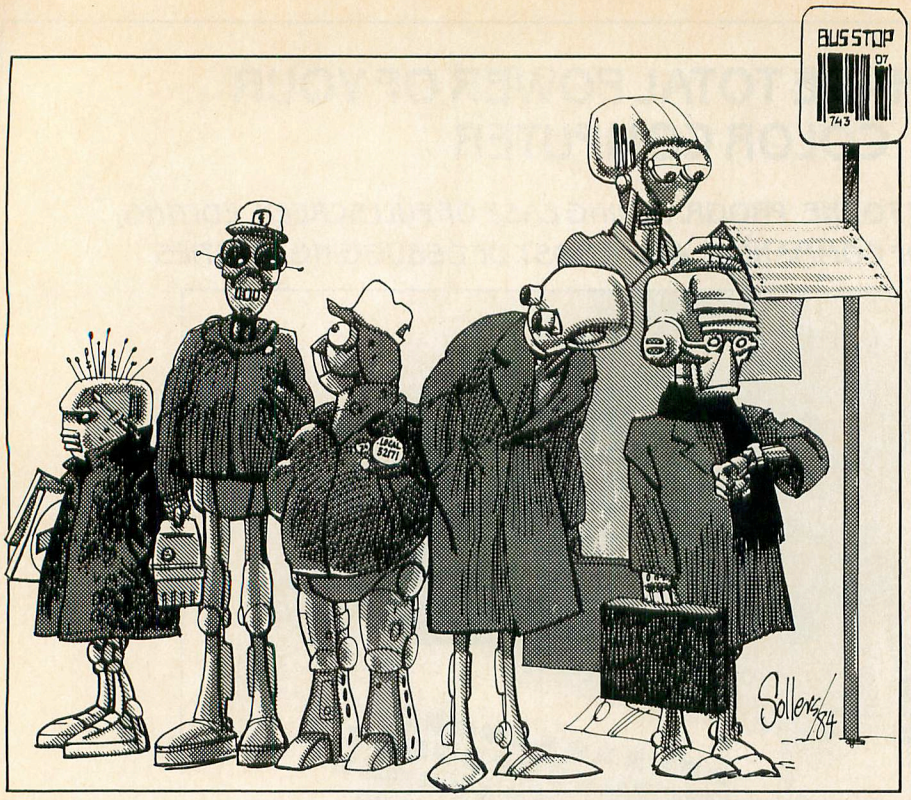

biological brain and nervous systems. Writing longhand, driving a car, riding a bicycle all become second nature to us only after the controlling "program" is "designed" and "debugged" and installed properly in the muscle control "interfaces" of our brains. Nature was careful enough to provide some failsafe protection by including reflex "software" in our spinal cord, reducing the possibility of injury when our "master operating system" is in a slow mode or totally inattentive to some conditions.

Distributing intelligence in a robot puts small, adequate processors in charge of a small group of related motors, actuators, and sensors. These processors control and coordinate this group only when commanded by a supervising processor that coordinates the actions and tasks of all the subsystems. This system may even supervise only a part of the robot, commanded by a processor whose thoughts deal solely with building task commands together into larger tasks to reach a desired goal.

This process often happens inside of us, once we decide on a goal, without any further concentration on the outcome. If hunger prompts me to make eggs for breakfast, I automatically recall what is required (eggs, shortening, pan, spatula, stove) and where they can be found (in the kitchen: eggs and shortening in the refrigerator, pan and spatula hanging on the wall over the stove).

Carrying out the task suddenly involves all the levels of my nervous system and thought structure. I seek out the kitchen, avoiding obstacles along the way, while my legs obey both general "move forward" and specific "detour around that object" commands, simultaneously compensating for the threshold and linoleum tile. My hands reach for the pan and refrigerator handle without missing, guided by feedback from my eyes. The pan's handle is greasy and nearly slips away before I set it on the large stove burner. The loose refrigerator handle is noticed (and noted as needing repair again) and I pull it carefully. Someone put the egg carton away empty, but left a pair of eggs in the door bin. One is frozen stuck and I notice too late. Cleaning up (after remembering where the mop is and fetching the pail) I simultaneously wonder *how* such a simple scenario could become so complex so fast.

All of the above *could* be accomplished by a robot with sufficient levels of hierarchy, not all of which would be divisions of hardware. "Conscious" train of thought could be a multi-level system of programs on a medium to large personal computer, such as a Color Computer 64K disk system with OS-9 or Flex as the operating system. Intermediate goals of navigating the living room and retrieving the eggs could be managed through a network of a scanning vision system, an arm coordinator guiding two sets of upper arm, forearm, and hand controllers, and a navigator guiding the drive wheels. A 4K Micro Color Computer running Forth would be sufficient for all the slave processors except the vision system, which would need as much as 32K.

Robot Related Publishers and Publications

Robotics Age Magazine
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(603)924-7136

Byte Magazine
70 Main St.
Peterborough, NH 03458
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TAB Books, Inc.
Blue Ridge Summit, PA 17214

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Small Robot Manufacturers

Hobby Robot Co., Inc.
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St. Champaign, IL 61820
(217)352-8485

Heath Company
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Benton Harbor, MI 49022

ANDROBOT, Inc.
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San Jose, CA 95103

Iowa Precision Robotics, Ltd.
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Milford, IA 51351
(712)338-2047

RB Robot Corp.
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The software in such a complete system would determine how coherent the being would appear. If provisions are provided for concentration of the master processor on any particular level, and each level is capable of learning additional things or at least compensating for changes in the environment, then the robot will "grow up" more naturally and easily than a hardwired logic program operating the entire body.

Now that the hardware is becoming more affordable every day, many approaches will be tried and innovations will prevail over the it'll-never-work law.

Alas, Poor Human

With so many more capabilities being added to today's "steel collar" workers, many people feel there soon will be precious little for today's average child to look forward to as a career possibility. If robots can build and maintain themselves (a distinct possibility today) and even redesign themselves (perhaps by the mid-21st century) what will there be left for us to do? Think of jokes we can play on robots without putting them behind schedule? Or will we be so preoccupied with worry about what may go wrong (or go wrong next) that we forget to enjoy ourselves and our good fortune?

The effectiveness of technology has always depended upon how appropriately it is applied. A robot cooking in my kitchen doesn't follow my common sense, as the expense and environmental programming (assuming design, construction, and operational programming were done by someone else) are much more than the awards merit: a prompt, properly cooked breakfast, sans any innovation, spontaneity, or creativity. Many people may not mind pre-programmed food, but an awareness that this is the *best* robotics in their kitchen will achieve in the foreseeable future may throw a wet blanket on their enthusiasm.

The most practical and feasible application for robotics today is in industry. It seems it will be a long time before personal robots will be functional enough to own, for reasons beyond those of the average pet. Their cost may come down to only three digits, but as robots are essentially just computers with complex peripherals, there will always be many add-ons that will add to the final bill before the robot will be able to do any useful work.

We will most likely see tomorrow's blue collar *and* white collar workers being replaced with robots and computer network systems. The mixed blessings will be expanded leisure time for some (the robot owners) and lack of a livelihood for those replaced, or even those merely displaced. No one claims it will be easy to retrain those workers displaced by robots.

Few even mention that the gap humans have left to work in the system is shrinking at an accelerating rate: more and more unemployed trying for fewer and fewer higher level jobs. How desirable is a completely automated, robotosized company, where orders are taken electronically, automatically manufactured to specification, delivered (by robot transport) to your door, and bills electronically prepared without human intervention? Especially if nearly no one can afford the merchandise at any price? What would become of the business if the owner died? Would it be parcelled out by electronic lawyers following a recorded will? Or would an electronic government simply nationalize it?

Look at your Color Computer. It can do much of the monotonous work and drudgery of everyday life. Do you want it to do *all* of your work for you? Even the interesting work? Perhaps we should leave something to look forward to each day to get us out of bed.

■ ■ ■

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By Tim Nelson

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Spelling Pizazz!

This program will help learning-disabled students practice spelling and reading.

4K Color Basic

by Jeanlee M. Poggi

THE TWO WORST SPELLING difficulties for learning-disabled students are a poor visual attention for words, and poor memory for visual details in words. There is no better tool for teaching visual attention than the computer!

Spelling Pizazz was designed to reward students for looking closely at words. The program also gives students lively repetition as a memory aid. The sample program (Listing 1) was planned to review five words that plague a college student in his essays and compositions. I prefer to teach by individualized word study that links a student's writing vocabulary and spelling.

The program can be adapted for students of all ages, and it can be modified to accommodate teaching methods of all sorts. For younger students, use shorter words. For older students, use longer words. Present words according to patterns or rules, if that's your style.

Some students will need a very sharp visual image. For them, the program will work best on a large black-and-white screen (a TV set with an 18-inch screen, mounted at eye level, is ideal for students with visual perceptual problems). Be sure the student sits at a comfortable distance from the screen, and show him or her how to vary contrast and brightness as needed. If students have both reading and spelling problems, have them read the words aloud to you or a stand-in before starting. Keep the list short: given the memory skills required, five words are plenty for any learning-disabled student, and the program will work best as a review.

When entered and run, the program starts with a screen that looks like this:

```
SPELLING PIZAZZ

I HAVE 5 WORDS FOR YOU TO SPELL.

I WILL GIVE YOU THE FIRST LETTER AS A CLUE.

STUDY THE WORDS AND THEN SPELL THEM.
GOOD LUCK!

WORDS: QUANTITY, WEATHER, STRATIFY, CONSUME, EFFICIENTLY

CLUE:E———?
```

The question mark is a prompt to the user to type in the word that starts with the clue letter. (I explain this verbally to students, as I don't want to make the written directions for the program too long.) If the user makes errors, the computer sympathizes: SORRY,WRONG and immediately gives the correct spelling. If answers are correct, the computer rejoices: CORRECT!!! and shows the student the number of correct answers. Most students like to see how well they can do in 10 or 15 tries.

At first, some students get so excited by the program that they'll forget the words on the list. You can help them for the first few runs through, or tell them to Break the program and run it again. (They'll lose their score, but that will motivate them to pay more attention to the word list next time.) There's only one catch to the program: each word to be spelled must start with a different letter.

Once you have set up Spelling Pizazz, it's easy to change to new words. Save your first lesson; then for each new group of words, load the program, List Line 10, and retype it. Start with the number of words, then follow with the words themselves. Run your new program and make sure misspellings haven't crept in, give it a distinctive name, and save it on a tape or disk.

If you want to help your students review spelling lists used in the classroom, or you'd like to teach patterns in words, you can modify the program. Just change the directions in Lines 50 – 70 so they read something like this: I HAVE 5 WORDS FOR YOU TO SPELL. EACH WORD ENDS IN ING. I WILL GIVE YOU THE FIRST LETTER AS A CLUE... Type the words you want, List the rest of the program as it's given, and — Voila! Or as my students spelled it — before using this program — "Wallah!"

■ ■ ■

Program

Program Listing. Spelling Pizazz

```
10 DATA 5,QUANTITY,WEATHER,STRAT
IFY,CONSUME,EFFICIENTLY
20 READ N
30 FOR X=1 TO N:READ W$(X):NEXT
40 CLS:PRINT"     ***SPELLING PI
ZAZZ***":PRINT
50 PRINT"       I HAVE"N"WORDS":P
RINT "      FOR YOU TO SPELL."
60 PRINT" I'LL GIVE THE FIRST LE
TTER AS"
70 PRINT" A CLUE.":PRINT
80 PRINT" STUDY THE WORDS AND TH
EN"
90 PRINT" SPELL THEM.  GOOD LUCK
!":PRINT
100 PRINT"  WORDS: " W$(1)
110 FOR X=2 TO N:IF X AND 1 THEN
 PRINT ", "; ELSE PRINT"  ";
120 PRINT W$(X); : IF X AND 1 TH
EN PRINT
130 NEXT X
140 W=RND(5) : IF W=L THEN 140
150 PRINT:PRINT "    CLUE: " LEF
T$(W$(W),1);
160 FOR X = 1 TO LEN(W$(W))-1 :
PRINT "-"; : NEXT X : PRINT
170 T = T + 1 : INPUT AN$
180 IF AN$=W$(W) THEN 220
190 PRINT "    SORRY, THAT IS NO
T RIGHT."
200 PRINT " THE CORRECT WORD IS:
 "W$(W)
210 GOTO 150
220 PRINT "     CORRECT!!!"
230 C = C + 1 : L = W
240 PRINT " THAT IS" C "OUT OF"
T "CORRECT"
250 GOTO 140
```

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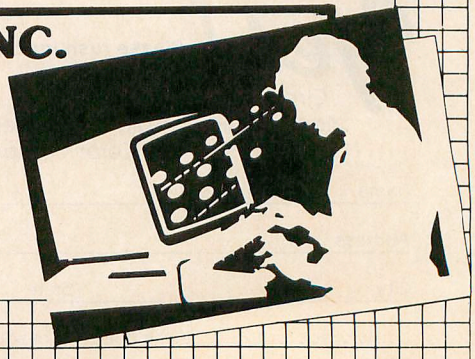

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16K Disk Extended Color Basic

The Devil's Disk Editor

Part III of a series on disks.

by William Barden, Jr.

I HAD JUST FINISHED typing in Dennis Kitsz's program to simulate a 100-piece symphony orchestra...Whew! Three hundred (count 'em!) Basic lines. Let's see... I'll kill the old file and then I'll be set — omigosh! I killed the good file! Do I have a back-up?

As it turned out, I did *not* have a back-up! I hated to enter all those lines again, but I wanted to be able to hear Franck's Second Symphony before nightfall. What to do?

Scanning through the Color Computer disk system manual, I came across the layout of the disk directory and file allocation table. I realized that even though I had killed the file, I might be able to retrieve it. After all, the file remains out there on disk somewhere, doesn't it? Or does it?

The end result of my attempt to retrieve Dennis's program was something I call the *Devil's Disk Editor*. It's a program that, among other things, will let you restore killed disk files, allocate disk space, correct errors in disk files, and investigate the format of different files on disk. I used the qualifier "Devil's" because, while it's useful, it's also easy to get in devilish messes while using it — you can easily "fix" the disk so that it's in worse shape than before.

photo by Charley Freiberg

Some Background

In my last article, I described the layout of the disk, the disk directory, the File Allocation Table (FAT, for short), and the

to page 103

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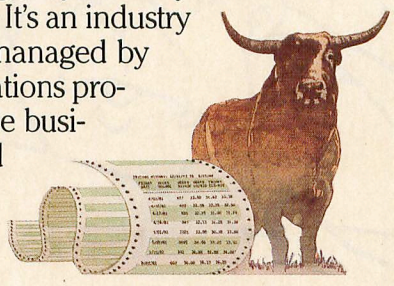

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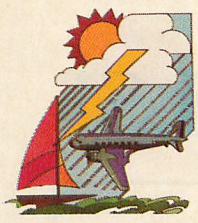

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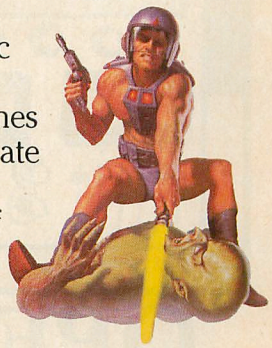

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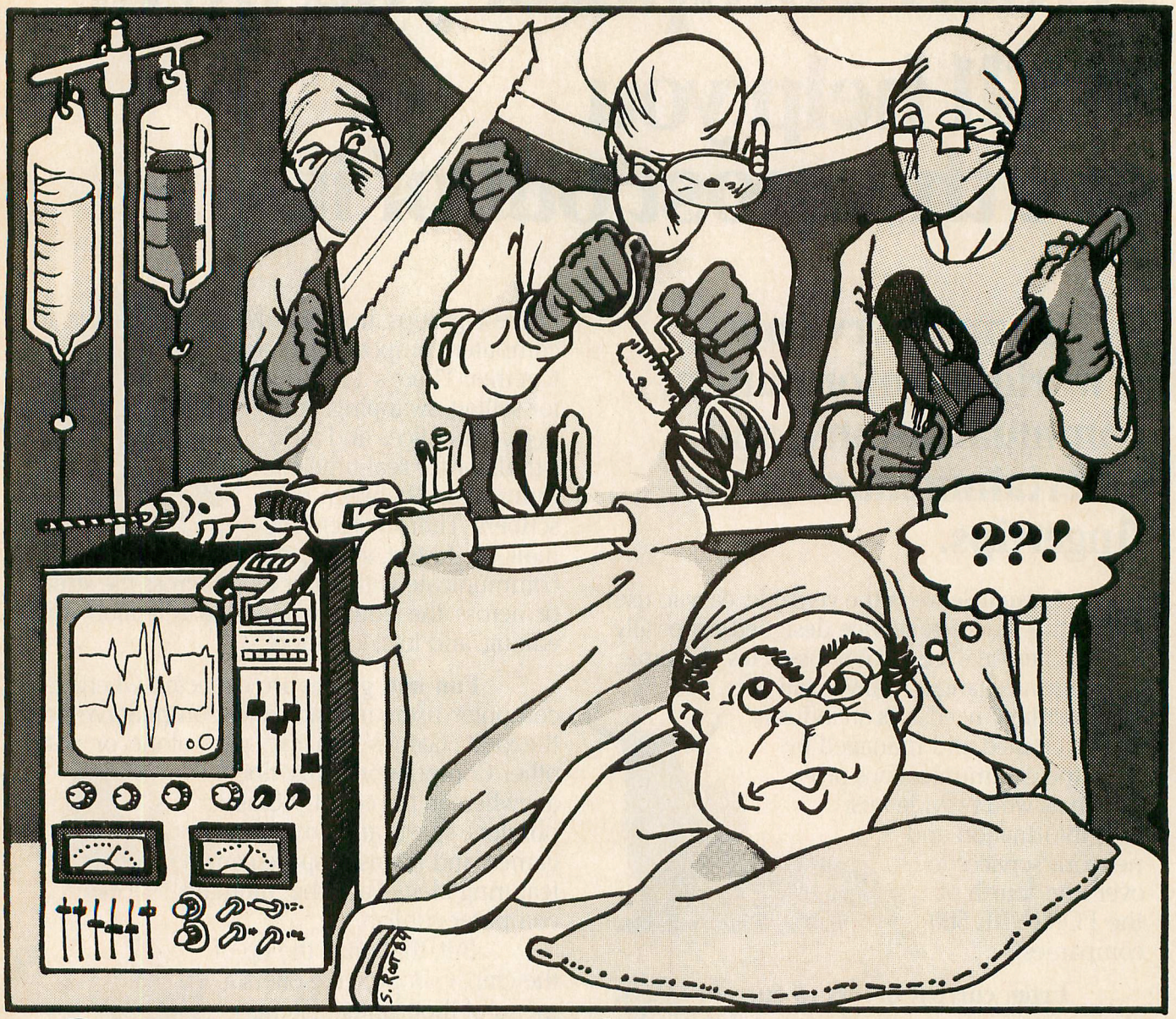

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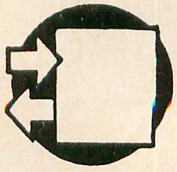

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DSKI$ command. Permit me to briefly review some of this material before we go on.

Color Computer disks under the Radio Shack Disk Operating System are made up of 35 *tracks* with 18 *sectors* per track. There are 256 bytes of data per track, so all told, there's space for 35 x 18 x 256 = 161,280 bytes of data per disk, as shown in Figure 1.

In the middle of each disk there's a *system* track. This track is used by the Disk Operating System and can't normally be used by mere mortals like us. Sectors 3 through 11 of track 17 are devoted to a *directory*. The directory lists the names of all disk files and where they are on disk, in addition to defining the file types, whether or not they're ASCII files, and the number of bytes in the last file sector. The directory format is shown in Figure 2.

Sector 2 of track 17 is the FAT. File space is not allocated on a sector basis, but rather nine sectors, or half a track at a time. Nine sectors or half a track, for reasons lost in antiquity, are called *granules*. As there are 35 tracks and 70 half tracks on each disk, there are 70 granules available to the Color Computer user. However, track 17 is used by the system, so two granules are subtracted from this total, leaving 68 granules free. These 68 granules are defined in the first 68 bytes of the FAT, sector 2 of track 17, as shown in Figure 3.

Each of the 68 bytes in the FAT is either a 0 through 67 ($00 – $43 in hexadecimal), a 255 ($FF), or a 192 through 201 ($C0 – $C9). If the byte defining the granule is a $FF, the granule is unused. If the byte is a $00 through $43, the byte points to the *next* granule in the FAT used for the file. If the byte is a $C0 through $C9, this granule is the *last* granule of the file and the 0 through 9 defines the number of sectors used for the file in this last granule.

Files don't have to be *contiguous*, occupying adjacent granules. A file might be spread over six granules at different areas on the disk. The *linked* FAT entries define the way the granules are chained together to make up the file, as shown in the Figure (refer to Fig. 2, March, part II).

For more on this, read "Disk Secrets," Part I and II, February, 1984 and March, 1984 **TCCM,** and the Technical Information chapter in the Radio Shack *Color Computer Disk System* manual — it does an excellent job of describing the way the disk is organized.

How to Use the Devil's Disk Editor

The DDE is shown in Listing 1, a Basic program that makes use of the DSKI$ and DSK0$ commands in Basic to read and write disk sectors. These two Basic commands let you read or write to any of the 630 sectors on a disk, even the FAT and directory sectors. They're powerful commands and let you read and modify the entire disk — *if* you know what you're doing!

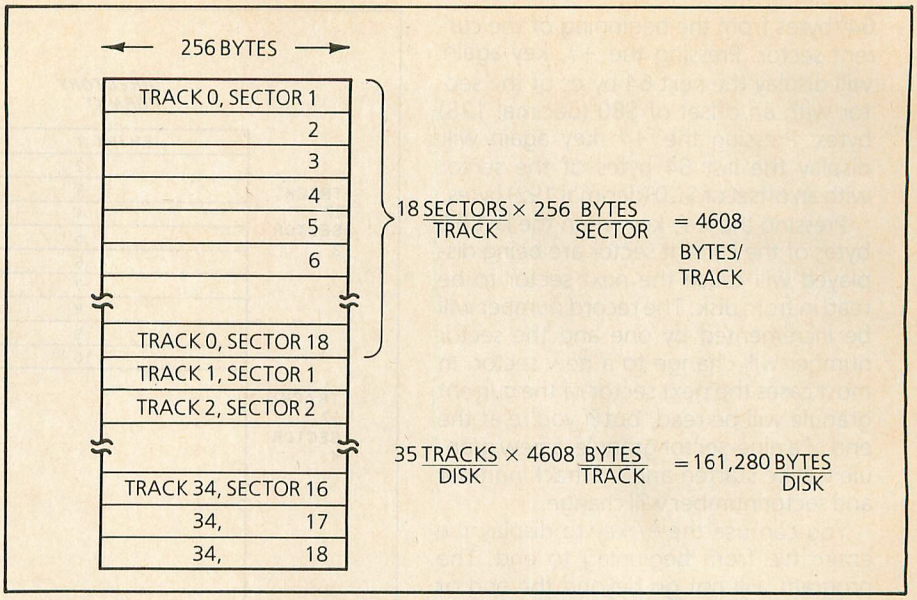

Figure 1. Tracks, Sectors and Bytes

Enter the DDE in its entirety and save it on disk. Run the program and you'll see the message: DEVIL'S DISK EDITOR displayed on the screen. At this point you can select any of five modes by pressing appropriate keys:

- Pressing the F key selects the File Mode
- Pressing the S key selects the Sector Mode
- Pressing the +/; key selects the Next Block Mode
- Pressing the – key selects the Previous Block Mode
- Pressing the M key selects the Modify File mode
- Pressing Clear restarts the program

The File Mode

The File Mode lets you read and display any disk file. After pressing the F key, you'll see the screen clear and the message FILE:. Enter the name of the file you want displayed, complete with extension and disk drive number. A typical file name might be DSK1CCM/BAS:1 or DIETCAL/BAS. If you don't include the *extension*, however, the file will not be found, as the program looks for the complete name in the directory.

After entering the complete file name, press Enter, and you'll see something similar to the following display:

```
DRV#: 0 TRK#: 15 SECTOR #: 10
FILE: DIETCAL/BAS REC#: 0
OFFSET: 0

FF 07 E2 26 1E 00 6E 9E ...$..N.
3A 20 87 40 35 2C 22 44 : .@5,"D
49 45 54 20 43 41 4C 43 IET CALC
55 4C 41 54 4F 52 22 00 ULATOR".
26 43 00 78 87 40 33 32 @C.X.@32
2C 22 45 4E 54 45 52 20 ,"ENTER
53 45 58 2C 20 4D 20 4F SEX, M O
52 20 46 22 3B 3A 20 89 R F";" .
```

In this example, the file DIETCAL/BAS was found on track 15, sector 10 on the disk in drive 0. The first *record* number is 0 and the *offset* is 0. The record number is actually the sector number of the file. (This may differ from the logical record number in some files.) Each time a new sector of the file is displayed, the record number will increase by one. The offset is a hexadecimal number of 0, $40, $80, or $C0. More on that shortly.

The data on the screen is the hexadecimal contents of the first 64 bytes of the file on the left, with the corresponding ASCII characters on the right. ASCII characters that cannot be displayed are denoted by a decimal point character. In this example, you can see that the first portion of the first record is a Basic program with some text. Other data displayed consists of Basic tokens, addresses, and line numbers.

The Next Block Mode

Pressing the +/; key at this point will display the next 64 bytes of the first sector of the file. You'll see the offset change from 0 to 40, indicating that the data on the screen is offset $40 (decimal

64) bytes from the beginning of the current sector. Pressing the +/; key again will display the next 64 bytes of the sector with an offset of $80 (decimal 128) bytes. Pressing the +/; key again will display the last 64 bytes of the sector with an offset of $C0 (decimal 192) bytes.

Pressing the +/; key when the last 64 bytes of the current sector are being displayed will cause the next sector to be read in from disk. The record number will be incremented by one and the sector number will change to a new sector. In most cases the next sector of the current granule will be read, but if you're at the end of a nine-sector granule, a new granule will be started and the track number and sector number will change.

You can use the+/;key to display the entire file from beginning to end. The program will not go beyond the end of the last sector of the file, but it will display the four 64-byte offset groups of the last sector even though the file might end in the first 64 bytes.

The Last Block Mode

At any time during the display of the file you can press the – (minus) key to go back to the previous block of 64 bytes. You'll see the offset changing by 64 bytes. At the beginning of a new sector, the previous sector will be read in and displayed. If the beginning of an intermediate granule is being displayed, the program will read in the previous granule and display the last block of the last sector of that portion of the file.

As in the case of the Next Block Mode, you can't go beyond the limits of the file — you can't go to a previous block or sector when you're at the beginning of the file.

The Modify File Mode

You can press the M key while a file is being displayed to get into the Modify File Mode. In this mode you can change the contents of a file by moving a screen cursor and changing the screen display. When you've finished changing the file, you can then press Enter to permanently change the file contents on disk. A word of warning on this mode: *Know what you are changing and keep a record of the original contents of the file if you're unsure of the changes.* It is *very* easy to destroy disk files or to destroy the contents of other parts of the disk.

You'll see an orange cursor after pressing the M key, as shown in Figure 4. You can move the cursor around by using the arrow keys. The right arrow will move the cursor to the right and will move to the next line at the end of a line. The left arrow will move the cursor to the left or to the previous line at the beginning of a line. The up and down arrows will move the cursor from one line to the next, keeping the same character position on the line as the cursor moves.

To change data in the file, move the cursor to the byte you want to change and then enter two hexadecimal digits. You'll see the hex digits displayed in inverse video to signify that the data was changed from the original. At the same time, you'll see the display of ASCII data change on the right, as long as the data represents an ASCII character. The cursor will automatically move to the next digit position, skipping blanks so you can change a number of consecutive locations.

When you've finished changing the data, press Enter. There'll be a pause and the new data will then be written out to disk. You can then go to the next or previous block to make additional changes.

If you want to cancel all changes you've made to the current block, press Clear. The file will not be updated, and the program will go back to the command input mode. *Any changes made to another block will not be canceled.*

The Sector Mode

The above commands let you step through any type of a file and modify any

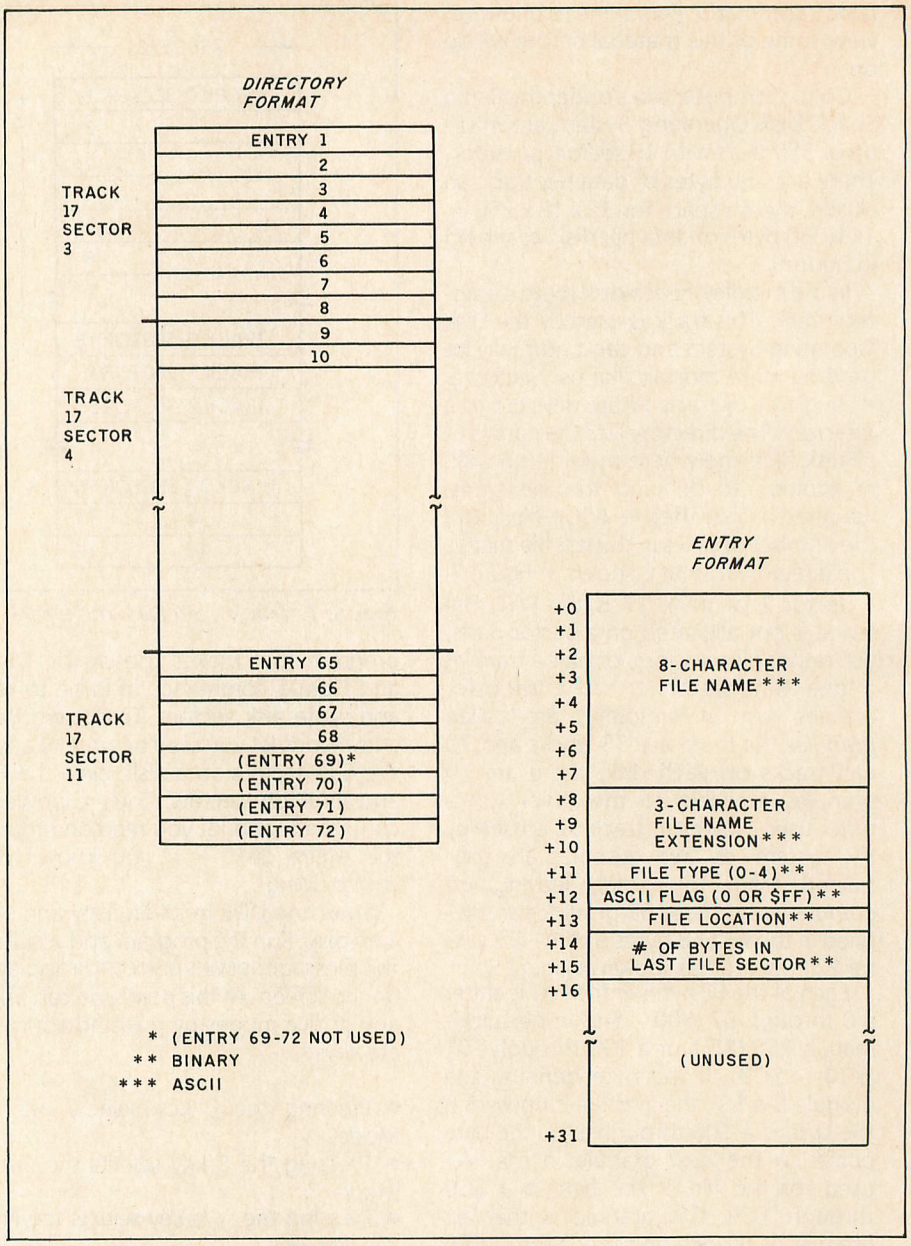

Figure 2. Directory Format

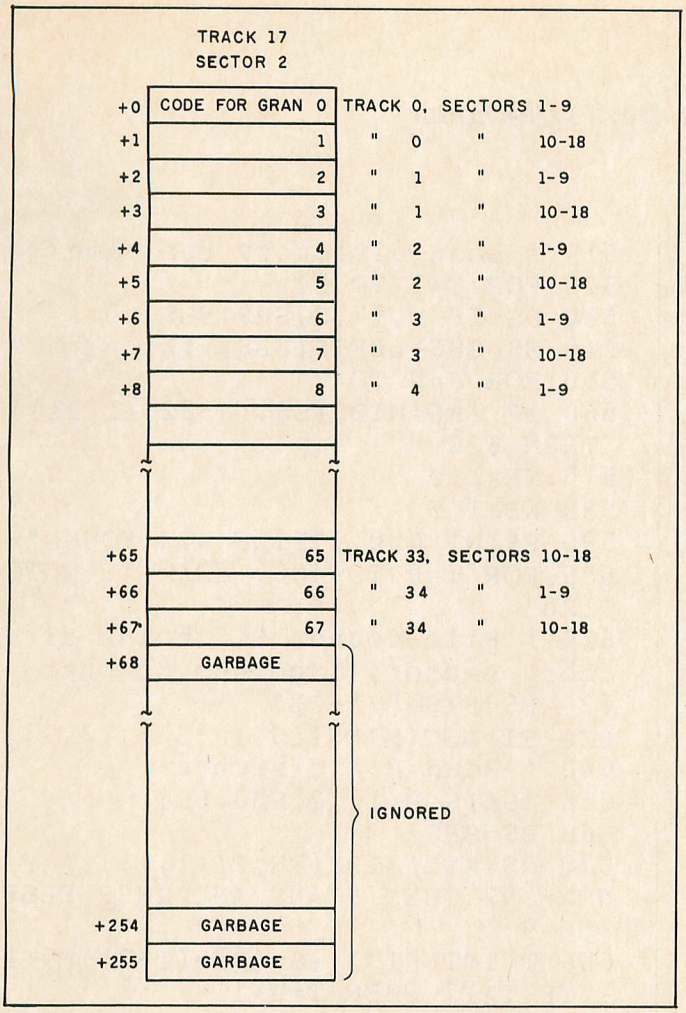

Figure 3. File Allocation Table

data in the file. The file is displayed from beginning to end. The Sector Mode lets you display a block of sectors that are not necessarily connected with any file.

To get into the Sector Mode, press S. You'll see the following display: DRV#:. Enter the disk drive number from 0 through 3. You'll then see: DRV#: 0 TRK#:?. Enter the track number for the sector that you want to display. Track numbers go from 0 through 34. You'll then see: DRV#: 0 TRK#: 17 SECTOR#:?.

Enter the sector number of the sector you want to display. Sector numbers go from 1 through 18 (and for some mysterious reason do not start with zero). After you've entered the sector number, you'll see a display identical in format to the one in the File Mode, except that the file field will be blank. The record number field will remain at zero throughout the display in this mode, as the sectors do not necessarily have any relationship to file records.

Pressing the +/; key will display the next block of 64 bytes as in the file mode. Continually pressing +/; will display the four blocks of the current sector and the display will then move to the next sector. When the last block of the last sector in a track is displayed, the first sector of the next track will be displayed.

Pressing the – key will display previous blocks or sectors. When the first sector of the current track is being displayed, pressing – will move to the last sector of the previous track.

The Modify File Mode will work as before, except that in this case the sector to be modified isn't necessarily associated with any file.

▸ *Program* ■ ■ ■

April Definitions

Interpreter — a person who can speak both human and computer languages fluently. Handy to have, and available in very short supply.

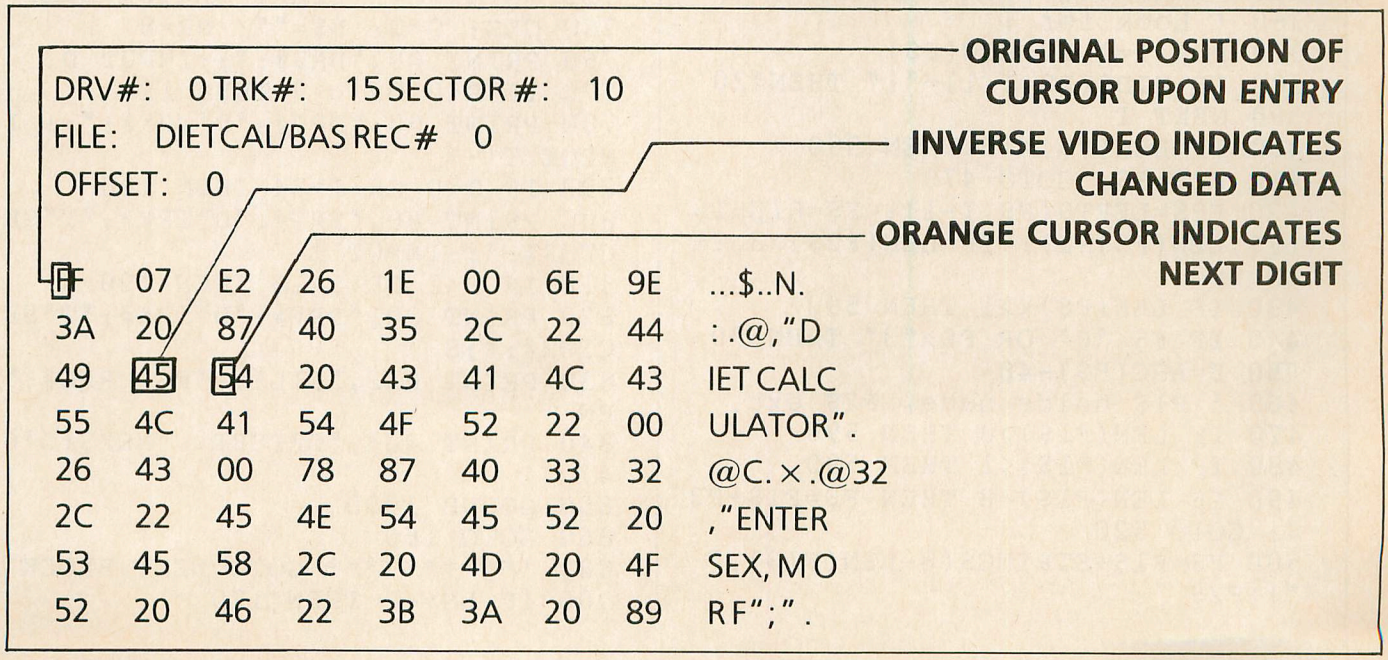

Figure 4. Modify File Mode

Program Listing 1. Devil's Disk Editor

```
100 ' DEVIL'S DISK EDITOR
110 CLEAR 3000
120 CLS
130 PRINT @ 198,"DEVIL'S DISK ED
ITOR"
140 D=0: T=0: S=0: F$="": RN=0:
O=0: LS=-1
150 B$="FS+;-M"+CHR$(12)
160 A$=INKEY$
170 FOR I=1 TO 7
180 IF A$=MID$(B$,I,1) THEN 210
190 NEXT I
200 GOTO 160
210 ON I GOTO 250,750,900,900,11
10,1300,120
230 '********** START FILE DUMP
250 CLS: NR=0: O=0
260 PRINT @ 32,"FILE: ";: LINEIN
PUT F$
270 F1$="":F2$=""
280 ' Look for / or .
290 FOR I=1 TO LEN(F$)
300 IF MID$(F$,I,1)="." THEN340
310 IF MID$(F$,I,1)="/" THEN340
320 NEXT I
330 F1$=F$: GOTO 470
340 F1$=LEFT$(F$,I-1): F$=RIGHT$
(F$,LEN(F$)-I)
350 IF LEN(F$)=0 THEN GOTO 470
360 ' Look for :
370 FOR I=1 TO LEN(F$)
380 IF MID$(F$,I,1)=":" THEN420
390 NEXT I
400 IF LEN(F$)<>3 THEN 590
410 F2$=F$: GOTO 470
420 F2$=LEFT$(F$,I-1): F$=RIGHT$
(F$,LEN(F$)-I): IF LEN(F2$)>3 TH
EN 590
430 IF LEN(F$)<>1 THEN 590
440 IF F$<"0" OR F$>"3" THEN590
450 D=ASC(F$)-48
460 ' F1$ holds name, F2$ ext.
470 IF LEN(F1$)>8 THEN 590
480 IF LEN(F1$)<1 THEN 590
490 IF LEN(F1$)=8 THEN F$=F1$+F2
$: GOTO 520
500 F$=F1$+STRING$(8-LEN(F1$),"
")+F2$
510 ' Scan directory for name
520 FOR S=3 TO 11
530 DSKI$ D,17,S,SH$,SL$
540 S$=SH$+LEFT$(SL$,112)
550 FOR J=0 TO 7
560 IF (F$=MID$(S$,(J*32)+1,11))
 THEN 620
570 NEXT J
580 NEXT S
590 PRINT @201,"FILE NOT FOUND"
600 FOR I=0 TO 400: NEXT I: GOTO
 120
610 ' File found. S1$ holds dire
ctory sector, I points to entry
620 F$=F1$+"/"+F2$
630 FT=ASC(MID$(S$,(J*32)+14,1))
640 ' Read F A T sector
650 DSKI$ D,17,2,SH$,SL$
660 P$=SH$
670 NS=ASC(MID$(P$,FT+1,1)): IF
NS>=192 THEN NS=NS AND &H3F ELSE
 NS=9
680 T=INT(FT/2):S=(FT-(T*2))*9+1
: IF T>17 THEN T=T+1
690 ' FT holds pointer, P$ holds
 first part of F A T
700 OF=FT
710 GOTO 820
730 '******** START SECTOR DUMP
750 CLS: O=0: F$="": NR=0
760 PRINT @0,"DRV#:";:INPUT D
770 IF D<0 OR D>3 THEN 120
780 PRINT @0,"DRV#:"D"TRK#:";: I
NPUT T
790 IF T<0 OR T>34 THEN 120
800 PRINT @0,"DRV#:"D"TRK#:"T"SE
CTOR#:";:INPUT S
810 IF S<1 OR S>18 THEN 120
820 PRINT @0,"DRV#:"D"TRK#:"T"SE
CTOR#:";S
830 PRINT @32,"FILE: "F$" REC#:"
RN
840 PRINT @64,"OFFSET: "HEX$(O*6
4)
850 GOSUB 1950
860 GOTO 160
880 '********** GOTO NEXT BLOCK
900 IF LS=-1 THEN 120
```

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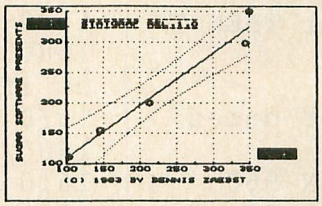

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```
910 IF F$<>"" THEN 1000
920 O=O+1: IF O<>4 THEN 940 ELSE
 O=0: S=S+1: IF S<>19 THEN 940
930 S=1: T=T+1: IF T<>35 THEN 94
0 ELSE T=0
940 PRINT @0,"DRV#:"D"TRK#:"T"SE
CTOR#:"S
950 PRINT @32,"FILE: "F$" REC#:"
RN
960 PRINT @64,"OFFSET: "HEX$(O*6
4)
970 GOSUB 1950
980 GOTO 160
990 ' Next block for named file
1000 O=O+1: IF O<>4 THEN 940
1010 O=0: S=S+1: RN=RN+1: NS=NS-
1: IF NS=0 THEN 1020 ELSE 940
1020 IF (ASC(MID$(P$,FT+1,1))<19
2) THEN 1040
1030 O=3: RN=RN-1: S=S-1: NS=NS+
1: GOTO 160
1040 FT=ASC(MID$(P$,FT+1,1))
1050 T=INT(FT/2):S=(FT-(T*2))*9+
1: FT=ASC(MID$(P$,FT+1,1))
1060 IF T>17 THEN T=T+1
1070 IF FT>=192 THEN NS=FT AND &
H3F ELSE NS=9: GOTO 940
1090 '***** GOTO PREVIOUS BLOCK
1110 IF LS=-1 THEN 120
1120 IF F$<>"" THEN 1180
1130 O=O-1: IF O<>-1 THEN 1160 E
LSE O=3
1140 S=S-1: IF S<>0 THEN 1160
1150 S=18: T=T-1: IF T=-1 THEN T
=34
1160 GOTO 940
1170 ' Previous block for named
file
1180 O=O-1: IF O<>-1 THEN 960
1190 O=3: RN=RN-1: S=S-1: IF (S=
0) OR (S=9) THEN 1200 ELSE 940
1200 IF FT<>OF THEN 1220
1210 O=0: RN=RN+1: S=S+1: GOTO 1
60
1220 FOR I=1 TO 68
1230 IF (FT=ASC(MID$(P$,I,1))) T
HEN 1260
1240 NEXT I
1250 PRINT @192,"I/O ERROR": GOT
O 600
1260 FT=I: GOTO 940
1280 '****** MODIFY MEMORY MODE
1300 IF LS=-1 THEN 120
1310 CL=4: CC=0
1320 ' MAIN LOOP here
1330 CP=CL*32+CC+1024: A=PEEK(CP
)
1340 A$=INKEY$
1350 IF A$<>"" THEN POKE CP,A: G
OTO 1380
1360 IF PEEK(CP)=A THEN POKE CP,
255 ELSE POKE CP,A
1370 GOTO 1340
1380 IF A$<>CHR$(9) THEN 1440
1390 ' Move cursor Right
1400 CC=CC+1: IF CC+1-INT((CC+1)
/3)*3=0 THEN CC=CC+1
1410 IF CC<24 THEN 1430
1420 CC=0: CL=CL+1: IF CL>11 THE
N CL=4
1430 GOTO 1330
1440 IF A$<>CHR$(8) THEN 1500
1450 ' Move cursor Left
1460 CC=CC-1: IF CC+1-INT((CC+1)
/3)*3=0 THEN CC=CC-1
1470 IF CC>-1 THEN 1490
1480 CC=22: CL=CL-1: IF CL<4 THE
N CL=11
1490 GOTO 1330
1500 IF A$<>CHR$(10) THEN 1540
1510 ' Move cursor Down
1520 CL=CL+1:IF CL=12 THEN CL=4
1530 GOTO 1330
1540 IF A$<>CHR$(94) THEN 1590
1550 ' Move cursor Up
1560 CL=CL-1:IF CL=3 THEN CL=11
1570 GOTO 1330
1580 ' Restart if CLEAR or Proce
ss if ENTER
1590 IF A$=CHR$(12) THEN 120
1600 IF A$=CHR$(13) THEN 1750
1610 ' Change data
1620 IF A$<"0" OR A$>"F" THEN 13
30
1630 IF A$>"9" AND A$<"A" THEN 1
330
1640 A=ASC(A$): A=A AND 191
1650 POKE CP,A
1660 IF CC+2-INT((CC+2)/3)*3=0 T
HEN CM=CP-1 ELSE CM=CP
1670 AL=PEEK(CM) AND 191: AR=PEE
K(CM+1) AND 191
1680 IF AL<48 THEN AL=AL+9 ELSE
AL=AL-48
1690 IF AR<48 THEN AR=AR+9 ELSE
AR=AR-48
```

to page 112

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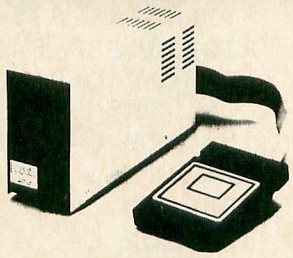

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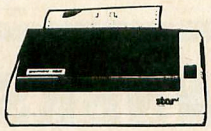

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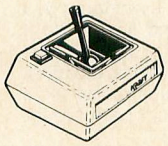

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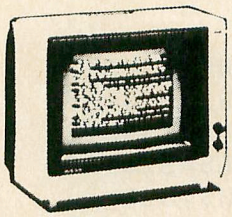

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```
1700 AC=(AL*16)+AR: IF AC<32 OR
AC>127 THEN AC=46
1710 CM=INT(CC/3)+(CL*32)+24+102
4
1720 POKE CM,AC
1730 GOTO 1400
1740 ' Write out new sector
1750 A$=""
1760 FOR R=0 TO 7
1770 FOR C=0 TO 7
1780 CP=(R*32)+128+(C*3)+1024
1790 AH=PEEK(CP) AND 191: AL=PEE
K(CP+1) AND 191
1800 IF AH<48 THEN AH=AH+9 ELSE
AH=AH-48
1810 IF AL<48 THEN AL=AL+9 ELSE
AL=AL-48
1820 AC=(AH*16)+AL
1830 A$=A$+CHR$(AC)
1840 NEXT C
1850 NEXT R
1860 IF O=0 THEN SH$=A$+S1$
1870 IF O=1 THEN SH$=S0$+A$
1880 IF O=2 THEN SL$=A$+S3$
1890 IF O=3 THEN SL$=S2$+A$
1900 DSKO$ D,T,S,SH$,SL$
1910 GOTO 160
1930 '********************* READ
 IN AND DISPLAY CURRECT SECTOR
1950 IF LS=S THEN1970 ELSE LS=S
1960 DSKI$ D,T,S,SH$,SL$
1970 S0$=LEFT$(SH$,64):S1$=RIGHT
$(SH$,64):S2$=LEFT$(SL$,64):S3$=
RIGHT$(SL$,64)
1980 IF O=0 THEN SF$=S0$ ELSE IF
 O=1 THEN SF$=S1$: GOTO 2000
1990 IF O=2 THEN SF$=S2$ ELSE IF
 O=3 THEN SF$=S3$
2000 FOR R=0 TO 7: R8=R*8: RT=R*
32: FOR C=0 TO 7
2010 A=ASC(MID$(SF$,(R8)+C+1,1))
2020 AL=INT(A/16): AR=A-AL*16
2030 AL=AL+48: IF AL>57 THEN AL=
AL+7
2040 AR=AR+48: IF AR>57 THEN AR=
AR+7
2050 PRINT @(RT)+128+(C*3), CHR$
(AL);CHR$(AR)" ";
2060 IF A>=32 AND A<128 THEN AC=
A ELSE AC=46
2070 PRINT @(RT)+128+C+24,CHR$(A
C);
2080 NEXT C: NEXT R
2090 RETURN
```


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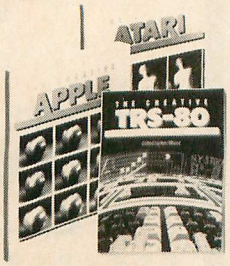

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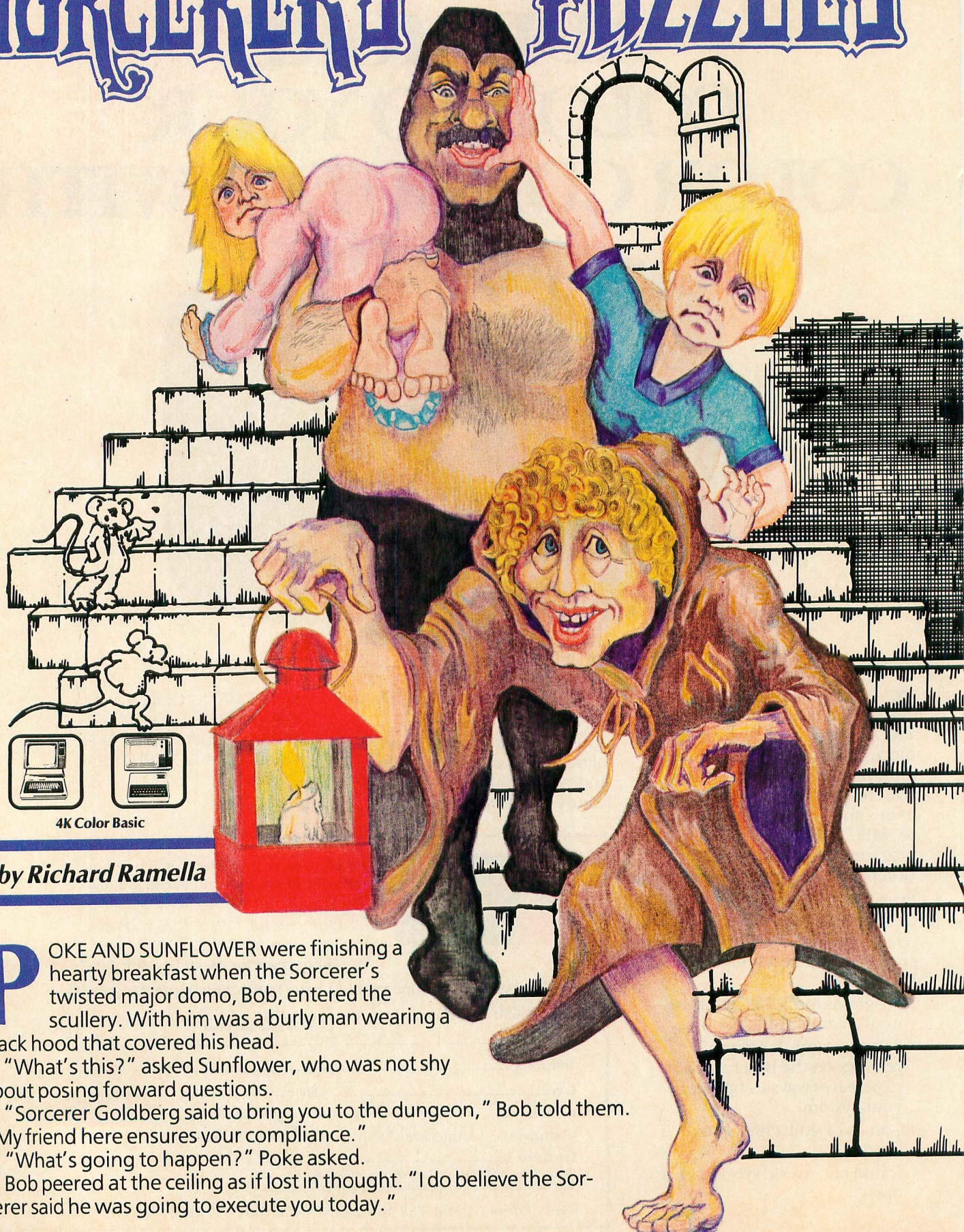
SORCERER'S PUZZLES



4K Color Basic

by Richard Ramella

POKE AND SUNFLOWER were finishing a hearty breakfast when the Sorcerer's twisted major domo, Bob, entered the scullery. With him was a burly man wearing a black hood that covered his head.

"What's this?" asked Sunflower, who was not shy about posing forward questions.

"Sorcerer Goldberg said to bring you to the dungeon," Bob told them. "My friend here ensures your compliance."

"What's going to happen?" Poke asked.

Bob peered at the ceiling as if lost in thought. "I do believe the Sorcerer said he was going to execute you today."

Sunflower threw down her napkin and stood. Her chair clattered to the floor behind her. Poke stared at Bob and the hooded man, with a nearly unhinged jaw.

"Fetch them up, Harold," Bob directed, and the man in black stepped forward with a crablike motion and clamped a hammy hand on the back of each neck.

"No!" Poke screamed. Sunflower pummeled hooded Harold's midsection in quiet fury.

Neither could escape. With Bob limping along in the lead and Harold following with a prisoner secured under each arm, the procession passed through a long stone hallway and descended to the dank nether regions of the castle. Down a torchlit hall they went, past rusted cells and the sounds of small creatures skittering in the dark.

At the end of the hall was a huge oak door, which opened to reveal the Sorcerer standing before an empty blackboard. "Good morning," he said with a smile.

"Why are you doing this?" Sunflower demanded.

"I think you'll agree it's time," Sorcerer Goldberg said.

"I quit!" said Poke. "I don't want to be your apprentice *n-o-o-o* more! Just let me out of here!"

"Oh, come now," the Sorcerer chuckled, "it won't be all that bad!"

"What's worse than death?" Sunflower asked as hooded Harold set her and Poke on the floor, then fell back a pace to guard the door.

"Death?" said the Sorcerer. "Is that a rhetorical question?"

"Bob said you were going to execute us," Poke told the Sorcerer.

Bob nodded gleefully.

"I didn't say "execute," I said "educate," the Sorcerer frowned.

A look of genuine disappointment came over Bob's face. "A harmless misunderstanding," he said finally. "These ears aren't what they used to be."

"I suppose I won't be needed now," hooded Harold realized with a trace of wistfulness in his voice.

"I should say not," the Sorcerer laughed. Turning to Bob, he advised, "I think you owe the apprentices an apology."

"Why? Because I happen to be a bit deaf? I hardly think so."

The Sorcerer said nothing, but a small lightning bolt immediately came out of nowhere, striking Bob a bit below the small of his back. He leaped into the air — quite agilely. "Sorry!" he screamed. "I'm incredibly sorry for any misunderstanding my deafness may have created."

"You may go," the Sorcerer told Bob and Harold. Bob left muttering in a low voice and rubbing that part so recently zapped by lightning.

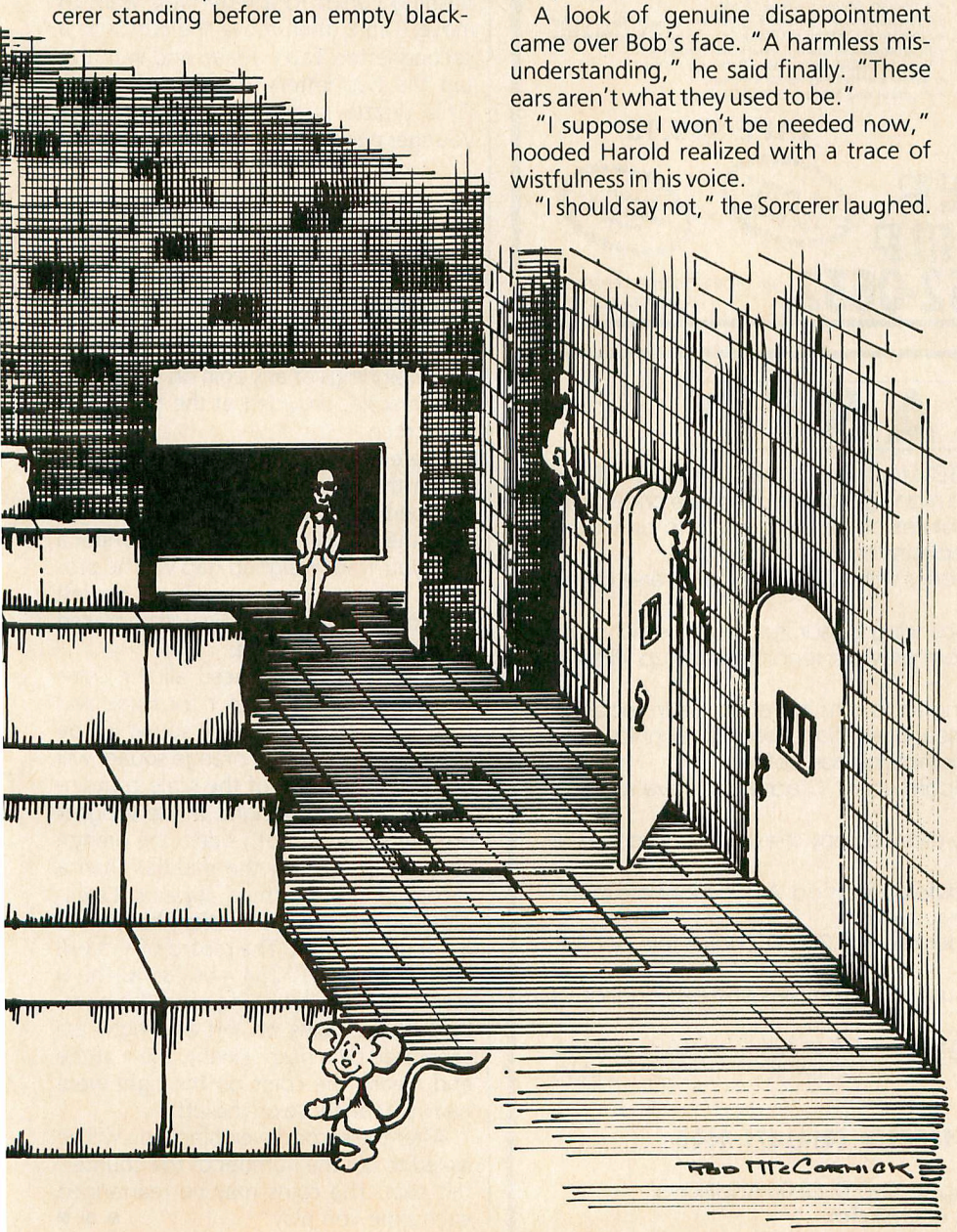
"This is a classroom," the Sorcerer announced as Poke and Sunflower sat at the only two student desks in the room. "I'm going to educate you in specific subjects as a prelude to a mission you'll be making for me in a month or so."

"A quest!" Poke said, nudging Sunflower.

"More in the nature of a scavenger hunt," the Sorcerer corrected. "But that comes later, not this time. For now I wish to test you in four areas: cooperation, insight, patterns and resourcefulness."

"Oh, we have all those and more," Poke nodded.

"We'll see," said the Sorcerer, turning to the blackboard...



(Sorcerer's Notes — All the following programs work on any TRS-80 Color Computer, including the MC-10. However, the program "Ahah" requires a line change for the MC-10, and this change is given as a remarks line in the Listing.)

Partners

Poke and Sunflower are told to write either the number 1 or 2 on a slip of paper. This continues in a series. Each starts with 50 gold coins. If one writes the number 2 and the other the number 1, the one who writes 2 gets more coins, but the one who writes 1 loses 10 of his coins. If both write the number 1, both lose 10 coins. If both write the number 2, both lose five coins. If one of the players loses all coins, both lose. Both win when both have 100 or more coins. In this puzzle the player represents Poke to see if he can discover the scheme Sunflower is using to ensure both players win. Type RUN, tap Enter, and answer the questions.

Ahah

There are two puzzles here. The first presents a series of letters. Some are above and others are below an orange line on the screen. The goal is to deter-

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mine why this particular arrangement is logical. The answer cannot be stated in computer terms, so when you feel you are ready for the next puzzle in this program, tap Enter.

The second puzzle, which is unrelated to the first, presents a list of nine letters. The player is asked to type in the tenth, unstated letter, which continues the series. The program knows if the answer is right or wrong; yet, the player will not find the answer anywhere in the Program Listing.

Alphaswitch

In 17 moves, put the letters A – X in alphabetical order, with the rows of letters reading left to right like the words on a page. Letters are correctly ordered by exchanges. Tap the Arrow Keys to take the flashing cursor to a letter you want to move. Tap E, then move the cursor to a second letter. Tap E again, and with this tap the two letters will be exchanged. (This puzzle is designed especially for younger players.)

The Counterfeit Doubloon

There are nine doubloons. All are yellow, but only eight are truly gold. One is counterfeit. The object is to determine which doubloon is phoney through only two weighings of any coin on either side of the scale, provided at the bottom of the screen.

There is a pointing orange cursor beneath the row of nine coins (which are numbered). Move the cursor left or right with the Arrow Keys. When it is under a coin you want weighed, tap W. The program will ask WHICH SIDE? Tap L for left or R for right, and the coin will be placed on that side of the scale.

When you have placed all the coins you wish weighed, tap T for total, and three things will happen. A sound will be played and a flashing orange square will appear on the side of the scale containing the heaviest weight. If the weights are the same on both sides, the orange square will flash in the middle. Then a record of the weighing appears. Example: You weigh coins 1 – 4 on the left and 5 – 9 on the right. The record of this will be as follows: 1) 1234 – 56789 R. The 1) stands for first weighing, and the numbers of the coins on left and right are separated by a dash. Finally, the R at the end means the coins on the right were heavier than those on the left.

After the second weighing, you will be asked to tell the number of the counterfeit coin. The coins may be rearranged each time you play. ■ ■ ■

☎ Enter 13 on TeleResponse page 159

Program Listing. Partners

```
100 REM * PARTNERS * TRS-80 COLO
R COMPUTERS
110 REM * COLOR BASIC - EXTENDED
 COLOR BASIC - MC-10 BASIC *
120 REM * SORCERER'S PUZZLES #6
* RICHARD RAMELLA
130 CLS
140 CLEAR 100
150 S$="SUNFLOWER"
160 P$="POKE"
170 S=50
180 P=50
190 PRINT S$" HAS"S
200 PRINT P$" HAS"P
210 FOR A=1 TO 2
220 PRINT
230 PRINT S$" WRITES:"A
240 PRINT
250 PRINT "WHAT DOES "P$" WRITE"
;
260 INPUT B
270 IF B<>1 AND B<>2 THEN PRINT
"ONLY ANSWERS ACCEPTED: 1 OR 2":
 GOTO 250
280 CLS
290 IF A=2 AND B=1 THEN PRINT S$
" +20. "P$" -10.": S=S+20: P=P-1
0
300 IF A=1 AND B=2 THEN PRINT S$
" -10. "P$" +20.": S=S-10: P=P+2
0
310 IF A=1 AND B=1 THEN PRINT "B
OTH LOSE 10.": S=S-10: P=P-10
320 IF A=2 AND B=2 THEN PRINT "B
OTH LOSE 5.": S=S-5: P=P-5
330 PRINT
340 PRINT S$" HAS"S
350 PRINT P$" HAS"P
360 IF P>99 AND S>99 THEN PR NT
"VERY GOOD. THE PARTNERS WIN.":
END
370 IF P<1 THEN PRINT P$" IS BRO
KE."
380 IF S<1 THEN PRINT S$" IS BRO
KE."
390 IF P<1 OR S<1 THEN PRINT "BO
TH LOSE ALL.": END
400 NEXT A
410 GOTO210
420 END
```

Program Listing. Ahah

```
100 REM * AHAH * TRS-80 COLOR CO
MPUTERS
110 REM * COLOR BASIC - EXTENDED
 COLOR BASIC - MC-10 BASIC *
120 REM * SORCERER'S PUZZLES #6
* RICHARD RAMELLA
130 CLEAR 100
140 Q=1294
150 REM * FOR MC-10 MAKE LINE AB
OVE 140 Q=16654
160 CLS2
170 Z$="NESSFFTTO"
180 FOR A=65 TO 90
190 IF A>64 AND A<69 OR A=71 OR
A=74 OR A>79 AND A<84 OR A=85 TH
EN B$=B$+CHR$(A): A$=A$+CHR$(32)
: GOTO 210
200 A$=A$+CHR$(A): B$=B$+CHR$(32
)
210 NEXT A
220 PRINT @ 35,A$;
230 FOR Z=67 TO 92
240 PRINT @ Z,CHR$(255);
250 NEXT Z
260 PRINT @ 99,B$;
270 PRINT @ 160,"IT'S NOW TIME T
O FIDDLE"
280 PRINT @ 192,"AROUND WITH A R
IDDLE"
290 PRINT @ 224,"IN AN ALPHABETI
CAL SHOW,"
300 PRINT @ 256,"FOR WHAT'S UP A
BOVE"
310 PRINT @ 288,"DOESN'T SEEM TO
 HAVE LOVE"
320 PRINT @ 320,"FOR WHAT IS SIT
TING BELOW."
330 PRINT @ 352,"IT'S NEITHER CO
DE NOR EQUATION."
340 PRINT @ 384,"QUESTION: WHY T
HE SEPARATION?"
```

♦ more

```
350 PRINT @ 480,"HO! HO! HO!";
360 IF INKEY$="" THEN 360
370 CLS3
380 PRINT @ 64,"WONDER, PONDER,"
390 PRINT @ 96,"PONDER, WONDER..
."
400 PRINT @ 128,"HAVE A CASE"
410 PRINT @ 160,"OF VEXING WEARI
ES."
420 PRINT @ 192,"BLUNDER, BLUNDE
R,"
430 PRINT @ 224,"MIND ASUNDER...
"
440 PRINT @ 256,"WHAT COMES NEXT
"
450 PRINT @ 288,"IN THIS NICE SE
RIES?"
460 PRINT @ 356,"";
470 FOR A=9 TO 1 STEP -1
480 PRINT MID$(Z$,A,1);" ";
490 NEXT A
500 PRINT @ 480,"TYPE THE CHARAC
TER:";
510 X$=INKEY$
520 IF X$="" THEN 510
530 IF ASC(X$)=PEEK(Q) THEN PRIN
T @ 480,"CORRECT. BUT WHY?": END
540 PRINT @ 480,"NO, THAT ISN'T
IT."
550 END
```

■■■

Program Listing. Alphaswitch

```
100 REM * ALPHASWITCH * TRS-80 C
OLOR COMPUTERS *
110 REM * COLOR BASIC - EXTENDED
 COLOR BASIC - MC-10 BASIC *
120 REM * SORCERER'S PUZZLES #6
* RICHARD RAMELLA *
130 DATA C,A,B,O,H,U,Q,F,R,X,L,J
,M,I,P,D,T,E,S,G,W,N,V,K
140 CLEAR 100
150 X$="ABCDEFGHIJKLMNOPQRSTUVWX
"
160 H=288
170 CLS0
180 DIM A$(24)
190 FOR B=1 TO 24
200 READ A$(B)
210 NEXT B
220 GOSUB 430
230 B=1
240 Y=2
250 X=2
260 SET(X,Y,8)
270 Z$=INKEY$
280 RESET(X,Y)
290 IF Z$=CHR$(10) AND Y+4<15 TH
EN Y=Y+4: B=B+6
300 IF Z$=CHR$(9) AND X+10<53 TH
EN X=X+10: B=B+1
310 IF Z$=CHR$(94) AND Y-4>1 THE
N Y=Y-4: B=B-6
320 IF Z$=CHR$(8) AND X-10>1 THE
N X=X-10: B=B-1
330 SET(X,Y,8)
340 IF Z$="E" AND N=0 THEN N=N+1
: D$=A$(B): F=B: GOTO 360
350 IF Z$="E" THEN N=N+1: E$=A$(
B): G=B
360 IF N=2 THEN GOSUB 380
370 GOTO 270
380 A$(G)=D$
390 A$(F)=E$
400 N=0
410 PRINT @ H,D$;E$"/";
420 H=H+3
430 D=1
440 FOR V=0 TO 192 STEP 64
450 FOR G=V TO V+25 STEP 5
460 PRINT @ G," "A$(D)" ";
470 Y$=Y$+A$(D)
480 D=D+1
490 NEXT G
500 NEXT V
510 IF Y$=X$ THEN 550
520 Y$=""
530 M=M+1
540 RETURN
550 PRINT @ 480,"SOLVED IN";M;
560 SOUND 100,1
570 FOR X=1 TO 20
580 NEXT
590 PRINT @ 480,"              ";
600 REM * 12 SPACES BETWEEN QUOT
ES IN LINE 590 *
610 SOUND 200,1
620 FOR T=1 TO 20
630 NEXT
640 GOTO 550
650 END
```

■■■

```
100 REM * THE COUNTERFEIT DOUBLO
ON * TRS-80 COLOR COMPUTERS
110 REM * COLOR BASIC - EXTENDED
 COLOR BASIC - MC-10 BASIC *
120 REM *SORCERER'S PUZZLES #6 *
 RICHARD RAMELLA
130 CLEAR200: CF=RND(9): CLS0: S
=104
140 Z$="": AB$="": WL$="": WR$="
": WR=0: WL=0: C$="": B$=""
150 P$=CHR$(251): SL=386: SR=411
: L$=CHR$(8): R$=CHR$(9)
160 FOR A=1 TO 32: X$=X$+CHR$(12
8): NEXT A: N$=LEFT$(X$,2)
170 T$=CHR$(128): FOR A=1 TO 9:
A$(A)=CHR$(147)+CHR$(147): A(A)=
2: NEXT A
180 A(CF)=1: FOR A=1 TO 3: B$=B$
+CHR$(175): NEXT A
190 FOR A=1 TO 12: AB$=AB$+CHR$(
128): C$=C$+CHR$(207): NEXT A
200 FOR A=366 TO 462 STEP 32: PR
INT @ A,B$;: NEXT A: PRINT @ 418
,C$;
210 PRINT @ 433,C$;: GOSUB 680:
C=1: H=67: PRINT @ H,P$;
220 A$=INKEY$
230 IF A$=L$ OR A$=R$ THEN PRINT
 @ H,T$;
240 IF A$=R$ THEN H=H+3: C=C+1
250 IF A$=L$ THEN H=H-3: C=C-1
260 IF H<67 THEN H=91: C=9
270 IF H>91 THEN H=67: C=1
280 PRINT @ H,P$;
290 IF A$="W" AND A$(C)<>"" THEN
 GOSUB 320
300 IF A$="T" THEN PRINT @ H,T$;
: GOSUB 450
310 GOTO 220
320 GOSUB 670
330 PRINT @ 330,"WHICH SIDE?";
340 A$=INKEY$
350 IF A$="" THEN 340
360 IF A$<>"L" AND A$<>"R" THEN
320
370 PRINT @ H-64,N$;
380 IF A$="L" THEN K=SL: GOTO 40
0
390 K=SR
400 PRINT @ K,A$(C);: A$(C)=""
410 IF A$="L" THEN SL=SL-32: WL=
WL+A(C): WL$=WL$+RIGHT$(STR$(C),
1): GOTO 430
420 SR=SR-32: WR=WR+A(C): WR$=WR
$+RIGHT$(STR$(C),1)
430 GOSUB 670
440 GOTO 220
450 IF WL>WR THEN XZ=326: V$="L"

460 IF WR>WL THEN XZ=341: V$="R"

470 IF WR=WL THEN XZ=303: V$="E"

480 FOR G=1 TO 10
490 PRINT @ XZ,CHR$(255);
500 SOUND 100,1
510 PRINT @ XZ,T$;T$;
520 SOUND 200,1
530 NEXT G
540 S=S+32
550 Q=Q+1
560 PRINT @ S,Q") ";WL$"-"WR$;"
";V$;
570 IF Q=1 THEN FOR M=130 TO 386
 STEP 32: PRINT @ M,T$;T$;: PRIN
T @ M+25,T$;T$;:NEXT: GOSUB 680:
 GOTO 140
580 IF Q=2 THEN PRINT @ 232,"PHO
NEY? (1-9)";: G$=INKEY$: IF G$="
" THEN 580
590 LL=VAL(G$)
600 PRINT LL;
610 IF Q=1 THEN 140
620 IF A(LL)=1 THEN PRINT @ 264,
"RIGHT!";: SOUND RND(50)+200,1:
GOTO 620
630 PRINT @ 264,"NO, IT WAS COIN
"CF;
640 SOUND 204,2: SOUND 204,2: SO
UND193,2
650 SOUND 210,3: SOUND 204,4: SO
UND 193,6
660 FOR T=1 TO 20: NEXT: GOTO 64
0
670 FOR J=330 TO 343: PRINT @ J,
T$;: NEXT J: RETURN
680 B=1: FOR A=3 TO 29 STEP 3: P
RINT @ A,A$(B);: PRINT @ A+31,B;
690 B=B+1: NEXT: RETURN: END
```

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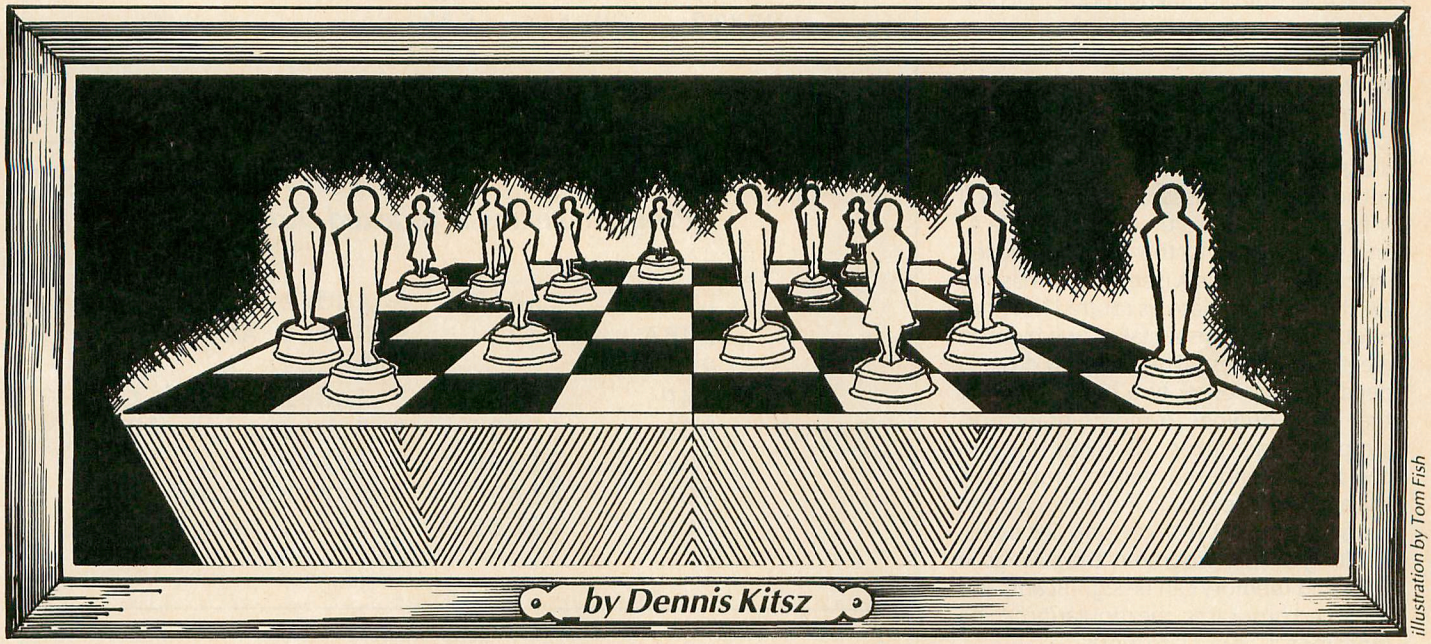

illustration by Tom Fish

by Dennis Kitsz

The game of Life — in color

CUSTOM COLOR THIS MONTH is a little departure. I get so involved presenting hardware or software projects that I forget then that what's most important to me is revealing concepts you can take with you and use in the future. The topics this month are *indirect addressing* and high-resolution color graphics.

Machine code is a series of electronic patterns understood by your Color Computer's 6809 microprocessor as instructions. *Addressing* is the way the commands in a machine code program get the information they need to complete an instruction. That information goes in and out of the processor from memory, or is shared by internal processor storage areas known as *registers*. The X register is one of these storage areas inside the

16K Color Basic

6809 processor, and can hold two bytes of information.

There are many kinds of addressing; three related kinds are *immediate*, *extended* and *indirect*. LDX #$1234 is immediate: it states, "load the X register immediately with value hexadecimal $1234 (decimal 4660)." LDX $1234 is extended: it states, "load the X register with the value found at memory addresses $1234 and $1235." Finally, LDX [$1234] is indirect: it states, "get the bytes at addresses $1234 and $1235; concatenate them, producing a 16-bit number; use that number as an address; load the X register with the data at that address."

Immediate addressing says "here it is"; extended says "find it there"; indirect says "go there to learn where to find it."

Indirect addressing probably sounds like a clumsy and roundabout way of getting information. It's not clumsy, but it is roundabout, and that roundaboutness is its precise advantage. Say you've got a super-high-speed action game in the writing, and you need to make moves based on keyboard input. We'll talk about keyboard input itself later, but imagine for the moment that the numbers 0 – 9 are crucial in your game. Say each number causes an entirely different game action, such as shooting balls or using flippers in some sort of arcade pin-

more

ball. You could, of course, check the value of each number, and if it fits, jump off to a routine. It might look something like Program Listing 1 (but longer).

This kind of programming would do the job, and naturally it would be quite fast since it's written in assembly language. But it grabs lots of memory, and, if timing is critical, it is an uneven process; that is, getting to the last possible choice in the list takes more machine time than getting to the first choice.

There's an entirely different and very powerful technique available with *indexed indirect*. Consider this: you can load an index register X or Y with the address of the zeroeth element of a table of subroutine addresses, subtract an ASCII offset from your accumulator, double A, and simply jump to the address indexed indirectly by X *plus* A (see Program Listing 2). The A accumulator is rotated left (that is, doubled) because it takes two bytes to create an address. The indexing process needs to skip every two bytes. Observe that the original compare-branch-or-jump routine takes 70 bytes for ten choices. This indexed indirect routine has the advantage of being more regular and much faster, yet it takes only 29 bytes. For long or fast programs, the savings in time and memory can be significant, and for timed programs, the regularity can be meaningful. I'll put it to work.

The program will be the "Game of Life," a nifty set of rules by which theoretical populations of cells are born, live, and die. The rules are simple. First, this mythical population lives in a regular, two-dimensional grid. On this grid, which can be imagined simply as intersecting horizontal and vertical lines, any given cell position is surrounded by eight other cell positions. Three "live" cells will give birth in any empty cell they surround; two or three surrounding cells will keep that cell alive. If the neighborhood population grows over three cells, or falls under two cells, the cell dies.

These simple rules can cause an incredible number of predictable population patterns to arise. Civilizations grow and shrink, rise and fall. Some stabilize in tiny colonies, or rise to great empires. On a video screen, these changes can transform a random population into an astoundingly regular ebb and flow. It becomes hypnotic.

The "Game of Life" is now a traditional computer problem, originally invented and proposed by British mathematician John Conway. His proposal delighted computer people at the time, and continues to be fascinating as more detailed color screens and more capable computers are developed. You don't *play* the Game of Life. Once you have created an

Program Listing 1. Value Checking Routine

```
        CMPA    $30     * 2 bytes
        BNE     NEXT1   * 2 bytes
        JMP     FLIP    * 3 bytes
NEXT1   CMPA    $31
        BNE     NEXT2
        JMP     FLAP
NEXT2   CMPA    $32
        BNE     NEXT3
        JMP     FLOP
```

Program Listing 2. Indexed Direct

```
        LDX     TABLE   * Addresses
        SUBA    $30     * Strip ASCII
        ROLA            * Double A
        JMP     [A,X]   * Indexed indirect
TABLE   FCB     $1234   * Subroutine #0
        FCB     $1366   * Subroutine #1
        FCB     $1A9C   * Subroutine #2
        FCB     $20EF   * etc.....
```

Program Listing 3. Game of Life—Slow Motion

```
10 PMODE0: PCLEAR1: DIMA(65,33)
20 FOR X=1024 TO 1535
30 POKEX,127+RND(17): NEXT
40 FOR X=1 TO 62: FOR Y=1 TO 30
50 IF POINT(X,Y)<>0 THEN 60 ELSE
 140
60  A(X-1,Y-1)=A(X-1,Y-1)+1
70  A(X  ,Y-1)=A(X  ,Y-1)+1
80  A(X+1,Y-1)=A(X+1,Y-1)+1
90  A(X-1,Y  )=A(X-1,Y  )+1
100 A(X+1,Y  )=A(X+1,Y  )+1
110 A(X-1,Y+1)=A(X-1,Y+1)+1
120 A(X  ,Y+1)=A(X  ,Y+1)+1
130 A(X+1,Y+1)=A(X+1,Y+1)+1
140 NEXT: NEXT
150 FOR X=0 TO 63: FOR Y=0 TO31
160 IF A(X,Y)<2 THEN RESET(X,Y):
 GOTO 190
170 IF A(X,Y)=3 THEN SET(X,Y,1):
 GOTO 190
180 IF A(X,Y)>3 THEN RESET(X,Y)
190 NEXT: NEXT
200 FOR X=0 TO 65:FOR Y=0 TO 33
210 A(X,Y)=0: NEXT: NEXT:GOTO40
```

■■■

initial population, it plays itself until the populations have stabilized in life or death.

With such a simple set of rules, it becomes a perfect computer application. The set of rules by which any application is completed is called an algorithm. The algorithm for the Game of Life is:

1. Where three cells surround an empty position, cell birth takes place.
2. Where two or three cells surround a live cell, life goes on.
3. When the surrounding population drops below two, a cell dies.
4. When the surrounding population rises above three, a cell dies.

I'd first like you to see this in slow motion. Run the Basic program in Program Listing 3. As you watch, a random population is generated in low-resolution graphics. This is the starting population, called the Garden of Eden. Once the population has been established, the Game of Life begins.

The populations you are watching develop slowly, since Basic must make a large number of simple comparisons and calculations for which it is ill suited. Doing such calculations by hand can take hours per generation. Yet, the simple-mindedness of assembly language finds this a fertile area.

The process of moving from generation to generation is made up of one overall task: check the "neighborhood" of cells, so to speak, and then maintain the status quo, give birth to cells, or kill cells. There are many ways of dealing with that task, however. You might check by neighborhood, or by cell, or look for the presence of any population in an area. Statistically, the Game of Life more often results in a lesser number of live cells — at least after the Garden of Eden has been created and the generational growth has begun.

My old friend and teacher, Phil, approached the algorithm from this point of view. It complicated the programming slightly, but sped along the real time required to move from generation to generation. That's the approach I'm going to use for this example.

Playing With Life

To begin the Game of Life on the Color Computer, you have to know how to establish the degree of screen resolution you wish to use, and how that mode is manipulated. This is especially important when using the 6847 video display generator, because each graphics mode has a different number of colors and a different manner of dealing with how the bits in a memory byte are reflected on the screen.

I'd like to select detailed, regular and square picture elements. The highest resolution mode offers individual pixels, but I'd also like to use color so different generations and empty cells are shown in different colors — empty cells in black, perhaps, births in yellow and established cells in blue. The mode labeled CG3 offers a 2 by 2 pixel in four colors. I'll use it.

Now, rules in hand and video mode selected, I can structure the neighborhood counting process. To create this screen, 3072 bytes are required to produce 12,288 screen points, at a resolution of 128 by 96. In the screen memory, combinations of bit pairs determine the color, and four bit pairs fill a byte.

Establish mode CG3 and select the screen memory by using the upper memory addresses of the SAM registers. Among the other things to establish is the color set — that is, which set of four possible colors to display. The sets are green, yellow, blue and red for set 0; buff, cyan, magenta, and orange make up set 1. The choice for color set is specified in the Color Computer memory map as bit 3 of the output port at address $FF22.

April Definitions:
File — A hardware device used to smooth out program execution.

Some arbitrary decisions must be made. I've selected addresses $0000 through $0BFF for the video display; that address has to be presented to the SAM. The SAM contains write-only registers which are set or reset to produce the seven-bit upper portion of the display address.

And finally, interrupts must be turned off to speed the execution of the program. The details of all these set-up routines will be shown in the final program; let me give you a summary now of the pre-program set-up:

1. Interrupts must be disabled.
2. One of two possible color sets must be selected. This program will use set 1 for greatest definition.
3. The display screen memory must be defined. Screen memory will run 3,072 bytes from $0000 to $0BFF.
4. The color graphics modes must be established. Color Graphics 3 will be used, binary mode 100, to achieve a screen resolution of 12,288 points in four colors.

The final set-up information is actually the Garden of Eden population. Because there's memory garbage and other information present upon turning the computer on into Basic or EDTASM+, you'll be able to use that residual material as the Garden of Eden. Creation of random numbers is another subject, and Basic will be wiped clean by this program; so until then, Life begins in the garbage pile of memory.

Scratchpad Memory

I'll be talking about *scratchpad memory*. Also called a work area, scratchpad memory acts as temporary storage for calculated information on the way to a final result. For example, long division on a microprocessor is a fairly complicated task, and there aren't enough registers inside the 6809 processor to complete it. All the temporary quotients, remainders, and so forth, are stored in a working arithmetic area. When you call for the answer to a complicated mathematical formula in Basic, the working area required can be thirty or forty bytes, in addition to temporary stack storage of the results from within each and every set of parentheses.

In this version of the Game of Life, 3072 bytes of display memory represent 12,288 screen display points. In other words, each screen display point requires two bits of a byte. These quarter bytes provide for economical use of memory, but are more time-consuming to handle in a program because they have to be shifted left or right, or masked, or whatever, to retrieve their information. Point 0 on the screen is byte zero, bits 7 and 6; point 2 is byte zero, bits 5 and 4; point 12287 on the screen is byte 3071, bits 1 and 0. The relationship isn't difficult, but the program handling it can be.

Exclusively for reasons of speed, then, I chose to set up a scratchpad memory 12,288 bytes long — one byte for each point on the screen. Although it's wasteful of memory, it's very speedy because my "neighbor" information is immediately accessible in raw form. Since there are from zero to eight neighbors for every point, I could have used *nybbles* (a nybble is four bits), but I chose to use the whole byte, again to avoid the time required for rotating and masking.

I've also made an arbitrary decision to choose $1000 to $3FFF for these 12,288 bytes of scratchpad memory. That's hex $3000 bytes. So the screen display runs from $0000 to $0BFF and the scratchpad runs from $1000 to $3FFF. All the mem-

ory that's left for the program itself is $0C00 to $0FFF. I'll put the program at $0C80.

Back To The Set-Up

So, Life involves writing a program beginning at $0C80 to perform the set-up, and to clear scratchpad memory to zero. Scratchpad memory runs from $1000 to $3FFF and must be filled with zeroes.

Although there is a simple way to fill memory, there is a faster but less obvious one. The simple way is to load an accumulator with the value needed to fill memory, to point the X or Y register to the start of that memory, and to store and increment your way through.

The less obvious method is to use the 6809's fast and powerful stack instructions: more later.

Although we're still pretty far from its actual use in this program, I want to remind you that one of the current topics is indexed indirect addressing. Indexed indirect is the mode where the operand is an address pointing to a pair of memory locations, and this pair of sequential eight-bit memory locations make up an address which is the eventual location of the data. For example, say register X points to memory location $3000. Say that memory location $3000 contains byte $AB and memory location $3001 contains byte $99. Now, say finally that memory location $AB99 contains byte $FF. Loading the A accumulator zero-offset indexed indirect to X would result in A containing $FF. The program should help you understand the usefulness of this technique.

At this point I've prepared the set-up and the scratchpad memory clearing. To disable interrupts, you would ORCC #$50, which sets bits 4 and 6 of the condition code register. To choose color set 1, you need to set bit 3 of port address $FF22. Furthermore, bits 4, 5 and 6 are the graphics mode selection bits, and bit 7 is the alphanumeric/graphic selector (see Figure 1).

There are 16 different display modes in the Color Computer, all but one available in two color sets. That gives you 31 choices. This wide selection is only available in computers where the 6847 video display generator and the 6883 SAM are used together; both are smart circuits, and so they interact in complex and versatile ways. The mode I've selected for the Game of Life is full color graphics 3. If you follow down on the display mode chart in your manual, you'll see full graphics 3C, and the required bit conditions. The detailed memory map shows these bits; I'll remind you that the MC6847 modes (the first five columns) are, respectively, bits 7, 6, 5, 4 and 3.

	MC6847					SAM Mode		
Mode Type	G/$\overline{A}$	GM2	GM1	GM0 EST/$\overline{I}$	CSS	V2	V1	V0
Internal Alphanumerics	0	X	X	0	X	0	0	0
External Alphanumerics	0	X	X	1	X	0	0	0
OSemigraphics — 4	0	X	X	0	X	0	0	0
Semigraphics — 6	0	X	X	1	X	0	0	0
Semigraphics — 8*	0	X	X	0	X	0	1	0
Semigraphics — 12*	0	X	X	0	X	1	0	0
Semigraphics — 24*	0	X	X	0	X	1	1	0
Full Graphics — 1C	1	0	0	0	X	0	0	1
Full Graphics — 1R	1	0	0	1	X	0	0	1
Full Graphics — 2C	1	0	1	0	X	0	1	0
Full Graphics — 2R	1	0	1	1	X	0	1	1
Full Graphics — 3C	1	1	0	0	X	1	0	0
Full Graphics — 3R	1	1	0	1	X	1	0	1
Full Graphics — 6C	1	1	1	0	X	1	1	0
Full Graphics — 6R	1	1	1	1	X	1	1	0
Direct Memory Access†	X	X	X	X	X	1	1	1

Figure 1. Video display modes using the Synchronous Address Multiplexer and the Video Display Generator together.

To achieve mode G3C, bit 7 must be high, bit 6 is high, bits 5 and 4 are low, and bit 3 is up to you. Bit 3 is high for color set 1. The left five bits of the binary number created for port $FF22 is 11001. The rightmost three digits are powered up to 111 on a 16K machine. So, the complete binary number to select full color graphics mode 3, color set 1, is 11001111, or hex $CF. The instructions are simplicity itself...

```
LDA #$CF
STA $FF22
```

...easily selecting the proper modes.

But in the process, don't forget the SAM; it has to be properly programmed as well. According to the chart you've been looking at, mode G3C requires that SAM bits V2, V1 and V0 be programmed binary 100. SAM addresses $FFC0 through $FFC5 control the SAM modes. To set mode G3C, then, set bit V2 and clear bits V1 and V0. That means (remembering the SAM's write-only register technique) write to addresses $FFC5 $FFC2, and $FFC0. To store any value to $FFC5, $FFC2 and $FFC0...

```
STA $FFC5
STA $FFC2
STA $FFC0
```

The final set-up information is to choose the display memory starting address, which I've selected to be found at $0000. The display offset information is provided by the SAM, so that set-up information must be written to the SAM, done by writing to addresses $FFC6 through $FFD2. To establish starting address $0000 means that binary values 0000 000 must be put into the seven SAM address offset positions. To place a zero in the SAM — that is, to clear a bit — you write to an even-numbered address. To place a one in the SAM — to set a bit — you write to an odd-numbered address. The display memory calls for binary 0000 000, so that calls for writing to addresses $FFC6, $FFC8, $FFCA, $FFCC, $FFCE, $FFD0 and $FFD2.

The most straightforward way of doing this might be to store an accumulator at each location — STA $FFC6, STA $FFC8, STA $FFCA, etc. Since all even addresses are being set, I've chosen this case-specific solution:

```
        LDB   #$07
        LDX   #$FFC6
VIDEO   STA   ,X++
        DECB
        BNE   VIDEO
```

which writes to every even-numbered address, for a total of seven. The B register does the counting, and the X register points to the first SAM video address.

This completes the pre-program set-up.

Filling Memory

I suggested that stack instructions might be used to fill memory. Program

Listing 4 is a standard method of doing a memory fill from $1000 to $3FFF.

The time-consuming part of this routine is the last three instructions, requiring six, four and three processor clock cycles, respectively. The total of 13 cycles is repeated 12,288 times, for a total of 159,744 cycles. At 894,886 clock cycles per second, this operation takes a considerable 179 milliseconds — nearly one-fifth of a second. For fast action games, that isn't.

Consider the solution in Program Listing 5 instead. After clearing A, B, X and Y to zero, the S stack is pointed to the top of the memory area to be cleared. Remember that the stack pushes down from the top. A, B, X, and Y are then pushed on the stack using one instruction. The stack is compared immediately with $1000, the bottom of scratchpad memory, and if the result is plus (if S is greater than or equal to $1000), the routine is repeated.

The number of clock cycles required for the PSHS instruction is five plus one additional for each byte pushed. Six bytes are pushed in total, meaning that PSHS A,B,X,Y takes 11 cycles to complete. So the heart of this memory fill routine requires 11, five and three cycles — a total of 19. Nineteen cycles is longer than the 13 needed for the previous example. But remember that in this case, *six* bytes are pushed at once. 12,288 divided by six is 2,048; there are only 2,048 repetitions of this routine. Two thousand forty-eight times 19 is 38,912 clock cycles; again, at 894,886 clock cycles per second, this instruction completes in only 44 milliseconds. That's slightly less than one-quarter the time of the previous method, just one-twentieth of a second.

Where you need to fill blocks of memory very quickly, the push-stack method is ideal. Don't forget to save the stack pointer if you need to, and also to replace the stack pointer when you're done with it. In this program, I put the stack pointer at $0DBF; when I'm finished with it: LDS #$0DBF. At this point, the Garden of Eden is populated, video display set-up is complete, interrupts are disabled, scratchpad memory is cleared, and the stack is in position. It's time to evaluate the Garden of Eden for the population of its neighborhoods.

Populations

If Joe lives in a house on this regular memory grid, then he's potentially got a neighbor to the northwest, north, and northeast; to the west and east; and to the southwest, south, and southeast: eight neighbors in all. The screen grid in this graphics mode is 128 by 96, 128 houses across by 96 houses down. If Joe lives in house 3761, then he's got potential neighbors in houses 3761 minus 129 (that's northwest), 3761 minus 128 (that's north), 3761 minus 127 (that's northeast). There's a house to the west at 3761 minus one, and a house to the east at 3761 plus one. Finally, there are houses to the southwest at 3761 plus 127, to the south at 3761 plus 128, and to the southeast at 3761 plus 129.

I'll convert those to hex. The screen is hex $80 by $60, so Joe's got neighbors at −$81, −$80, −$7F, −$01, +$01, +$7F, +$80, and +$81. If the Y index register points to Joe, then the neighbor offsets would be: − $81,Y; −$80,Y; −$7F,Y; −1,Y; 1,Y; $7F,Y; $80,Y; and $81,Y.

The process, then, is really a kind of inverse of this. If those eight are Joe's potential neighbors, then Joe is the neighbor of those eight. So instead of going to every cell and evaluating all eight neighbors, you can go to every cell and see if it is alive (that's the key). If it's alive, you increment the neighbor count; if not, you move along to the next.

So instead of making 12,288 checks of eight neighbors, you make 12,288 checks for life. Only if a cell is live does the action become:

```
INC     −$81,Y
INC     −$80,Y
INC     −$7F,Y
INC     −1,Y
INC     1,Y
INC     $7F,Y
INC     $80,Y
INC     $81,Y
```

This is the heart of the neighborhood scratchpad routine. Now think back to the actual display screen.

Only 3,072 bytes are used to display the 12,288 cells. Somehow you've got to break these into quarter bytes very quickly, and evaluate them. You might choose a mask-and-shift strategy, where each pair of bits is shifted left, then masked and evaluated. You might choose a mask-and-compare strategy, where four separate routines are used to evaluate the four separate quarter-bytes. Both methods would work, but in addition to masking or shifting, each technique would require saving and restoring the original value, testing, and branching.

The method I've selected takes advantage of the rotate instruction, which rotates the bits of a byte around in a circle — but through the carry flag. The advantage here is that, by carefully selecting how I represent live and dormant cells, I can rotate bits of the display byte through the carry flag and use the carry to branch

Program Listing 4. Memory Fill

```
        CLRA                * Set A to 0
        LDX     #$1000      * Point X to $1000
LOOP    STA     ,X+         * Store zero
        CMPX    #$4000      * See if finished
        BNE     LOOP        * Go back 'til done
```

Program Listing 5. A Speedier Method

```
        CLRA                * Set A to 0
        CLRB                * Set B to 0
        TFR     D,X         * Set X to 0
        TRF     D,Y         * Set Y to 0
        LDS     #$4000      * Point S to top
LOOP    PSHS    A,B,X,Y     * Push 6 bytes
        CMPS    #$1000      * See if bottom
        BPL     LOOP        * Back until lower
```

to the proper routine. Rather than spend time explaining the concept, I'll take you right to the routine itself. Look at Program Listing 6: as you examine the program excerpt, keep in mind that I've defined 00 as a dormant cell, 01 as a newborn cell, and 11 as a mature cell (that is, past the first generation).

X and Y are pointed to display and scratchpad, respectively. The B accumulator serves as a quarter-byte counter. The A accumulator holds the byte from display to be evaluated.

Now here's the trick. The value in A is rotated left twice, through the carry flag. That leaves the rightmost bit of the display pair sitting in the carry flag, and the leftmost bit of the pair sitting in the bit 0 position of the accumulator. If the carry is clear, the cell is either dormant (00) or defined as illegal (10): in either case, it is not a neighbor, so the routine moves down to the label NEXTQ. If the carry is set, then the cell is either a newborn (01) or a mature cell (11), and the eight neighborhood incrementing instructions are completed. The label NEXTQ follows. *Load effective address* adds a value to Y; here it increments Y by one. The quarter-byte counter is decremented, and the rotate-and-branch routine is repeated until four quarter bytes have been done. CMPX #$0C00 tests for the end of the 3,072 byte display area. That's it. At the end of 3,072 groups of four quarter-byte tests, 12,288 bytes of scratchpad memory will be filled with neighborhood information.

To understand this process more intimately, you might take some time to draw a small grid of display points excerpted from the screen (say 16 by 16), a corresponding page of memory bytes (it would be 4 by 16), and a chart of scratchpad memory. Put some random cells in place on the display grid, then determine the display bytes. Finally, evaluate the results in scratchpad memory.

Life and Death

Once the neighborhood values have been determined, that information is used to give birth to a cell, to allow a cell to become dormant, or to leave the cell unchanged. As with all programming, there are many ways to make this happen. And, as always, the most obvious solution isn't necessarily the fastest or the most efficient. The obvious solution is something like Program Listing 7.

Another technique — and a fast one — would have started by filling the scratchpad memory with $FE instead of $00. In this circumstance, zero or one neighbor would result in the scratchpad

Program Listing 6. Breaking Down Bytes

```
         LDX     #$0000   * Point X to display
         LDY     #$1000   * Point Y to scratchpad
NXTCEL   LDB     #4       * Count four quarter bytes
         LDA     ,X+      * Get video display byte
         PSHS    CC       * Save carry flag info
QUARTR   PULS    CC       * Restore carry flag info
         ROLA              * Rotate A through carry
         ROLA              * And rotate A again
         PSHS    CC       * Save carry (part of byte)
         BCC     NEXTQ    * If C=0, then cell not live
         INC     -$81,Y   * Northwest neighbor
         INC     -$80,Y   * Northern neighbor
         INC     -$7F,Y   * Northeast neighbor
         INC     -$01,Y   * Western neighbor
         INC     +$01,Y   * Eastern neighbor
         INC     +$7F,Y   * Southwest neighbor
         INC     +$80,Y   * Southern neighbor
         INC     +$81,Y   * Southeast neighbor
NEXTQ    LEAY    1,Y      * Get next scratchpad position
         DECB             * Count down quarter bytes
         BNE     QUARTR   * Get next quarter byte
         PULS    CC       * Else restore stack info
         CMPX    #$0C00   * See if at end of display
         BNE     NXTCEL   * Get next value
```

Program Listing 7. An Obvious Solution

```
         LDA     ,Y
         BEQ     DEATH
         DECA
         BEQ     DEATH
         DECA
         BEQ     NO CHANGE
         DECA
         BEQ     BIRTH
         DECA
```

Program Listing 8. A Quicker Method

```
LDA      ,Y        * Get value from scratchpad
BMI      DEATH     * If negative ($FE or $FF), then death
BEQ      NO CHANGE * If zero ($00), then no change
DECA               * Decrement A to set flags
BEQ      BIRTH     * If zero ($01 minus 1), then birth
BRA      DEATH     * Otherwise is $02 or greater
```

Program Listing 9. Indexed Indirect

```
         ASLA               * Double A (two-byte offset)
         LDX     #TABLE     * Point to table of addresses
         JMP     [A,X]      * Go to routine at X+A
TABLE    FDB     DEATH
         FDB     DEATH
         FDB     NO CHANGE
         FDB     BIRTH
         FDB     DEATH
```

value being left with $FE or $FF. Two neighbors would produce $00 in the scratchpad, three neighbors would yield $01, and more than three neighbors would produce $02. A much quicker method, the final routine would look like Program Listing 8.

There's a lot in that short routine, and it's very fast. In fact, in this situation, it's a toss-up in speed to the one I've chosen. Depending on the value in the scratchpad, it can take three, six, 11 or 14 clock cycles to complete; my sample method always takes 12 cycles. Indexed addressing has a logical look to it, so that's what I've chosen. Indexed indirect looks like Program Listing 9.

The A register is shifted left to double its value; this is true because an address is two bytes long and therefore requires an even byte offset. The X register is pointed to the zeroeth entry in the table of jump addresses. The command JMP [A,X] causes the sum of A+X to be calculated, the data at addresses A+X and A+X+1 to be retrieved and concatenated, and the result to be given to the program counter. This routine is simple (more transparent than the earlier one) and demonstrates regularity and consistency. Take some time to review this routine and contrast it with the previous one. You'll note that where things might get complicated (for example, if there were ten or twenty choices instead of merely eight), the former routine gets serpentine and sluggish, whereas the indirect indexed jump is a fast and streamlined six-byte jewel.

By the way: you'll note that I've used the notation "FDB" in the program mentioned above. This is an assembler *pseudo-op*, an instruction for the assembler to use the information you've provided and place the equivalent binary data in memory. The pseudo-op FCB places a single byte in the program; FDB places two bytes; and FCC places an ASCII string.

The scratchpad is being evaluated, so all that's left to write is the set of death, birth, and no-change routines. To force a cell into dormancy, both bits are set to zero; the resulting color is buff, the same color as the background. Recalling that the display byte has been rotated through the carry flag, the routine looks like Program Listing 10.

You can leave it to a general-purpose exit routine to complete the rotation and testing.

The no-change routine is slightly more complicated because it isn't really no change. As you recall, I wanted to add some visual variety by having newborn cells displayed in a different color from mature cells. Newborns are color 01 (cyan) and matures are 11 (orange), so "no change" for these means changing newborns to matures, and leaving matures as is. On the other hand, dormant cells are left dormant, and illegal cells present in the Garden of Eden are made dormant. Dormants are buff (00) and illegals are magenta (10), so "no change" for these means changing illegals to dormants, and leaving dormants as is. See how it looks in Program Listing 11.

That leaves only the birth routine, which, if a cell is already alive, can be considered a "no change" routine. It is slightly more complex than the previous routines because dormant cells must be changed to newborns (00 to 01); illegal cells must be changed to newborns (10 to 01); newborns from the previous gen-

Program Listing 10. Forcing Dormancy

```
        ANDA    #$FE    * Set to 0X
        ANDCC   #$FE    * Set to 00
        BRA     EXIT    * Go out
```

Program Listing 11. No Change

```
        BCS     HIGH    * Go if C = 1
        *               * C = 0
        ANDA    #$FE    * Set to 00
        BRA     EXIT    * Go out
HIGH    *               * C = 1
        ORA     #$01    * Set to 11
        BRA     EXIT    * Go out
```

Figure 2. Birth Routine Parameters

Present Cell:	**Changes To:**
00 (buff) (dormant)	01 (cyan) (newborn)
10 (magenta) (illegal)	01 (cyan) (newborn)
01 (cyan) (newborn)	11 (orange) (mature)
11 (orange) (mature)	11 (orange) (mature)

EDTASM+ and the Game of Life

The Game of Life presented in this article is an assembly language listing. To use it, you must have a copy of the Radio Shack Editor/Assembler EDTASM+ cartridge. You should not enter everything you see in Program Listing 14, which is an assembled listing (final computer output). Using the I command (refer to the EDTASM+ manual for details), enter the listing starting with the line number column (00100, 00110, 00120, etc.). To save yourself typing, you may leave off the comments (everything following an asterisk *), which are for reference only. Finally, assemble the Game of Life to tape using the A command, and in memory using the A/IM/AO command. Then execute the Game of Life, either load it from tape (CLOADM) and execute (EXEC), or assemble in memory (A/IM/AO), quit the editor assembler (Q), and execute the program (EXEC&H0C80).

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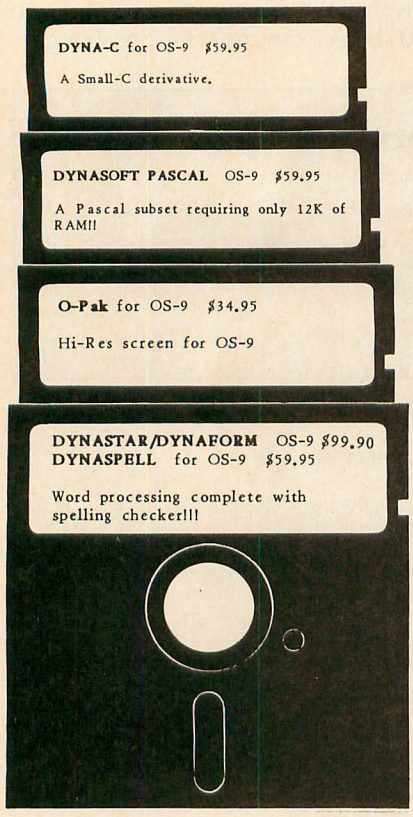

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Program Listing 12. Creation

```
              BCC     LOW     * Pass if C = 0
              *               C = 1
              ORA     #$01    * Set to 11
              BRA     EXIT    * Go out
        LO    *               C = 0
              ANDA    #$FE    * Set to00
              ORCC    #$01    * Set to 01
              BRA     EXIT    * Go out
```

Program Listing 13. Switching Screens

```
              STA     $FFCD   * Switch to screen at $1000
              LDX     #$1000  * Point X to new screen
              LDY     #$0000  * Point Y to old screen
TRNSFR        LDA     ,X+     * Get value from new screen
              STA     ,Y+     * Store value to former screen
              CMPX    #$1C00  * See if screen is finished
              BNE     TRNSFR  * Go back to finish screen
              STA     $FFCC   * Redirect video to $0000
```

Program Listing 14. The Game of Life

```
                        00100 ********************************************************
                        00110 *                                                      *
                        00120 *                THE GAME OF LIFE                      *
                        00130 *                                                      *
                        00140 *   BASED ON THE PASTIME DEVELOPED BY JOHN CONWAY      *
                        00150 *                                                      *
                        00160 * COLOR COMPUTER VERSION 1.0 BY DENNIS BATHORY KITSZ  *
                        00170 *                                                      *
                        00180 ********************************************************
                        00190 *
0C80                    00200         ORG     $0C80
                        00210 *
                        00220 * DISABLE INTERRUPTS BY MASKING I AND F BITS IN CCR   *
                        00230 *
0C80 1A   50            00240 START   ORCC    #$50    * DISABLE INTERRUPTS
                        00250 *
                        00260 * COLOR SET 0 CHOICES ARE GREEN, YELLOW, BLUE, RED
                        00270 * COLOR SET 1 CHOICES ARE BUFF, CYAN, MAGENTA, ORANGE
                        00280 * PORT ADDRESS $FF22 CONTROLS COLOR SETS, OTHER INFO
                        00290 *
0C82 86   CF            00300         LDA     #$CF    * VALUE FOR COLOR SET
0C84 B7   FF22          00310         STA     $FF22   * CHOOSE COLOR SET
```

more

eration must be changed to oldsters (01 to 11); and oldsters are left unchanged (11 to 11). Putting it in chart form helps; see Figure 2.

The carry flag is again the determining factor. If the carry flag is clear (zero), a newborn is created; if the carry flag is set, an oldster is created (or maintained). See how it looks in Program Listing 12.

There you have the heart of it. There's some work to do right at the end. Consider this: if you store the display byte directly back on the screen, the new generation will swim down over the previous generation. Since one of the premises of the Game of Life is that all generational changes take place simultaneously, this swimming effect should be avoided. It can be avoided by filling a second area of memory and switching screens. But with 3,072 bytes required for display, 12,288 bytes required for the scratchpad, and about 230 bytes for program and stack, that leaves less than 700 bytes for a second screen. What to do?

My solution lies in using that scratch-

pad for two purposes. Think of it this way. Each four-cell display byte is represented by four bytes of scratchpad memory. Once four scratchpad bytes have been used to determine the new display byte, they are no longer needed. After eight scratchpad bytes are evaluated, two display bytes have been produced. After all 12,288 scratchpad bytes have been used, 3,072 display bytes have been produced.

In that pattern lies the opportunity. The new display screen can be placed in scratchpad memory, because the using up of the scratchpad memory always outpaces by a ratio of four to one the production of display memory bytes. When the new screen has been produced, the video offset address in the SAM can be switched to that new screen in scratchpad memory.

Now since scratchpad memory has to be used again for the next generation, that screen has to be ushered out of that area of memory. Once the video has been redirected from $000 to $1000, the contents beginning at $1000 can be transferred to memory beginning at $0000. Then, when the original display memory is filled with the new generation, the video offset address can be switched back. The evaluation of the generation, production of the new generation, screen switching, and display memory transfers are entirely invisible. The code is in Program Listing 13.

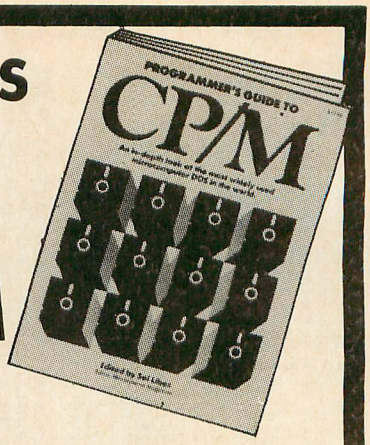
Finally, we must put all the pieces together, keep track of where and how the stack is used, and organize the automatic repeating process to keep the generations going. The entire commented program is presented in Program Listing 14.

Watching the Game of Life is a fascinating experience. A lot has been written about this pastime, and versions in three dimensions and many colors have been developed. I hope you've been intrigued by the concept of indirect addressing, especially how it can simplify, together with compartmentalized or modular programming, an apparently complicated example. The modules were designed for speed, and with little modification they could be used as complete subroutines... those that select color sets, video display memory, and graphics modes and the one to fill memory are complete. The Life routines consist of the evaluation block and the more complex regeneration section.

Please remember that this Life program is a demonstration of programming concepts; if you want new random populations, or cursor control, or different colors or modes of resolution, it's up to you. Enjoy.

■ ■ ■

PROGRAMMER'S GUIDE TO CP/M



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```
                        00320 *
                        00330 * THE DISPLAY SCREEN MEMORY IS SELECTED TO RUN FROM
                        00340 * $0000 TO $0BF0 (3072 BYTES), USING COLOR GRAPHICS
                        00350 * MODE 3.  THE FOLLOWING ROUTINE RESETS EVEN ADDRESSES
                        00360 * $FFC6 THROUGH $FFD2 IN THE SAM, SELECTING THE VIDEO.
                        00370 *
0C87 C6   07            00380         LDB     #$07    * VIDEO DISPLAY ADDRESSES
0C89 8E   FFC6          00390         LDX     #$FFC6  * FIRST SAM VIDEO ADDRESS
0C8C A7   81            00400 VIDEO   STA     ,X++    * DO EVERY OTHER ADDRESS
0C8E 5A                 00410         DECB            * DONE WITH SETUP YET?
0C8F 26   FB            00420         BNE     VIDEO   * DO NEXT DISPLAY ADDRESS
                        00430 *
                        00440 * THERE ARE THREE GRAPHICS MODES TO BE SELECTED TO
                        00450 * ACHIEVE COLOR GRAPHICS MODE 3.  SAM ADDRESSES $FFC0
                        00460 * THROUGH $FFC5 SET UP COLOR GRAPHICS MODES.
                        00470 *
0C91 B7   FFC5          00480         STA     $FFC5   * SET GRAPHIC MODE 2
0C94 B7   FFC2          00490         STA     $FFC2   * RESET GRAPHIC MODE 1
0C97 B7   FFC0          00500         STA     $FFC0   * RESET GRAPHIC MODE 0
                        00510 *
                        00520 * THE FOLLOWING ROUTINE CLEARS A 12K AREA OF MEMORY
                        00530 * FOR USE AS A SCRATCHPAD WORK AREA WHEN EVALUATING
                        00540 * THE PRESENT GENERATION OF CELLS.  THE METHOD CHOSEN
                        00550 * HERE TO CLEAR MEMORY IS VERY FAST.  INSTEAD OF A
                        00560 * "STA ,X+" STYLE OF MEMORY FILLING, SIX BYTES (THE
                        00570 * TWO ACCUMULATORS PLUS THE X AND Y REGISTERS) ARE
                        00580 * CLEARED TO ZERO.  THE STACK IS POINTED TO THE TOP
                        00590 * OF THE MEMORY TO BE CLEARED, AND THE SIX BYTES ARE
                        00600 * PUSHED ON THE STACK UNTIL THE MEMORY AREA IS FULL.
                        00610 *
0C9A 4F                 00620 AGAIN   CLRA            * SET ACCUMULATOR A = 0
0C9B 5F                 00630         CLRB            * SET ACCUMULATOR B = 0
0C9C 1F   02            00640         TFR     D,Y     * SET REGISTER Y = 0
0C9E 1F   01            00650         TFR     D,X     * SET REGISTER X = 0
0CA0 10CE 4000          00660         LDS     #$4000  * STACK TO TOP OF SCRATCHPAD
0CA4 34   36            00670 NEXT1   PSHS    A,B,X,Y * PUSH 6 BYTES ON THE STACK
0CA6 118C 1000          00680         CMPS    #$1000  * IS STACK UNDER #$1000 YET?
0CAA 2A   F8            00690         BPL     NEXT1   * KEEP GOING IF NOT THERE
                        00700 *
                        00710 * THE STACK IS THEN SET OUT OF THE WAY OF THE
                        00720 * "NEIGHBORHOOD" INCREMENTING ROUTINE WHICH FOLLOWS.
                        00730 *
0CAC 10CE 0DBF          00740         LDS     #$0DBF
                        00750 *
                        00760 * THE "NEIGHBORHOOD" INCREMENTING ROUTINE USES THE
                        00770 * HOOPER METHOD.  IN MOST CONCEPTUALIZATIONS OF THE
                        00780 * GAME OF LIFE, EACH CELL POSITION IS CHECKED FOR
                        00790 * THE NUMBER OF NEIGHBORS WHICH SURROUND IT.  IT TURNS
                        00800 * OUT THAT, AFTER THE FIRST GENERATION (THE GARDEN OF
                        00810 * EDEN GENERATION), THERE ARE ALWAYS LESS LIVE CELLS
                        00820 * THAN DORMANT ONES.  SO INSTEAD OF CHECKING FOR THE
                        00830 * NEIGHBORS OF EACH CELL, IT IS FASTER TO CHECK EACH
                        00840 * CELL TO DETERMINE WHOSE NEIGHBOR IT IS.  WHEN ALL
                        00850 * CELLS HAVE BEEN CHECKED, A COUNT OF NEIGHBORS HAS
                        00860 * BEEN CREATED.
                        00870 *
0CB0 8E   0000          00880         LDX     #$0000  * POINT X TO DISPLAY
0CB3 108E 1000          00890         LDY     #$1000  * POINT Y TO SCRATCHPAD
                        00900 *
0CB7 C6   04            00910 NXTCEL  LDB     #$04    * COUNT FOUR QUARTER BYTES
0CB9 A6   80            00920         LDA     ,X+     * GET VIDEO DISPLAY BYTE
0CBB 49                 00930 QUARTR  ROLA            * ROTATE A THROUGH CARRY
0CBC 49                 00940         ROLA            * ROTATE A THROUGH CARRY
0CBD 24   19            00950         BCC     NEXTQ   * IF C=0, THEN CELL NOT LIVE
                        00960 *
                        00970 * HERE IS THE NEIGHBORHOOD:
                        00980 *       -------------------
                        00990 *       / -81 / -80 / -7F /
                        01000 *       -------------------
                        01010 *       / -01 / JOE / +01 /
                        01020 *       -------------------
                        01030 *       / +7F / +80 / +81 /
                        01040 *       -------------------
                        01050 *
0CBF 6C   A9 FF7F       01060         INC     -$81,Y  * UPPER LEFT NEIGHBOR
```

```
0CF3 49                 01410         ROLA            * ROTATE THROUGH CARRY FLAG
0CF4 49                 01420         ROLA            * ROTATE THROUGH CARRY FLAG
0CF5 34   03            01430         PSHS    A,CC    * RE-SAVE ROTATING A, CARRY
0CF7 A6   A0            01440         LDA     ,Y+     * GET VALUE FROM SCRATCHPAD
0CF9 48                 01450         ASLA            * DOUBLE IT (2-BYTE OFFSET)
0CFA 8E   0CFF          01460         LDX     #ZAP    * GET START OF TABLE
0CFD 6E   96            01470         JMP     [A,X]   * ADD OFFSET & JUMP TO ROUTINE
                        01480 *
0CFF      0D11          01490 ZAP     FDB     DEATH   * ROUTINE NEIGHBORHOOD = 0
0D01      0D11          01500         FDB     DEATH   * ROUTINE NEIGHBORHOOD = 1
0D03      0D19          01510         FDB     NOCHNG  * ROUTINE NEIGHBORHOOD = 2
0D05      0D25          01520         FDB     BIRTH   * ROUTINE NEIGHBORHOOD = 3
0D07      0D11          01530         FDB     DEATH   * ROUTINE NEIGHBORHOOD = 4
0D09      0D11          01540         FDB     DEATH   * ROUTINE NEIGHBORHOOD = 5
0D0B      0D11          01550         FDB     DEATH   * ROUTINE NEIGHBORHOOD = 6
0D0D      0D11          01560         FDB     DEATH   * ROUTINE NEIGHBORHOOD = 7
0D0F      0D11          01570         FDB     DEATH   * ROUTINE NEIGHBORHOOD = 8
                        01580 *
                        01590 * THE DEATH ROUTINE MUST CREATE COLOR VALUE 00 ON THE
                        01600 * COLOR GRAPHICS DISPLAY SCREEN.  HALF OF THIS VALUE
                        01610 * IS PRESENTLY IN THE A ACCUMULATOR, AND THE OTHER
                        01620 * HALF IS IN THE CARRY FLAG.  BOTH ARE SET TO ZERO
                        01630 * IN THIS ROUTINE.
                        01640 *
0D11 35   03            01650 DEATH   PULS    A,CC    * SAVE DISPLAY, ROTATING BIT
0D13 84   FE            01660         ANDA    #$FE    * MASK OUT BIT ZERO
0D15 1C   FE            01670         ANDCC   #$FE    * MASK OUT CARRY BIT
0D17 20   18            01680         BRA     OUT     * GO OUT TO ROTATE & DISPLAY
                        01690 *
                        01700 * THE NO-CHANGE ROUTINE IS NOT PRECISELY THAT IN THIS
                        01710 * CASE.  COLORS IN THIS GRAPHICS MODE ARE BUFF, CYAN,
                        01720 * MAGENTA AND ORANGE, AS REPRESENTED BY PATTERNS 00,
                        01730 * 01, 10 AND 11.  IN THIS PROGRAM, DORMANT CELLS ARE
                        01740 * SHOWN IN BUFF (00), NEWBORN CELLS IN CYAN (01), AND
                        01750 * CELLS OLDER THAN ONE GENERATION AS ORANGE (11).  THE
                        01760 * VALUE 10 (MAGENTA) IS DEFINED AS ILLEGAL.  HOWEVER,
                        01770 * SHOULD IT OCCUR IN THE "GARDEN OF EDEN", IT MUST BE
                        01780 * CHANGED TO 00.  THIS ROUTINE MAKES THE CHANGE.
                        01790 *
0D19 35   03            01800 NOCHNG  PULS    A,CC    * RESTORE ROTATED DISPLAY INFO
0D1B 25   04            01810         BCS     HIGH    * IF SET, MEANS BIT ZERO = 1
0D1D 84   FE            01820         ANDA    #$FE    * MAKE 10 OR 00 BECOME 00
0D1F 20   10            01830         BRA     OUT     * AND GO OUT, STORE & DISPLAY
0D21 8A   01            01840 HIGH    ORA     #$01    * MAKE 01 OR 11 BECOME 11
0D23 20   0C            01850         BRA     OUT     * AND GO OUT, STORE & DISPLAY
                        01860 *
                        01870 * THE BIRTH ROUTINE IS ALSO A "NO CHANGE" ROUTINE IF
                        01880 * THE NUMBER OF NEIGHBORS IS PRECISELY THREE AND A
                        01890 * LIVE CELL ALREADY EXISTS.  VALUES FOR NEWBORNS ARE
                        01900 * GIVEN AS 01 (CYAN), BUT ALREADY EXISTING CELLS MUST
                        01910 * BE CHANGED TO OLDER CELLS IN ORANGE (11).  ALSO,
                        01920 * ANY ILLEGALS (10, MAGENTA) MUST BE CHANGED.
                        01930 *
0D25 35   03            01940 BIRTH   PULS    A,CC    * GET ROTATED DISPLAY VALUE
0D27 24   04            01950         BCC     LOW     * GO IF CARRY = 0 (00 OR 10)
0D29 8A   01            01960         ORA     #$01    * IF C=1, MAKE 11 = OLDSTER
0D2B 20   04            01970         BRA     OUT     * GO OUT, STORE AND DISPLAY
0D2D 84   FE            01980 LOW     ANDA    #$FE    * C = 0; MAKE 00 OR 01 BE 00
0D2F 1A   01            01990         ORCC    #$01    * THEN MAKE VALUE BECOME 01
                        02000 *
                        02010 * THE "OUT" ROUTINE IS AN ORDERLY EXIT, TESTING FOR
                        02020 * THE ROTATED POSITION OF A (THE QUARTER-BYTE COUNT),
                        02030 * DOING THE FINAL (NINTH) ROTATE TO GET THE BYTE
                        02040 * BACK IN POSITION IF NECESSARY, STORING THE FINAL
                        02050 * BYTE IN A TEMPORARY SCREEN, AND BRANCHING BACK IF
                        02060 * THE ENTIRE 3,072 BYTE BLOCK (12,288 CELLS) HAS NOT
                        02070 * BEEN DONE.
                        02080 *
0D31 34   03            02090 OUT     PSHS    A,CC    * STASH ROTATING BIT, VIDEO
0D33 5A                 02100         DECB            * TEST FOR NEXT QUARTER BYTE
0D34 26   BB            02110         BNE     HERE    * IF NOT DONE, GET NEXT QUARTER
0D36 35   03            02120         PULS    A,CC    * RESTORE ROTATING BIT, VIDEO
0D38 35   10            02130         PULS    X       * RECOVER STASHED X REGISTER
```

```
                        0D3A 49          ROLA            * ROTATE TO RESTORE POSITION
                        0D3B A7          STA     $1000,X * AND STORE BACK INTO DISPLAY
                        0D3F 30          LEAX    1,X     * GET NEXT POSITION IN PLACE
                        0D41 8C 0C00     CMPX    #$0C00  * SEE IF END OF DISPLAY YET
                        0D44 26 A3       BNE     CIRCLE  * IF NOT, BACK FOR NEXT BYTE
                                *
                                * THE FOLLOWING ROUTINE REDIRECTS THE SCREEN TO $1000,
                                * WHERE THE NEW GENERATION HAS BEEN CREATED.  IT THEN
                                * COPIES THAT INFORMATION INTO THE SCREEN STARTING AT
                                * $0000, AND SWITCHES SCREENS.  THIS WORK-AND-SWITCH
                                * PROCESS PREVENTS THE NEW GENERATION FROM SWIMMING
                                * DOWNWARD OVER THE PREVIOUS GENERATION AS YOU WATCH.
                                *
                        0D46 B7 FFCD     STA     $FFCD   * SWITCH TO SCREEN AT $1000
                                *
                        0D49 8E 1000     LDX     #$1000  * POINT X TO NEW SCREEN
                        0D4C 108E 0000   LDY     #$0000  * POINT Y TO OLD SCREEN
                        0D50 A6 80       LDA     ,X+     * GET VALUE FROM NEW SCREEN
                        0D52 A7 A0       STA     ,Y+     * TRANSFER VALUE TO OLD SCREEN
                        0D54 8C 1C00     CMPX    #$1C00  * SEE IF SCREEN IS FINISHED
                        0D57 26 F7       BNE     XFER    * GO BACK TO FINISH SCREEN
                                *
                        0D59 B7 FFCC     STA     $FFCC   * REDIRECT VIDEO TO $0000
                                *
                        0D5C 7E 0C9A     JMP     AGAIN   * AND REPEAT THE WHOLE PROCESS
                                *
                                0C80     END     START
                        00000 TOTAL ERRORS

                        0AGAIN  0C9A             NEXTQ   0CD8    QUARTR  0CBB
                        0BIRTH  0D25             NOCHNG  0D19    START   0C80
                        0CIRCLE 0CE9             NXTCEL  0CB7    VIDEO   0C8C
                        0DEATH  0D11             OUT     0D31    XFER    0D50
                                                                 ZAP     0CFF
```

```
0CC3 6C A8 80   01070            INC     -$80,X  * UPPER NEIGHBOR
0CC6 6C A8 81   01080            INC     -$7F,X  * UPPER RIGHT NEIGHBOR
0CC9 6C 3F      01090            INC     -$01,X  * LEFT NEIGHBOR
0CCB 6C 21      01100            INC     $01,Y   * RIGHT NEIGHBOR
0CCD 6C A8 7F   01110            INC     $7F,Y   * LOWER LEFT NEIGHBOR
0CD0 6C A9 0080 01120            INC     $80,Y   * LOWER NEIGHBOR
0CD4 6C A9 0081 01130            INC     $81,Y   * LOWER RIGHT NEIGHBOR
                01140   *
0CD8 31 21      01150   NEXTQ    LEAY    1,Y     * GET NEXT SCRATCHPAD POSITION
0CDA 5A         01160            DECB            * COUNT DOWN BY QUARTER BYTES
0CDB 26 DE      01170            BNE     QUARTR  * GET NEXT QUARTER BYTE
0CDD 8C 0C00    01180            CMPX    #$0C00  * SEE IF END OF DISPLAY
0CE0 26 D5      01190            BNE     NXTCEL  * ELSE GET NEXT VALUE
                01200   *
                01210   * ONCE THE NEIGHBORHOODS HAVE BEEN DETERMINED, THE
                01220   * INFORMATION IS USED TO GIVE BIRTH TO A CELL, ALLOW
                01230   * A CELL TO DIE, OR LEAVE THE CELL UNCHANGED.  A TEST
                01240   * FOR 0 OR 1; 2; 3; 4 OR MORE NEIGHBORS COULD BE DONE
                01250   * BY USING THE SCRATCHPAD INFORMATION.  IN THIS CASE,
                01260   * THE INFORMATION (0 THROUGH 8 NEIGHBORS) IN THE
                01270   * SCRATCHPAD IS USED AS AN OFFSET TO A TABLE OF
                01280   * ADDRESSES.  THE X REGISTER POINTS TO THE ZEROETH
                01290   * ENTRY IN THE TABLE, AND THE A REGISTER PROVIDES THE
                01300   * OFFSET.  X+A IS THE ADDRESS OF THE DEATH, BIRTH AND
                01310   * NO CHANGE ROUTINES.
                01320   *
0CE2 8E 0000    01330            LDX     #$0000  * POINT X TO VIDEO DISPLAY
0CE5 108E 1000  01340            LDY     #$1000  * POINT Y TO SCRATCHPAD
                01350   *
0CE9 C6 04      01360   CIRCLE   LDB     #$04    * COUNT FOUR QUARTER BYTES
0CEB A6 84      01370            LDA     ,X      * GET VIDEO DISPLAY BYTE
0CED 34 10      01380            PSHS    X       * STASH X REGISTER FOR LATER
0CEF 34 03      01390            PSHS    A,CC    * STASH VIDEO, CARRY INFO
0CF1 35 03      01400   HERE     PULS    A,CC    * RESTORE VIDEO, CARRY INFO
```


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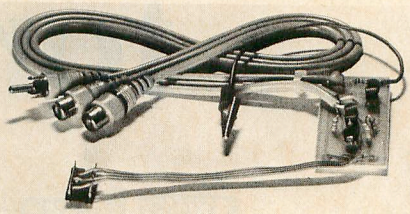

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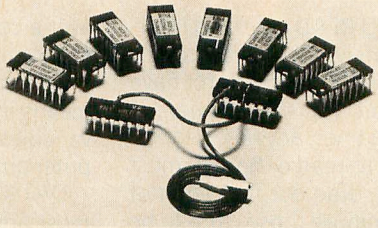

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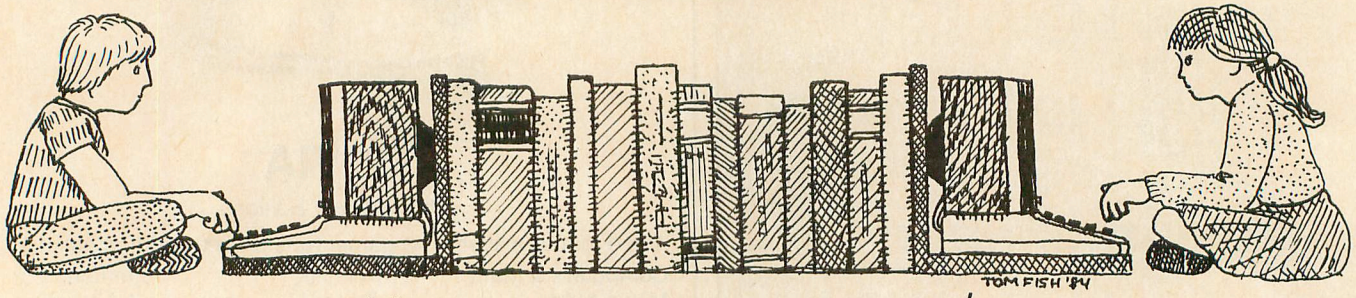
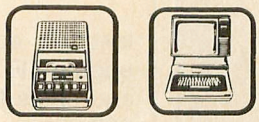


How to get your computer to read.

by Jean Plesser



4K Color Basic or 16K Color Basic

HAVE YOU READ anything interesting lately? Or are you one of those hate to read...don't have the time...I'll wait for the movie...I'd rather play video games, anyway, people? Whether we love to read or hate it, most of us sigh heavily, drag our feet and put off until the last minute those (sure to be dull) reading assignments.

Now you can get some of that frustration out of your system. You can give reading assignments to your heart's content and your computer will obey your every (dull as it may be) READ command! Imagine the power..."READ A$: READ N: READ X$,Y,Z$. And, no games for you until all your reading is done!"

Well, now that you've gotten a taste of the power, let's learn how to use it.

READ D$. Where is D$??

Of course we can't just prop up a book in front of a computer and type READ on the keyboard, then just walk away. Whatever a computer reads must be part of a program and the READ command directs the computer to DATA statements. *Data* means information and data is stored in variables used in many ways by a computer program.

DATA statements can be entered almost anywhere within a program, but I prefer to put them last. After you type the line number, type the word DATA, then type the information you want the computer to read. Each word, number, or piece of information is separated by a comma (,). When the computer reaches a comma, or the end of a data line, it stores the data it has just read in a variable, then it leaves an invisible pointer at that place and continues to follow the program. Let's put this to work.

```
10 CLS:PRINT
20 FOR L=1 TO 3
30 READ D$
40 NEXT L
50 DATA APRIL FOOL'S DAY, PASSOVER, EASTER
60 END
```

Line 10 clears the screen and PRINTs a blank line at the top of the screen.

Line 20 begins a FOR/NEXT loop that will repeat three times.

Line 30 — The READ statement tells the computer to READ a piece of data and store it in D$.

Line 40 adds one to L and sends the computer back to Line 20 until L=3.

Line 50 is a line of data that will be read by the READ statement.

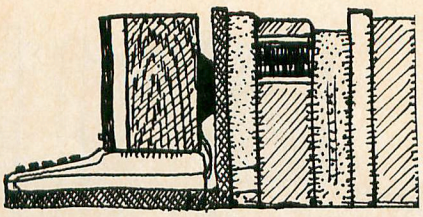
Line 60 ends the program when the loop is complete.

When you RUN this program this is what will happen:

When L=1 the computer will READ "APRIL FOOL'S DAY", store it in D$, and the invisible pointer will move to the next piece of data.

When L=2 the computer will READ "PASSOVER" and when it stores PASSOVER in D$, APRIL FOOL'S DAY will be erased and the pointer will move to the next word.

When L=3 EASTER will be the piece of data read and stored in D$, erasing PASS-



OVER, and the pointer will move over for more data.

Printing Data

We could have the computer READ all day but if we never have it do anything with the data it doesn't serve much purpose. It's like reading a page when your mind is on something else — you may as well have read nothing at all. So, let's do something with the data our program is reading. Add these lines to the program:

```
15 ? "APRIL'S HOLIDAYS ARE:"
35 ? D$
```

Now, when you RUN the program, you'll be able to see how the data in D$ changes each time new data is read. Your Video Display Terminal (VDT) should show:

```
APRIL'S HOLIDAYS ARE:
APRIL FOOL'S DAY
PASSOVER
EASTER
```

RUN the program a few times to see that the data is always the same. Then change Line 60 to: 60 GOTO 20. Now when you RUN the program, you'll get an error message after your data is printed: ?OD ERROR IN 20. Your computer is telling you that it is out of data.

Remember the invisible pointer that kept moving over to find more data? Well, we left the pointer after the word EASTER and then told the computer to READ more data. The computer looked, found nothing and gave us an error message. To prevent this add these lines:

```
60 RESTORE
70 GOTO 10
```

The RESTORE command sends the pointer back to the first DATA statement. Now the computer will READ and PRINT your data over and over again and you must press the BREAK key to stop the program. The RESTORE command is used whenever you want to READ the data more than once in a program.

Numbers and symbols can be used within DATA statements also. And when the computer finishes a line of data it will go on to the next line looking for more data or further instructions. Make these changes in your program:

```
50 DATA 1—APRIL FOOL'S DAY
60 DATA 17–PASSOVER
70 DATA 22–EASTER
80 END
```

This program gives you the dates the holidays will fall on. Use this idea to make monthly calendars so you'll be sure not to miss a special event, birthday, or any other important date. If you have a printer you can make copies for your entire family. To print a line on your printer use PRINT #−2 in place of the word PRINT in your program.

Data vs Input Statements

In the great conflict of INPUT statements vs DATA statements, there really is no winner. The INPUT statements that we've been using in the last two lessons have been used for data we want to change each time we RUN the program. DATA statements are used in a program for data that is used over and over again because it will be there each time the program is executed.

DATA statements are perfect for storing names, addresses and telephone numbers, book and record collections, inventories (that's how many you have of each kind of thing) and many, many other things. Let me give you an idea of how you can create a program that will list your library of books.

A Book List

Listing 1 is a sample program that will guide you in creating programs to list things. Book List 1 lists books by title and author. There are a couple of new things in this program, so let's go over the program lines:

Line 100 is a remark statement (REM) telling what the program is.

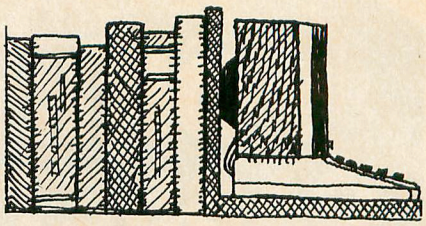
Line 110 clears the screen, and PRINTs blank lines and the title of the program.

Line 120 begins the loop that READs and PRINTs the data.

Line 130 — this READ statement uses two variables. T$ is for the title of the book and A$ is for the author's name. Because we are reading two pieces of data in one statement, our loop only repeats five times — once for each book, not once for each data line.

Line 140 PRINTs a book's title on one line, then PRINTs two spaces and the author's name on the next line.

Line 150 repeats the loop until R=5.



Line 200 is the first data statement for the first book's title.

Line 210 is a data line for the book's author — last name is first. See anything different? I used quotation marks (" ") around the author's name. Why? When using last name first, a comma is used to separate the first and last names. A comma is also used to separate data on a line, so the quotation marks let the computer know you want this comma to be printed and everything inside the quotes is one piece of data.

Enter the program and RUN it to see how the titles and authors are listed. Now, make these changes in Line 140 to see how you can print data in ways other than just in the order the data was read: 140 PRINT A$:PRINT " ";T$.

This time the author's names will be printed first: 140 PRINT T$. Even though the computer has read A$, it doesn't have to PRINT it. And, it doesn't have to PRINT T$: 140 PRINT A$.

You can print data in many different ways to serve many different purposes. The READ statement simply stores the data in variables, so once the data has been put into a variable you can do whatever you wish with the variable. Also if you READ numeric data statements and store the data in numeric variables, you can use the data for calculations.

Alphabetize That List

If a list is lengthy, the easiest and fastest way to find a name is alphabetically. We saw how fast our computers can do this task in last month's article, and we can use the same program statements to alphabetize a book list.

Listing 2 uses the same data as Listing 1, but this time the titles will be printed in alphabetical order. You may want to go over last month's article if you have any difficulty with the alphabetizing portion of the program, and if you're not sure about arrays and DIM statements, go back to February's column.

Variable names for Listing 2:

T1$ — array for book titles in the order of the data statements.

A1$ — array for author's names in the order of the data statements.

T2$ — array for book titles in alphabetical order.

A2$ — array for author's names in the

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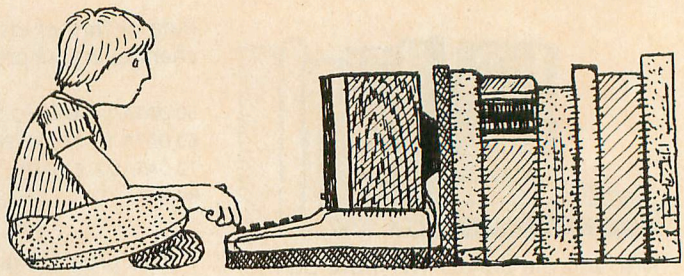


order of the alphabetized book titles.
R — numeric variable for the READ loop.
T$ — the READ variable for a book title.
A$ — the READ variable for an author's name.
A — holds a number for comparing and alphabetizing the T1$ array.
P — numeric variable for alphabetizing loop.
L — numeric variable for comparing titles.
O — numeric variable for PRINT loop.

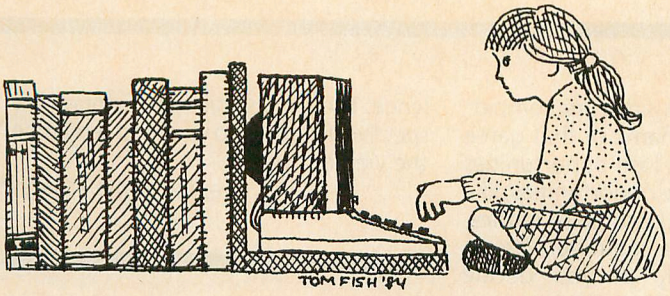
When you enter this program you may want to use your own data so you can list your library of books. Be sure to change the numbers in the DIM statements and in all the FOR/NEXT loops to the total number of titles you have in your data statements. And if your list is too long to appear on the screen at one time,

Program Listing 1. Book List

```
100 REM**BOOK LIST #1
110 CLS:PRINT:PRINT "BOOK & AUTH
OR LIST:":PRINT
120 FOR R=1 TO 5
130 READ T$,A$
140 PRINT T$:PRINT "   ";A$
150 NEXT R
200 DATA WHERE THE SIDEWALK ENDS
210 DATA "SILVERSTEIN, SHEL"
220 DATA A WRINKLE IN TIME
230 DATA "L'ENGLE, MADELEINE"
240 DATA USBORNE GUIDE TO COMPUT
ERS
250 DATA "SMITH, BRIAN REFFIN
260 DATA SLEEP BOOK, DR. SEUSS
270 DATA BASIC FUN,LIPSCOMB & ZU
ANICH
280 END
```

Program Listing 2. Alphabetized Book List

```
100 REM**BOOK LIST #2
110 DIM T1$(5),A1$(5),T2$(5),A2$
(5)
120 REM**PUT DATA INTO ARRAY
130 FOR R=1 TO 5
140 READ T$,A$
```



press the Shift key and the @ key at the same time — this will stop your program until you press any other key to continue.

If you later want to alphabetize the authors' names, just change the T variables to As and the A variables to Ts in Lines 210, 230, 240, 250, 300, and 310.

You're now ready to make lists, or files, of all sorts of things: collections, recipes, tools, toys, games, equipment, and...well, I'm sure you can think of lots of other things. These lists can be handy and helpful too, so give it a try and you'll soon be putting your computer to some real work!

Next month we'll use data statements to draw pictures launch a rocket and create an electronic greeting card for Mom. Happy April holidays and don't let anyone catch you being an April Fool! ■■■

```
150 T1$(R)=T$: A1$(R)=A$
160 NEXT R
170 REM**ALPHABETIZE DATA
180 A=1
190 FOR P=1TO5
200 FOR L=1TO5
210 IFT1$(L)<T1$(A)THEN A=L
220 NEXT L
230 T2$(P)=T1$(A)
240 A2$(P)=A1$(A)
250 T1$(A)="ZZZZZZZZ"
260 NEXT P
270 REM**PRINT SECTION
280 PRINT:PRINT"ALPHABETICAL BOO
K LIST:"
290 FOR L=1 TO 5
300 PRINT "   ";T2$(L)
310 PRINT "     ";A2$(L)
320 NEXT L
330 END
400 DATA WHERE THE SIDEWALK ENDS
410 DATA "SILVERSTEIN, SHEL"
420 DATA A WRINKLE IN TIME
430 DATA "L'ENGLE, MADELEINE"
440 DATA USBORNE GUIDE TO COMPUT
ERS
450 DATA "SMITH, BRIAN REFFIN"
460 DATA SLEEP BOOK, DR. SEUSS
470 DATA BASIC FUN, LIPSCOMB & Z
UANICH
480 END                    ■■■
```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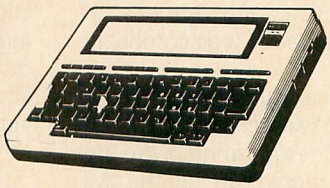

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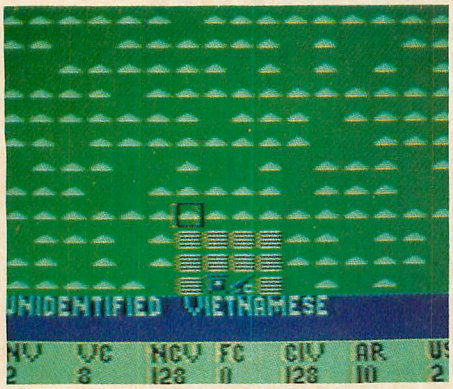
VC



Microcomputer Games (Avalon Hill)
4517 Hartford Road
Baltimore, MD 21214
$20 cassette

VC A NEW GAME from Microcomputer Games, an Avalon Hill subsidiary, simulates the frustrations inherent in waging war against guerillas in a Vietnamese province. The computer controls the guerilla forces, you control the American and South Vietnamese forces. Your task is to maintain as favorable a balance as possible between northern and southern sympathies, while also pacifying the province. VC is strictly a tactical exercise. Graphics are used only to represent the province and entities within it. There is no "arcade" type combat involved.

To win, you must cut off and destroy all VC (Viet Cong) and NVA (North Vietnamese Army) units operating in the province. You lose if more than half the civilian population either joins the VC or is destroyed. One big problem is that the VC can recruit from the civilian population while you watch. Selecting the highest difficulty level (5) means the VC and NVA have a better initial foothold in your province. The NVA is not a factor if you select the lowest level (0).

You can see only the province's hamlets (both neutral and friendly) and your own units. To find the VC or NVA, and to gain new recruits, you must comb the countryside. The VC will, as a rule, try to recruit from among the neutral civilian population. In fact, VC and NVA battalions are usually disguised as neutral civilians and are not recognizable until you bring one of your units next to them.

You begin with one U.S. Airmobile unit, one U.S. artillery unit and eight ARVN (Army of the Republic of Vietnam) battalions. Since both sides are competing for neutrals, the name of that game is to keep moving or lose opportunities for recruitment. Those opportunities, like the shelling and the outcome of battles, are determined by the computer. Strategy comes into play as you decide whether to bunch your units as they move around, which offers good protection from enemy fire but poor opportunities for recruitment, or whether to disperse your units, which switches those tables. You can only move one unit one square at a time. There's a running total of the number of forces sympathetic to either side, and the number of neutral civilians, displayed at the bottom of the screen.

After each of your turns, the computer randomly moves 10 civilian or VC/NVA units. If they move next to U.S. or ARVN units, combat will result. If they move next to a neutral civilian hamlet, recruitment may take place. If a neutral civilian group moves next to an allied unit, it may become friendly.

When it is your turn, you may move your units as desired, using either the joystick or the arrow keys. I found the game faster and more enjoyable with the joystick. To move a unit, you place the cursor on it, press the fire button, then move the cursor to the unit's destination and press the fire button again (the space bar may be pressed if you're not using a joystick). If any unfriendly units are occupying adjacent squares, combat results are displayed. After your move is complete, you may fire your artillery by using the cursor to spot, then pressing the fire button (or spacebar).

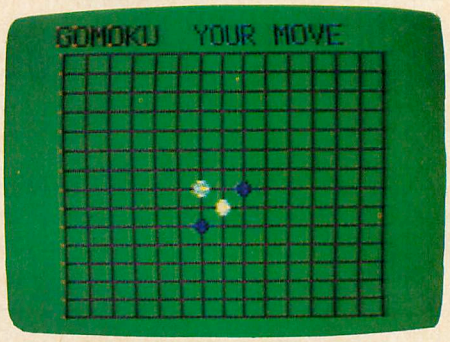
Although the game comes on tape, it can be loaded to disk easily. The execution address is above the disk buffers and can be used with the disk controller plugged in. Although there are some color codes on the map board, they are easily discernible on a black and white television, a plus for those who do not use color televisions as monitors.

The documentation is brief. The manual is 16 pages long, but most of it covers non-Color Computer models. Actual Color Computer documentation is only one page long. While that is enough to tell you how to play the game, you must experiment a little to see how things really work. For example, I experimented and found that shelling "friendly" troops would sometimes destroy them, and sometimes have no effect.

In general, VC is a challenging game that will provide hours of strategic challenge. There is a section on historical perspective if you're too young to remember the Vietnam war.

— by Norman Garrett

Gomoku/Renju



Radio Shack
One Tandy Center
Fort Worth, TX 76102
(817)390-3885
ROMpak, $19.95
16K

BOARD GAMES FROM JAPAN look a lot simpler than they are. Gomoku and Renju are not exceptions. The object of the games is to create a line of five pieces in a row, in any direction, before your opponent (either a person or a computer) does. Nothing simpler, you say? Wrong! These two games are so subtle that a lifetime of study is not too much time to devote to their intricacies.

The game starts off with a board laid out and a flashing cursor you can position with the arrow keys or the joystick. Your move is made permanent by pressing the return or fire buttons. There is also a command to take back the move if you think better of it.

The initial set-up is on a 15-by-15 grid. The computer has yellow pieces and you have blue ones. Blue always moves first, and therefore has an advantage.

If you want to play the yellow pieces (there are no rules to limit yellow's moves, as there are for blue) you start the game by pressing M, which forces the computer to make the next move.

The grid can be changed to any size, from nine-by-nine to the opening value, by pressing S repeatedly. Levels of play range from one to eight; the default level

is level three. "As the playing level and the strength increase, the program looks deeper and deeper into the game. The deeper it searches the more time it needs to think. Because of the time element, the use of levels above level five is recommended only for studying the theory of the game," says the manual.

Pressing D calls up the "displays thinking" option, the most valuable option because it allows you to watch the program consider all possible moves in real time. The effect is like an enormously speeded-up movie, a continuous flickering, but after awhile clear patterns emerge and you learn to follow the analysis. Enter D in level 8 and watch the computer trace all possible consequences of a given play for an hour or more.

Other options include: P, where the computer plays itself; H, where on your move, the computer supplies a hint and where on the computer's move, the move the computer is considering is shown; hit the shift and down arrow keys to take back your move (this will back the game up all the way to the beginning on repeated entry); and hit the Break key which, on your move, aborts the game, on the computer's move, forces its move.

The chief difference between Renju and Gomoku is the number of restrictions you, as yellow, can place on the blue pieces. For instance, you may forbid blue to follow any or all of the 24 "book openings." The program maintains a 78-member library of opening sequences, some of which extend 21 moves deep into the game, and will select them according to the game level when playing Gomoku. In Renju, it will select among the openings you have allowed it to use.

I have found only two problems with this game. First, if you answer N to the prompt NEW GAME? it will give you a new game anyway. Second, in the lower levels of Gomoku, any attack move you make, however frivolous, causes the program to go into defensive mode. This ability to make it discontinue an attack can give you a decisive advantage. Whether the defect figures in the really high levels I have not yet learned.

How the program might fare against one of Japan's master players I have no idea, but it should afford stiff opposition for anyone up to a really serious think game. If this is not the best designed game Radio Shack sells, I should like to know which one is. I recommend it to absolutely anyone, unreservedly.

— R.W. Odlin

RTD3.0

Silicon Rainbow Products
1111 West Camino Real
Suite 109
Sunnyvale, CA 94087
$30 disk
For any Color Computer

RTD3.0, THE REMOTE TERMINAL driver, solves the problem of getting the Color Computer to accept input from a modem or an external terminal. Microsoft didn't include an INPUT #−2 or LINEINPUT #−2 statement in Basic, so it is necessary to add a routine that sends input from the RS-232 port to the keyboard scanner, otherwise no Basic language bulletin board system (BBS) could run on a Color Computer.

RTD3.0 is the solution to the problem of the missing INPUT#− 2 statement. It's one answer for Color Computerists who might be writing their own BBS, or want to use their computer from a remote location.

To use RTD3.0 from a remote location, a user would type LOADM "RTD/BIN" and EXEC the program. Then, with an auto-answer modem hooked up to the RS-232 port, anyone calling the modem can act just as if they are sitting at the keyboard of the user's computer. The only exception to this arises when you want to execute an assembly language program, since Basic programs can be written to protect the area of memory where RTD3.0 resides. Assembly language programs pose a special problem, in that the executed program shouldn't use the INKEY$ command, nor should it reside in the same location as RTD3.0, or destroy the return address of RTD3.0, since RTD3.0 would then become lost. Therefore, Silicon Rainbow Products states that it can not guarantee RTD3.0 will work with every assembly language program. Basic programs pose no special problems, though.

To use RTD3.0 with BBS software the procedure is the same. The only prohibition is that INKEY$ can not be used since RTD3.0 does not alter INKEY$ to look for "keystrokes" from the serial port. Customization of RTD3.0 is a simple matter, due to a partial source code listing of the program provided in the documentation.

User options include changing baud among 110, 300 and 600, forcing line feeds on or off, and adding nulls after a carriage return. The program also keeps a count of the total number of characters typed by a user during a session as well as the count of the characters typed by the computer during a session. It can also disable the Break key from the remote terminal.

RTD3.0 has some fail-safe features. You may set a time limit to wait for input from a remote user before leaving the program, disable or enable lowercase, or enable a conversion of all input from upper- to lowercase so if the BBS crashes, users will not be able to command the Basic interpreter.

RTD3.0 offers the great flexibility needed to get the most out of a home-brewed BBS, at a very reasonable price. It's written in position independent code so it can be relocated to suit a 16K, 32K or 64K Color Computer, and comes on a non-protected disk.

— R. Wayne Day

The Complete Personal Accountant

The Programmers Institute
310½ West Franklin Street
Chapel Hill, NC 27514
(919)967-0861
$74.95 16K cassette
$79.95 32K cassette or disk

IF YOU LIKE to keep track of personal or small business finances with maximum flexibility and minimum effort, The Complete Personal Accountant certainly merits consideration. It keeps track of checking, savings, and credit card accounts, as well as loans, assets and liabilities. It analyzes your budget, generates net worth and income/expense reports, graphically displays expenditures and budgets, keeps track of appointments and bill payments, prints checks, and even keeps a mailing list. The Complete Personal Accountant is also totally menu driven and, best of all, easy to use. To effectively use it, you should be familiar with basic accounting principles and double-entry bookkeeping.

Most of the work in using The Complete Personal Accountant comes when you set it up. If you have things well enough organized, once you have completed the set-up, maintaining your accounts will take only a few minutes a week.

The Complete Personal Accountant's main menu lists 10 options: chart of accounts, checkbook maintenance, checkbook search, detail budget analysis, summary budget analysis, net worth-income/expense, payments calendar, appointments calendar, mailing list, and color graph. To get your accounts set up, you need to run the "chart of accounts" option, which is required for processing all your financial transactions. A standard chart of 66 named and numbered accounts is provided so you can avoid writing your own chart if, of course, the standard chart meets your needs. If you want to change it you may do so at any time using the chart of accounts menu; you'll be prompted all the way through. You are allowed a total of 99 accounts with up to nine sub-accounts for any given account (not to exceed 200 total sub-accounts for the 32K version or 100 for the 16K version). When you have completed the modification, you can and should print it, then save it to disk or tape.

To properly set up your chart you must be able to distinguish between assets, liabilities, equity, income and expense accounts. You must stay within the numbering parameters for these accounts when setting up your chart. The numbering parameters are: 1-20, assets; 21-45, liabilities; 46-50, equity; 51-60, income; and 61-99, expenses.

After modifying your chart you are ready to set up your checkbooks. To do this, call on option number two on the main menu, "checkbook maintenance." The checkbook maintenance program presents you with another menu: new checkbook or new month, load check files, save check files, checkbook file inquiry, balance checkbook, print individual checks, save check summary file, print checkbook to printer, and end this job.

To set up your checking account(s) select option number one, "new checkbook or new month." Enter your previous balance and your checks. For each check entered, you'll be asked for the check number, the account number, sub-account number, date of the check, payee, amount and whether or not the check is tax deductible. This system lets you break a single check down so it can be divided among several different account numbers.

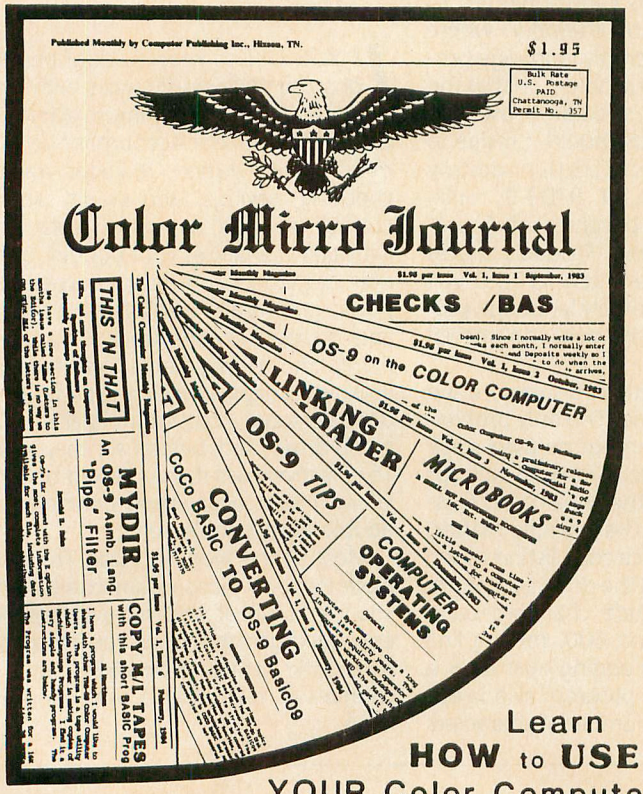
"Checkbook file inquiry" lets you search the file for certain payees, add new checks to it, delete checks or change check entries. One file is produced for each month for each checking account.

At the end of the month you can balance your checkbook by selecting option number five. When you're done, the program congratulates you if the statement balances or tells you how much you are off if it does not. Once you are successful, select option number seven, "save check summary file." This will sort your file and save it for later use as input to other routines, many that will require the checkbook file.

One drawback of this package is its use of a Basic sort. One lengthy check file sort took over 30 minutes. The Programmers Institute ought to add an assembly language sort to this part of the program.

Options number six and eight are print options. Number six lets you print checks. Number eight prints an entire check file, giving you a print-out of your check register. (I have not tested option six. If a business were to use this option, correct check data would result but checks might not conform to the company's print format. But the program can be modified to conform to check styles because The Complete Personal Accountant comes with modifiable source code.)

!!! FREE !!!



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The other checkbook option from the main menu is called "checkbook search." This program will search for individual checks, either by sequentially paging through all check entries or by keying on a specific field (key options are check number, deposit number, description, date or account number). The located checks may be printed either on the screen or your printer. This is a particularly handy feature when you're doing manual bookkeeping. It lets you print selected checks for insertion into bill files, for example.

Once your check files are up and running, you can turn your attention to the other features of The Complete Personal Accountant. Option five, "detail budget analysis," sets up a budget for a particular month, loads your chart of accounts and checkbook file and runs a budget analysis for the month. It analyzes each account and details transactions that took place. This option also lets you create and modify your budget for each month and to sort your budget analysis report by account number, account subcategory, date, amount or description. A good feature of the detail budget analysis program is that it lets you append several files together to analyze your budget for more than a one-month period or for more than one checking account.

"Summary budget analysis," option six, performs a similar function, except it creates a report which is a summary of the budget status of each account on the chart of accounts for the period in question. For each account it will report the amount budgeted, amount spent, totals reflecting the number of accounts over or under budget, the total budget, and the total spent. Those totals are further broken down into assets, liabilities, income and expense accounts for the fanciest of analytical possibilities.

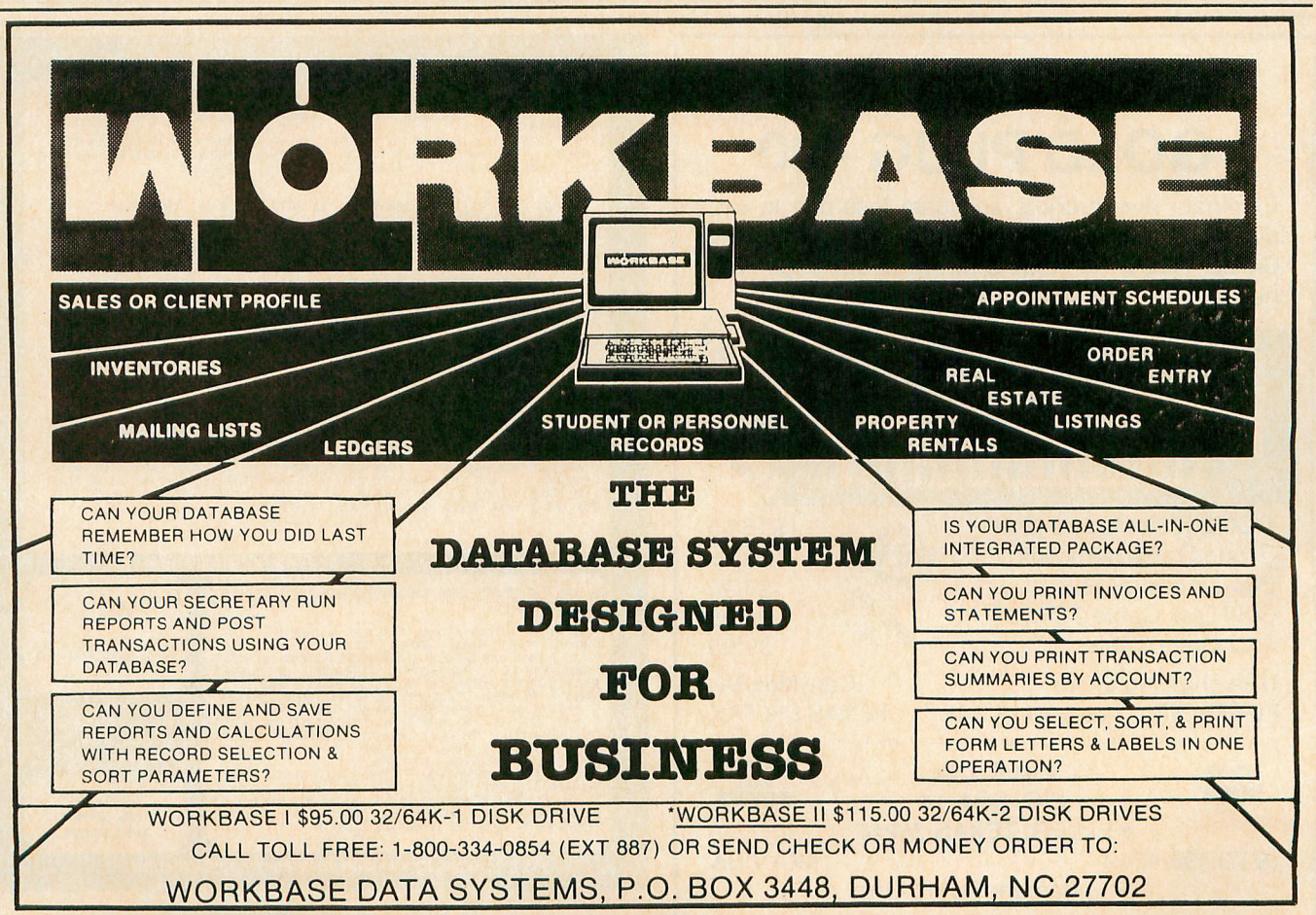
I find the net worth-income/expense program very useful when gauging my financial picture. This program is selected by using option seven on the main menu. Like the other programs, net worth-income/expense has an extensive menu. This program keys off of four files: the check summary file for the month since the last net worth-income/expense program was run, the prior balance sheet, the prior income statement, and the chart of accounts. The "file maintenance" option will load (or save) the necessary files.

You may want to perform pre-statement maintenance on your accounts before running your reports. This option will add loans, savings, investments, credit cards or do miscellaneous maintenance on the accounts. When you have completed the maintenance, you may run either the net worth statement or the income/expense statement. These reports will either print on the printer or the screen.

Drawbacks

One drawback to this particular program is its inability to perform maintenance with multiple checkbook files. No provision is made for appending files together and processing them at once. To perform proper maintenance, I had to go through the whole process once for each checking account. You only need to print the statement on the last one, since the effect of the multiple maintenance is cumulative.

The net worth and income/expense statements are well formatted but the sample reports included in the documentation are difficult to figure out. I suggest you work through the program and not spend a great deal of time trying to understand them. Things will clear up when



☎ Enter 34 on TeleResponse page 159

you run your own reports with recognizable data.

The "payment calendar" program is one of two calendar programs, the other is the "appointment calendar." Both work the same way but each uses its own disk files. The object of these programs is to keep track of bills due and appointments by organizing them by date. For each item entered, a complete record is set up. That allows you, using the search option, to look at the complete record on any given entry. Again, you may print all entries to either the screen or your printer. Changing, adding and deleting record entries is easy. These calendar features are handy but have one serious drawback which, to me anyway, makes them unusable. When a summary of appointments (or bills) is printed, it is printed as it was entered. Since I like to have *chronological* lists, and often add items later, the lack of a sort made these particular utilities next to useless to me. I tried inserting records in the proper place, but all "adds" go at the end of the file. If a sort were added to these programs, they would be excellent.

One program that does have a sort is the mailing list program. It lets you set up a database of names and addresses to go on mailing labels. Once the database is set up, you can add, change or delete names, as well as search for any given entry. You can search for specific account numbers, names, addresses, cities, states or zip codes. The mailing list may be sorted by account number, name, state or zip code. But again, the sort is a Basic one and is slow.

April Definitions:
Cursor — Any editor who can speak.

Finally, the color graph program will take any of six selected file combinations and graph them in bar graph form. It will compare any of the following to give an excellent graphic display: expense accounts to total expenses to date, income accounts to total income, relationship of each asset account to total assets, relationship of each liability account to total liabilities, compare check summary accounts to total checks for the month, and compare budgeted amounts to total budget.

After selecting the comparison desired, the program prompts you through loading the correct files. If you have multiple checking accounts and want to use option five, you will only be able to do it with one account at a time.

The Complete Personal Accountant is a powerful, comprehensive accounting package. It has features that would usually put its price well over the $100 mark. The documentation is outstanding, easy to read. It comes in a styled looseleaf binder and contains over 150 pages of instructions and tutorials, all fully indexed and cross-referenced. All menus are shown in the documentation in diagrammatic form so it is easy to see a menu synopsis for any specific program.

I have put my personal finances on The Complete Personal Accountant system for the past three months and have been quite pleased.

—Norman Garrett

(Ed.'s note: This product was formerly called "The Color Accountant.")

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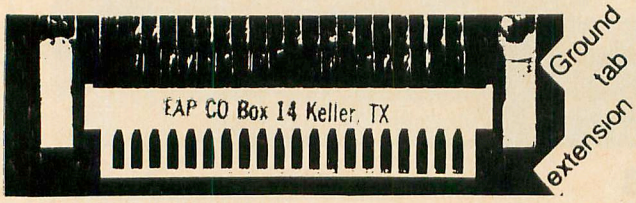

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A spread sheet is simply a tabular arrangement of numeric values, headings and, where desired, a set of formulas. Form 1040 for Federal income tax is a common example of a spread sheet: the values you provide are placed in blank locations in rows or columns. You then follow instructions to produce certain results, such as "add line 35 to line 42 and subtract line 20." These instructions are, in fact, formulas used to produce results from one or more of the values. Unfortunately, if you make an arithmetic error the results must be recalculated. If you estimate your tax for next year, usually repeated computations are necessary. The power of an electronic spread sheet is its automatic ability to recalculate all formulas each time a single value is changed.

Dynacalc is presently available in two versions: the Flex operating system from DataComp and Flex from Frank Hogg Laboratory. (Flex is a trademark of Technical Systems Consultants, Inc.). In nearly all instances, its functions are identical regardless of the version. This review describes features of Dynacalc which are common to both versions. Any features which are unique to a version will be given special mention.

As Delivered

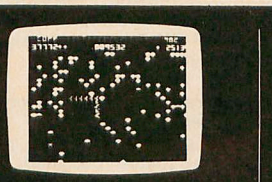
Dynacalc Release 2.5:9 is delivered on a 5¼-inch disk. A manual of about 40 pages and a reference page describe the features and use of this software. For the first 90 days after purchase, any updates to the software will be provided at no charge upon return of the original disk. (The owner is permitted to make back-up copies.) A fee of $15 for updates is required after expiration of the warranty.

A certain minimum set of computer components will be necessary in order to use this software. The Color Computer must have 64K bytes of random access memory for the Flex operating system, and there must be at least one disk drive. Use of a printer is optional. Since Dynacalc uses a high resolution screen of 51 characters on a line and 24 lines on a screen, I suggest using a TV set of good quality for easy reading.

The Disk

In addition to the Dynacalc file itself, the disk contains several sample data files. These supplement the descriptions of Dynacalc features which are difficult to explain in the manual. A utility program is included to let the owner change printer and text file parameters. For example, the default value for the length of a print line may be changed from 80 to 132 characters. On occasion, an extra file may be present which contains "last-minute" information.

Setting The Standards



COLORPEDE

This truly outstanding engineer designed, 100% machine language game with multi-colored high resolution characters and fast action will challenge the most avid arcade buff. Can be played by 1 or 2 players controlled with joy sticks or key board. Joy stick control is fast, smooth and accurate. As COLORPEDE slithers through the toad stools, you attempt to destroy the COLORPEDE, knock out the menacing Bouncing Bug and eliminate toad stools while accumulating higher and higher scores. Demonstration mode with top 5 scores. Pause feature. For 16K Color Computer and TDP-100.

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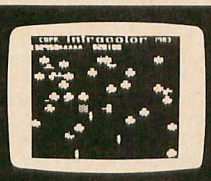

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The Manual

This comprehensive manual is not intended for beginners; it is more of a reference manual than a tutorial. In fact, the manual has a bibliography of seven books recommended for self-instruction. Since Dynacalc is patterned extensively after VisiCalc (a trademark of VisiCorp), familiarity with the VisiCalc spread sheets will greatly reduce the need for the manual. The table of contents for the Flex versions of the manual represents the thorough coverage of the material: System Requirements; Getting Started; Dynacalc Basics; Entering Data and Equations; Error Correction; Calling Dynacalc; Commands; Functions; Arithmetic Operations; Operating Tips; Error Messages; Screen Layout; Columns, Rows, and Cells; Key Definitions; Command Cross-Reference; Using Data Files; Bibliography; and Warranty and Update Service.

I am sure the author of the manual had a difficult time deciding between thorough and simple documentation. I find that the result is a complete manual that is difficult to use. The manual seems to lack an organization that is intuitive to me. Important tidbits of information which do not merit separate sections are hard to find. Although I was able to locate answers to almost all my questions, I frequently had to flip through several pages in search of the proper passages. Even though a convenient reference page of commands and functions is provided, there is no index to the manual. The reference page is simply a list of items without page numbers for detailed explanations.

Spread Sheet Format

Whether on the printed page, text file on disk, or on the video screen, the appearance of the spread sheet is identical. The spread sheet consists of individual cells arranged as a table of rows and columns. In Dynacalc, each column may have a different width if desired, but generally a global default width of nine characters is sufficient for most applications. Each column has a heading to distinguish it from other columns. There are 256 columns identified in a border as columns A through Z and AA through IV. There are also 256 rows. Each row is preceded by a border with the corresponding row number for identification. Therefore, the cell at the intersection of the first row and first column is given the name A1. The cell at the 256th row and column is named cell IV256. There are over 65,000 cells available for reference ($256 \times 256 = 65536$), although practical memory limitations do not permit all cells to be used at one time. Each cell may display a number, a label (text), or be blank. Since each cell has a name, names can be used in formulas to produce results in one cell by making reference to data contained in other cells. Row and column borders are optional for printer or text files on disk but are mandatory on the screen.

Screen Features

The Dynacalc user is presented with continually updated lines of information about the status of the spread sheet. The top three lines of the screen (these are above the column headings) show the cell name the user referred to last, if this cell contains a value or label, any formula associated with the cell, the amount of free memory remaining, the order and manner in which cells are to be processed for calculations, and any prompt or

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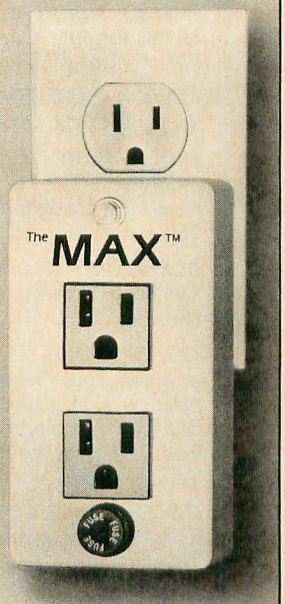

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error messages. Any change which affects information on these lines is displayed immediately. For example, as the user moves the cursor to cells in the spread sheet, the cell name on the top line is changed to agree with the current cursor position.

Since Dynacalc does not highlight the current cell by displaying it in inverse video (white text on a black background), the cursor symbol becomes an important graphic pointer to the present position on a spread sheet. The cursor symbol is the "underline." In both Flex versions of Dynacalc, this small symbol does not flash and is not obvious. It is difficult to see in complicated spread sheets and tends to get lost among the labels and values. Fortunately, the presence of the cursor position on the information line greatly reduces the significance of this problem.

A typical Dynacalc screen may consist of a display of five columns, each being nine characters wide, and 20 rows. Since the actual spread sheet may have many more columns and rows, this screen is considered a window to a larger picture. To see other cells of the spread sheet which are off the screen, the user simply attempts to position the cursor on the desired cell. The screen is dynamically redrawn each time the cursor reaches a screen edge. The window shifts one column right or left or one row up or down for each attempt at an edge. Dynacalc also permits random access to a cell by using a special control key in conjunction with the name of the cell. For convenience, there is a home key that can be used to display a window with cell A1 in the upper left corner.

Dynacalc allows a split window for two data regions. A split window means the screen is subdivided into more than one region. In this way, one region may be scrolled while another one can remain unchanged. The screen may be split either horizontally or vertically. Each region may be scrolled independently throughout the entire range of the spread sheet. This ability is very convenient when data from two distant sets of columns (or rows) must be viewed together. If desired by the user, scrolling in one region may cause an identical amount of scrolling to occur in the other region. In this manner, the two regions are said to be synchronized.

Many spread sheet applications use titles, column headings, and row headings to explain the contents of cells. This textual information is often placed at the top and left sides of the spread sheet. If the spread sheet is large, the current window may be too small to display this information with the data. Dynacalc uses the split screen method to keep this textual information on the screen and in position with the proper rows or columns. For titles, the region containing the text would remain on the screen while the region for data is scrolled through the spread sheet. Even simultaneous horizontal and vertical regions are allowed for titles. As the data region is moved up or down, the column headings remain stationary, but the row headings would move with their corresponding rows. As the data region is moved left or right, the row headings would remain stationary, but the column headings would move with their corresponding columns. The Dynacalc user specifies where the splits should be — that is, which and how many rows, columns, or rows and columns become regions.

Keyboard Features

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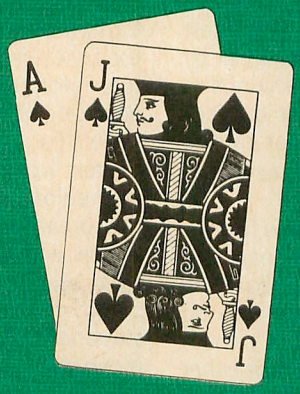

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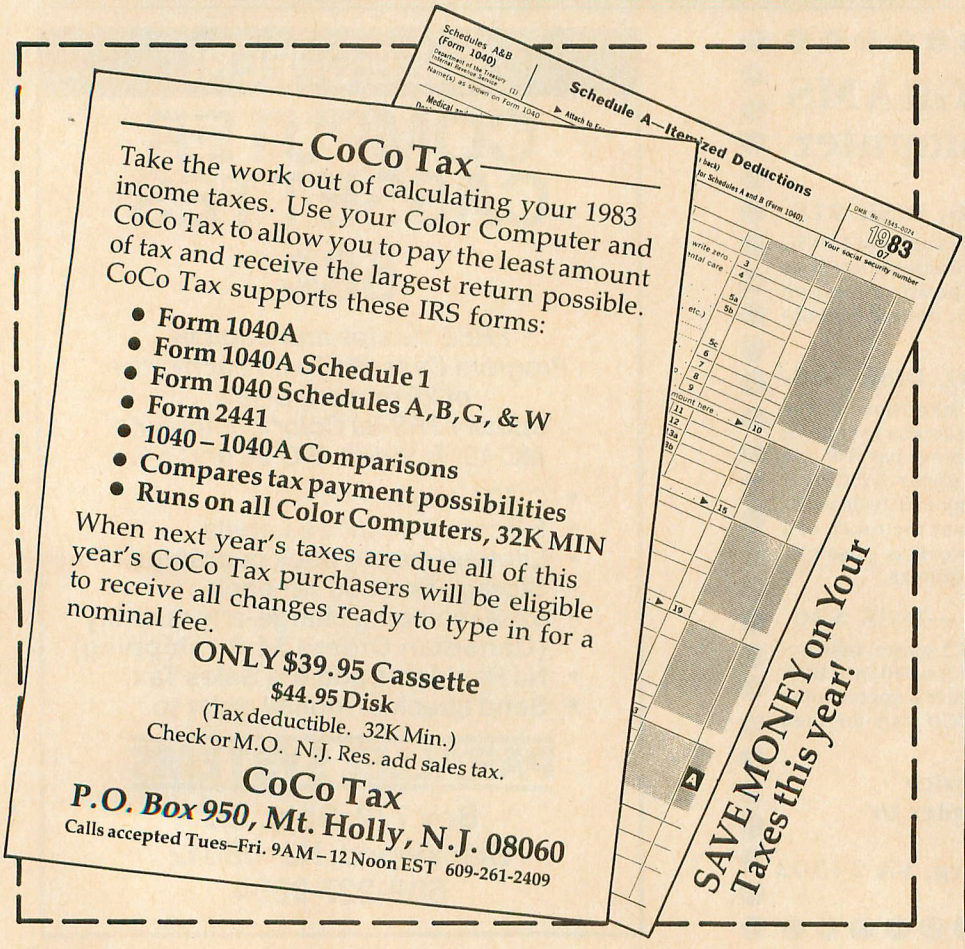

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the number of keystrokes needed to fill out a spread sheet. There are many features; a few of the most important are described below.

- Dynacalc allows a "type ahead" feature. While the screen is in the process of scrolling, keystrokes made during this time are remembered and processed as quickly as possible. You need not wait for a scroll operation to end before requesting a new action. For example, moving the cursor to a cell off the screen can be accomplished by rapid use of the cursor keys without pausing for the window to catch up with the correct position.
- As with most electronic spread sheets, the cursor is moved via the arrow keys. This is adequate as long as the desired cell is close to the current cursor position, but can become tedious for long or discontinuous moves. A "go to" function key (actually a combination of two keys) is available for distant cells. Depressing the function key followed by a cell designation will move the cursor to that cell. If the cell is not in the current window, a new window containing the cell will be displayed. As mentioned earlier, a Home Key will move the cursor to cell A1 or adjacent to any existing title regions near a split window.
- Making erroneous requests are not fatal. In nearly all cases, a key which is being entered can be cancelled by using the Break key. Whether in the middle of receiving data or specifications for some operation, Dynacalc can abort the process upon request and return control to the user for another action. This feature works so well that I have become rather cavalier on the keyboard. A few obvious interruptions are not allowed, such as terminating an active disk writing operation.
- Long formulas, text, values — in fact, the contents of any cell — may be corrected without typing the information again. An editing function allows inserting, deleting, and changing characters contained in a specified cell. Two simple mechanisms are used to initiate editing: if data entry is currently in process, a control key immediately places Dynacalc in the editing mode; if a correction is required in a cell that is not current, the user first moves the cursor to the new cell, hits a function key, and then begins to make changes. Editing capabilities are the same for either method of initiation. The cursor can be moved left or right to mark the location for editing. A backspace key is used for charac-

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ter deletion. Insertions occur at the current cursor position simply by typing what is desired. Finally, there is an optional overlay mode which allows a one-for-one replacement of characters as the new characters are typed. I find the ability to edit so helpful that I freely compose text or formulas on the screen. I know they may be easily changed immediately or at any other time.

Commands

Options, features, formats, and a variety of controls over Dynacalc are invoked by using a combination of a few single letters as commands. For example, the command sequence /AW lets the user set an attribute for the size of a column in the window. The / announces the command sequence. The letters A and W represent the command classes of "attribute" and "window," respectively. In many cases, one command call will result in a presentation of choices for subcommands or will result in prompts for additional specifications. In the above example, the user would be given the option of specifying a column size for the current column or for all columns in the window. A brief summary of the command classes is listed in the Table. Most of these commands allow choices. Subcommands (not discussed in this review) establish which choice is to be elected.

Upon request, Dynacalc will present a brief textual reminder of the meaning of any command or subcommand. This mode of help is available through the command key ?. Whenever Dynacalc expects a command or subcommand, the help mode may be called.

Values and Expressions

When a cell contains a number, the value may have originated from a simple number placed in the cell or from a complex expression. Numbers may be entered with or without decimal points or may be in scientific notation. The range of numbers (shown here in scientific notation) is −1.0e−37 to 9.999e37, where "e37" stands for 10 to the 37th power. Sixteen digits of significance are carried along in all calculations unless the user elects a rounding option or decides to declare a cell value to be an integer.

The value in a cell may be the result of the arithmetic operations addition, subtraction, multiplication, division, exponentiation, and an assortment of mathematical functions. Functions will be discussed later. Dynacalc evaluates an expression by calculating the result as it reads the expression from left to right. For example, the expression 3+A25xG3 is interpreted as (3+A25)xG3. In technical terms, there is no operator hierarchy or precedence. Since any number of parentheses may be used to direct the evaluation process, the first expression may be written as (3+A25)xG3 to obtain the expected result. My choice would have been to allow precedence since generally I use complex expressions and would like them to be easy to interpret. Fortunately, in no way is the utility of Dynacalc hampered.

A — attribute prefix for print format, width, labels, and others
B — replace the current cell with blanks
C — clear all cells of the entire worksheet
D — delete the current column or row
E — edit the contents of the current cell or its formula
F — specify the displayed format of the cell
I — insert a new column or row at the cursor position
M — move or sort columns or rows
O — output the spread sheet to a text file
P — print the spread sheet
Q — quit (exit) Flex or go to sleep
R — replicate cell data or formulas in other cells
S — call Flex utilities, load files, or save files
T — establish or cancel titles mode
W — establish or cancel split windows
? — call up the help screens

Dynacalc Commands Table

Functions

There are 26 functions in Dynacalc. I have grouped these for convenience into three categories: mathematical functions, administrative functions, and decision functions. Functions may be used in expressions, by themselves, or even referred to by other functions. By convention, a function is announced by the symbol @. For example, an expression using the square root function might appear as: 3+@SQRT(A5xK5+(B3 × B9)). Depending upon the function, there may be one, none, or several arguments which must be provided. Arguments may be numeric values, cell names, expressions, or a paired set of cell names which represents a range of cells from the first cell in sequence to the last cell. In any case, the list of arguments is contained within parentheses. Adjacent arguments in a list are separated by commas.

The mathematical functions are:

@ABS(x) — absolute value of x
@ACOS(x) — arc cosine of x
@ASIN(x) — arc sine of x
@ATAN(x) — arc tangent of x
@AVERAGE(x.y) — average of cells in range x to y
@COS(x) — cosine of x
@EXP(x) — natural antilogarithm, e to power x
@INT(x) — returns the integer part of x
@ROUND(d,x) — rounds x to the significant digit of value d
@LN(x) — natural logarithm of x
@LOG(x) — common logarithm of x
@MAX(x.y) — finds the maximum value in range x to y
@MIN(x.y) — finds the minimum value in range x to y
@NPV(r,x.y) — net present value at rate r from range x to y
@SIN(x) — sine of x
@SQRT(x) — square root of x
@STDDEV(m,x.y) — Standard deviation in range x to y using method m
@SUM(x.y) — sum of cells in range x to y
@TAN(x) — tangent of x

For trigonometric functions, arguments may be specified in degrees or radians.

A few functions are present for convenience, rather than for computational purposes (administrative functions). The function @PI represents the value 3.1415 92653589793. Another function, @NA, simply forces the contents of a cell to be displayed as >NA<, which stands for "not available." This function may be used by the designer of a spread sheet to place a diagnostic message on the screen. The function @ERROR forces a cell to be displayed as >ER< and serves much the same purpose as @NA. The presence of both @NA and @ERROR are generally used in conjunction with functions which make decisions and select alternate contents of cells.

Functions which return a single result from a list of choices can increase the versatility of any spread sheet (decision functions). For example, when taxable income is given as an argument, a function can look up an income tax rate from a previously stored table. Dynacalc has four valuable functions used to make selections from data contained elsewhere on the spread sheet. These are the @COUNT, @CHOOSE, @LOOKUP, and @INDEX functions.

The @COUNT(x.y) function is used to report the number of cells in the range x through y which contain values. Blank cells and labels are not counted. This function may be used, for example, to produce a count of the number of values

placed in a variable length table. On a spread sheet used to reconcile cancelled checks, a count of all check values which were entered for a month may be automatically produced by @COUNT. The count could then be visually compared against the tally provided on the bank statement.

In the simplest case, the @CHOOSE(n,x.y) function is used to select a value from a cell in the range x through y. The argument n may be a value, cell name, or an expression. If n had a value of 1, the value of the first cell in the range would be returned as the result. A value of n equal to 2 would return the value of the second cell, and so on. The most general form of @CHOOSE allows n to be followed by any number of ranges, expressions, and numbers. The usage: @CHOOSE(A1,G3.G5, B5,7.16,@ABS(−1),D2.F2) would produce a result from G3, G4, G5, B5, 7.16, 1, D2, E2, F2 for n having a corresponding value of 1 through 9.

The function @LOOKUP(n,x.y,z) is best illustrated by using our tax example. Suppose the taxable income has been computed and has the value n. Our problem is to find the proper tax rate for this income. Let us also say the tax rate table has been previously entered: incomes for all tax brackets are located in cells x through y in ascending order, and the tax rate for each bracket is located in a corresponding cell in column z. @LOOKUP would cause a search to begin at x until an income in the table is found that equals or exceeds n, the taxable income. The tax rate for this income bracket would be taken from the corresponding cell from column z and returned by @LOOKUP as its resulting value. (This example shows only one of several forms in which @LOOKUP can be used).

The function @INDEX(n,x.y,z) is similar to @LOOKUP, that is, a comparison is made and a corresponding value results. However, @INDEX requires an exact match between n and a value found in a cell in the range x through y. In addition, the cell values in the range need not follow any numerical sequence.

I hesitate to mention some omissions from Dynacalc since I really applaud the utility of this electronic spread sheet. Yet, there are some common functions — implemented in other spread sheets — that would have simplified converting applications from other spread sheets to Dynacalc. These functions use an argument which has the logical value of true or false. There are two other arguments, which contain numeric values. A function would produce the first numeric value if the logical argument were true and the second numeric value if the logical argument were false. Specifically, a logical value of true or false would result from a comparison between two values for equality, greater than or equal, less than, less than or equal, or not equal. Many publications of spread sheets contain examples which make use of these comparisons. While it is usually possible to find a substitute expression in Dynacalc to produce an equivalent result, I find that considerable ingenuity may be required to construct one.

Performance

There are several questions about the efficiency and accuracy of Dynacalc which I would have liked to answer definitively for you. How fast does Dynacalc perform calculations? How accurate are mathematical computations? Is there much space for large spread sheets? How fast does the screen scroll? I can provide you only with my impressions and a little quantitative data since there are few, if any, measurement standards.

Dynacalc does not actually scroll through the spread sheet. Each time a new row or column is to be displayed, the entire screen is re-drawn. Since the normal Flex screen routines are used for this purpose, speed is a function of Flex and not of Dynacalc. It is a condition that arises from the use of a high resolution screen on the Color Computer. Even different versions of Flex from the same developer may have different screen rates. Waiting for a screen of spread sheet information to appear is not a productive use of time.

Values, computations resulting from expressions, or the results of formulas are carried to sixteen digits of significance. The accuracy of any result may be less than sixteen digits since any computer has finite limitations. In two sample accuracy tests that I constructed on a trial spread sheet, Dynacalc produced very respectable results. The first test on the spread sheet consisted of evaluations of the expression @SQRT(k)x@SQRT(k)−k, where k is in the range of 1,2,3,...100. A perfect result would be the value of zero in all cases. The largest error was found to be 2.08e−13. In the second test case, the expression @EXP(@LN(k) — k was evaluated over the same range. Again, a perfect result would be zero in all cases.

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Here, the maximum error was 2.84e−14.

I measured the time required to produce the accuracy measurements in the above trial spread sheet. My subjective impression is that Dynacalc is quite fast, and its speed of calculation compares favorably with other well-known spread sheets on eight-bit microcomputers. In under 24 seconds, Dynacalc evaluated 200 square roots, one hundred exponentiations, one hundred natural logarithms, determinations of two maximum values over a range of one hundred values, and one minimum value over a range of one hundred values. Few household applications would ever reach this level of complexity.

The amount of data a spread sheet can hold depends upon the amount of memory available to Dynacalc. Under Flex 5.0:4 from Frank Hogg Laboratories, there are 22,396 bytes available. Under F-Mate 2.1 from Datacomp, 23,420 bytes are free. If the user does not need the help feature, an additional 6,530 bytes become free since the space for help information is deleted from memory. Even with the help feature enabled, I have found that it is easy to accommodate both a Federal income tax form and state income tax form on a single spread sheet with room to spare.

In retrospect, I would like to make a few suggestions to the designer of Dynacalc for future enhancements:

- Allow an option which preserves labels or formulas when a cell is cleared. The /C and /B commands presently clear both the content and context of cells.
- Highlight the current cell or develop a mechanism that improves the visibility of the cursor.
- Supply an index to the manual.
- Implement a basic set of functions for true and false decision-making.
- Permit long depressions of the arrow keys to act as an auto-repeat mode for easy cursor movement.

Dynacalc should satisfy nearly all your needs in complex home applications, in business applications, and in many scholastic and engineering needs. This software package merits your serious consideration as a tool for both casual and frequent use.

Dynacalc is available from other firms which market Flex software, as well as from Computer Systems Center. Inquiries about the product may be directed to Mr. Joseph Turner, Jr. at the CSC address, or by telephone at (314)576-5020 between the hours of 10am and 6pm.

—Eugene I. Grunby

A Radio Shack DOS version of this product was expected to be made available this spring, said Computer Systems Center President Joe Turner in January. That version is also expected to fix the objections our reviewer had with the Flex version. Radio Shack, in keeping with its policy of not commenting prematurely on whether or not products are to be available, declined comment.

—Ed.

Real Talker

Colorware Inc.
78-03 Jamaica Ave.
Woodhaven, NY 11421
$59.95 hardware voice synthesizer
$29.95 Y cable

LIKE MORE THAN THE SAME old buzz and beep from your computer? Colorware Inc. has a hardware voice synthesizer called Real Talker. The Real Talker package is composed of a cartridge-size synthesizer and a strong editor/driver to use with it.

If you are operating a tape system, simply plug the synthesizer directly into the cartridge port. No other connections have to be made. The synthesizer is a stand-alone unit, which speaks through your TV.

If you are operating a disk system, you will need a Y branching cable. Use the cable to connect the disk controller and the synthesizer to the cartridge port. The cable is composed of a male connector, which plugs into the Color Computer's cartridge slot, and two female connectors, for the disk controller and the synthesizer. The Y cable is also available from Colorware.

The editor/driver software comes on a single cassette. One side carries the 16K version and the other has the 32K version. On a disk system simply tape load the software and then save it to disk. The software automatically adjusts to either tape or disk.

The synthesizer can be operated by three methods: by sending a sentence to an assembly language driver; by using the supplied editor program; or by POKEing phonemes directly to the synthesizer.

If you choose the first method, load the assembly language driver into either &H2900 (16K) or &H6900 (32K). Set up the USR routine with the Define statement. Finally, send your sentence to the driver via the USR routine. Once the driver and the USR routine are set up, you can easily send as many sentences to the synthesizer as you like. The program accompanying this review is an example of this method: it reads ASCII disk files (Telewriter-64, Super Color Terminal, etc.). It's kind of like a talking book.

Using the second method, load and run the editor program. The editor is a Basic program and will automatically load via the assembly language driver. It really contains two editors, one for sentences and one for phonemes. (*Phonemes* are the basic parts of speech which make up words). You can send the word or sentence you are working with to the synthesizer from either editor, letting you hear how it sounds. The editor is easy to use, and it is fun to see and hear how phonemes make up our words.

The third method of use puts the editor to work. When you save a word or sentence to disk, the editor creates a stand-alone Basic subroutine. The subroutine POKEs phonemes directly to the synthesizer. The editor then saves the subroutine in ASCII data format, so it can later be merged into your Basic program. You don't need an assembly language driver to add voice to your programs! This saves you about 6K of memory.

At first glance, $29.95 seems expensive for a cable. However, not having the disk controller hanging off the side of your Color Computer is worth the price, let alone being able to connect two cartridges to your computer at one time. The cable is a good buy by itself.

—Bob Jack

Real Talker Example Program

```
 10 'FILE READER (TALKING BOOK)
 20 CLEAR 1000,&H68FF
 30 CLS
 40 LOADM "VOTOLD32"
 50 DEF USR0=&H6900
 60 DIR
 70 A$="THE NAME OF THE FILE TO BE READ"
 80 X=USR(A$)
 90 FOR X=1 TO 100:NEXT X
100 A$="NAME      SLASH      EXTENSION"
110 X=USR(A$)
120 LINE INPUT B$
130 IF B$="" THEN CLS:GOTO 60
140 CLS
150 OPEN "I",#1,B$
160 IF EOF(1)=-1 THEN 210
170 LINE INPUT #1,C$
180 PRINT C$
190 X=USR(C$)
200 GOTO 160
210 CLOSE
220 CLS
230 GOTO 60
```

Balloon Attack

by Tim Purvis
Computer Shack
1691 Eason
Pontiac, MI 48054
(313)673-8700
$21.95 cassette, $23.95 disk

IF YOU ARE AN avid arcade freak, joystick in hand, seeking new challenges behind every pixel, Balloon Attack is definitely not for you.

The idea of the game is to slide, by joystick or arrow key control, back and forth at the bottom of the screen while a hot air balloon drops bombs and other lethal objects down around you neck. The action is fast, but because it remains the same, could soon become boring.

On the other hand, if you are somewhat familiar with assembly language programming and interested in learning some of the programming tricks used by arcade game authors, this program can be useful. The big difference between this and other run-of-the-mill arcade games is that the author supplies the entire commented source code for the program in a very nice 24-page book, as well as a source code file on the disk. Subroutines are explained and variables defined. This program would be a good tutorial for a class in assembly language graphics. With all the controversy about pirating software and protection schemes, it is refreshing to see one author who is not paranoid and is willing to share his secrets...at least, for a price.

—Larry Cadman

The Answer

Midwest CoCo Systems
1800 West 91st Place
Kansas City, MO 64114
(816)444-6800
$179.95

MANY COLOR COMPUTER USERS, asked what they would wish for could they "wish upon a little star," would probably ask that the Color Computer be blessed with a parallel printer port, instead of an RS-232 port, so they could achieve compatibility with printers designed for use on other computers.

Additionally, telecommunicators often wish for another port to let them run a printer *on-line while* they're communicating with a BBS or a time-sharing system. At present the Color Computer doesn't allow this, since the RS-232 port is tied up with the modem, and there's no other place to plug a printer into the computer.

Though serial input/output has its advantages, a printer using the parallel output scheme of I/O runs a bit faster on each printed line, since the printer itself determines how fast the computer can send data to the printer instead of using a fixed rate of, say, 600 baud. In short, a parallel printer output speeds things up considerably over the long run, and may make available a printer that is not otherwise available in the short run. For example, a serial interface board for the Epson computer will run $25 to $150 above and beyond the cost of the standard parallel capable printer depending on the options and buffer the board has.

There are several manufacturers that market serial-to-parallel converters that plug into your RS-232 port and convert data to a parallel-compatible signal. The more efficient way though, is to provide a second port, in parallel, through the computer's data bus, so the RS-232 port is still available for use with a modem or another RS-232 device — which is what The Answer does.

The Answer plugs into your ROMpak port. It's housed in a Radio Shack disk controller ROMpak case, so the fit is secure. It provides two parallel ports and two ROMpak ports, one of which is for the disk controller. (A disk controller is not required. All software that comes with The Answer is compatible with tape input-output. But it's nice to know that if you buy a disk system at some point you can still use The Answer with it.)

Approximately 12 inches of clearance is needed on the right-hand side of your computer if The Answer is used with a disk controller. A "power on" LED and three software programs are part of The Answer. This product makes parallel printing possible with its parallel printer ports. Source listings of printer routines are part of The Answer's documentation, so customization of other programs is an option for a machine language programmer. Also, a second parallel port opens up numerous possibilities for use with control of remote devices, since they are fully documented and available for either input or output to the "real" world.

Installing The Answer is simple; you plug it in (with the power off, of course), plug in the disk controller (if one is being used), and plug in the ROMpak (if one is desired).

In operation, you activate either the disk controller (and Disk Extended Basic) or the ROMpak port when you turn the power on. Should you want to use the ROMpak port a toggle switch allows enabling or disabling of the automatic execute signal, which defeats the automatic start of ROMpaks. If the auto-execute is defeated, the ROMpak program may be started with an execute command; the most common starting address makes it EXEC &HC000.

A side benefit of this arrangement is that Disk Extended Basic may be defeated if you want to use this product with programs not compatible with a disk system. By selecting the ROMpak and not having a ROMpak installed in the slot, the Color Computer will come up in Extended Color Basic, letting you tape load some non-compatible programs.

Software included in The Answer package uses addresses above the disk ROM but below the registers used by the MC6883, so their routines may be used while the disk controller is also active.

In order to re-route the output from PRINT#−2 and LLIST statements, a short program is invoked by the command EXEC 65162 — this routine changes the address where the Basic interpreter will send the data to be printed. After it is executed, the familiar OK prompt returns, and all following PRINT#−2 or LLIST statements are automatically routed through the parallel interface to the printer.

Also included in The Answer is a monitor program, which lets data be read or written to RAM and moved around in memory, lets a machine language program load from tape or save to tape, and sets breakpoints within a machine language program. The monitor also executes other machine language routines or exits back to Basic.

A third piece of software solves the problem of printing while on-line with the modem: CoCo Term. This is a full-featured smart terminal package that supports both disk and tape input/output, as well as allowing a printer to be toggled on or off while on line with a bulletin board or another computer. Supporting communications at either 300 or 1200 baud, Coco Term has four separate buffers under user control. Downloading automatically is allowed by use of the CNTRL-R / CNTRL-T protocol supported by CompuServe and many other data services, including most of the Color Computer bulletin boards. Files may also be loaded in from disk or tape for later transmission. Coco Term also provides for inverse video (white letters on a black background) on its 51-character per line screen, though the border around the black screen remains light colored.

I found The Answer easy to use and reliable...but. Patches are provided for

making Telewriter-64 compatible with The Answer by modifying the Telewriter program. Though I know of others who have successfully patched Telewriter with The Answer, my Epson printer and Color Computer appeared not to be made for each other. I never could get a patched version to run reliably. My problems may not be related to The Answer, but to some other fluke within my system. This quirk may be a factor, though, when The Answer is used with a program that has its own printer driver routines. For example, my other word processing program, Elite Word, works fine with The Answer since it routes the printer through the Basic ROM instead of using a specially written printer routine.

The Answer has gold plated connectors for all input/output ports. I recommend some sort of support for the disk controller, as the far end of the controller ROMpak may sag a bit.

If you have a need for a parallel printer, or if telecommunications is your high priority along with the ability to print while on-line, The Answer may be just the answer.

— Wayne Day

KB-500 Keyboard

Key Tronic Corporation
Box 14687, Dept. E2
Spokane, WA 99214
(800)262-6006
$89.95

The KB-500 Keyboard at home.

IT SEEMS THAT MANY people are now using the Color Computer for serious typing. Why else would a large, well-known and respected keyboard manufacturer enter the replacement keyboard market for this "game" machine?

The KB-500 kit was pea-shooter simple to install. Key Tronic has solved the cable compatibility problem with a short cable adapter for late model (after October 1982) Color Computers with their flat plastic connectors. Installation instructions are quite complete, with diagrams of the computer case screw locations, internal connections, and support pegs. I had the case screwed together again in record time.

The keyboard's sculptured, low-profile key design makes my fast typing seem natural, not forced. Responsive non-stick key switches enable top notch efficiency; they just seem to know what I meant to type. And I'm delighted with the reassuring home row locating "pips" on the F and J keys. No longer will I look up from my work to see a screen filled with cryptograms because one hand was misplaced by a key width.

Another feature worthy of praise is the extra stiff springs in the Break and Clear keys. On cold mornings my stiff fingers have confounded me with errant strokes that fell close enough to one of these keys to wipe my efforts clean away. Now most of those fumbles are guided back from the brink by the abnormal pressure needed to fully depress these keys.

Those users who have short memories will thank Key Tronic for putting the *full* character legend on the key tops, including the left and right brackets, delete line key, scroll stopping key, and upper-/lowercase toggle key. No more experimental keystroking until you've found the right one, or thumbing through the manual when it *has* to be right the first time (as in Edit mode).

There is an extra key on the board below the Clear key, labled PF — the Programmable Function key. This key is the electrical equivalent of the F4 function key on other replacement keyboards. There is no assembly language software included with the kit to enable easy recognition of this key. However, there is an example of how to recognize it with the Basic PEEK function. Key Tronic's documentation on this key is inadequate for most first-time computer owners trying to use it effectively. They will probably seek technical guidance from a knowledgeable friend. It also leaves the assembly language programmer puzzling over how to patch into the keyboard driver in ROM to teach it what to do with this key.

The KB-500 comes with a limited 90-day warranty and a toll free number for technical assistance. I sincerely doubt the company will receive any significant number of calls for warranty work, but they may get tired of helping users debug their PF key routines.

Now that my human/machine command interface is solid and secure, my first typing pleasure will be an order for an 80 column display kit...

— J.T., **Color** *staff*

Amdisk-III

Amdek
2201 Lively Blvd.
Elk Grove Village, IL 60007
(312)364-01180
$499 retail

*WHAT'S SMALLER THAN A BREAD-*box, electrically compatible with standard 5¼-inch disk drives, and stores over 600K bytes of information? Amdek's Amdisk-III 3-inch flexible disk drive! At just under $500, this unit (see Photo 1) is a competitively-priced alternative to

☎ Enter 7 on TeleResponse page 159

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Radio Shack's 5¼-inch floppy-disk drives. The system is compatible with all disk-ready software for the Color Computer, and provides loads of convenient, reliable mass storage in a high-density package.

In the Amdisk-III, Amdek has combined two 3-inch drives, a power supply, and circuitry to allow the drives to "look like" standard 5¼-inch drives to the computer. Because the electronic signals are the same, the Amdisk-III can interface to a regular Color Computer disk controller.

Despite their physical differences, the disk rotation speed, data transfer rate, and even the data format of the Amdisk-III is the same as that of 5¼-inch drives, so software can't tell the difference. As with the larger drives, each 3-inch drive has 153K bytes of file-storage space (plus 4.5K of directory space); but, because you can store data on both sides of a disk, and because each Amdisk-III has two drives, total file capacity of the unit is 612K bytes.

In fact, only the ribbon-cable connector has been changed to protect the innocent: the unit does require a dual-row pin-type connector rather than the card-edge connector found on 5¼-inch drives. This means you must select one of the three data cables that Amdek can provide; they will allow zero, one, or two 5¼-inch drives, in addition to the Amdisk-III unit.

Set-up and Operation

Installing the Amdisk-III on your Color Computer is a straightforward task: the data cable will only connect one way. The Amdisk-III comes configured as drives 0 and 1, but if your system has one 5¼-inch drive it is a simple matter to set up the Amdisk-III as drives 1 and 2.

When using the Amdisk-III with other drives, you may find it necessary to remove the termination resistor package included in the 5¼-inch drives (although I didn't have to). Again, this is a relatively simple procedure and is described in the Amdisk-III manual.

Once the data cable is connected, it only remains to plug in the power cord, turn on the drives, and format some 3-inch disks. Because the 3-inch drives are completely software compatible, formatting is performed using DSKINI exactly as with 5¼-inch drives.

Operating the unit is simplicity itself: when you insert a disk into the Amdisk-

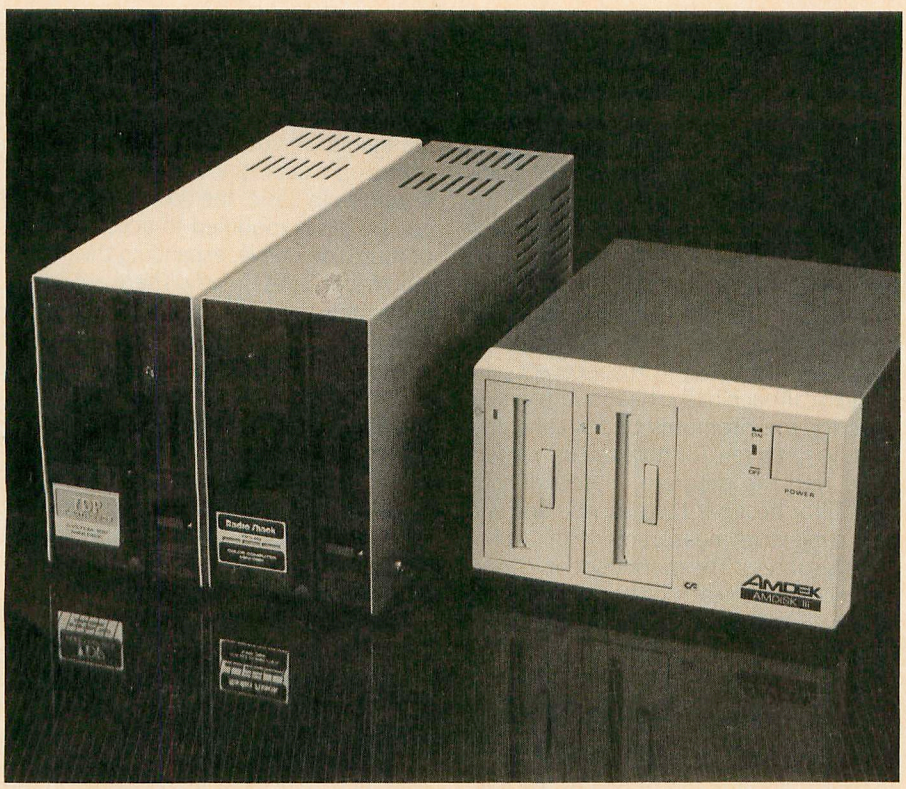

Photo 1. Amdek Drives vs. 5¼-Inch Drives

III, the eject button pops out; when you push the eject button, the disk pops out. An important point is that you can flip the disk over and so store data on both sides; but each drive is only a single-sided unit — you have to do the flipping over. The drive activity indicator is a rectangular LED that shows green when you're accessing side A, and red when you flip the disk over to access side B.

About the Disks

Although the disk itself is made of mylar, the same flexible material used in all floppy disks, it is enclosed in a hard plastic "shell," rather than a flexible vinyl envelope. *Sturdy* is the word for this arrangement. These 3-inch disks measure 3⅛ by 4 inches and are 3/16-inch thick (see Photo 2 and Figure 1). (Incidentally, they do fit into pockets easily.)

The plastic shell is tough, but flexible enough not to be brittle; you would have to squeeze pretty hard to get the shell walls to touch the surface of the disk — they should easily survive being sat or trod upon. The disk surface is protected by a shutter that closes both the access slot and the index hole when the disk is out of the drive. When you insert the disk into the drive, the shutter is activated by a slider along the edge of the shell; when the disk is removed from the drive, the shutter closes automatically.

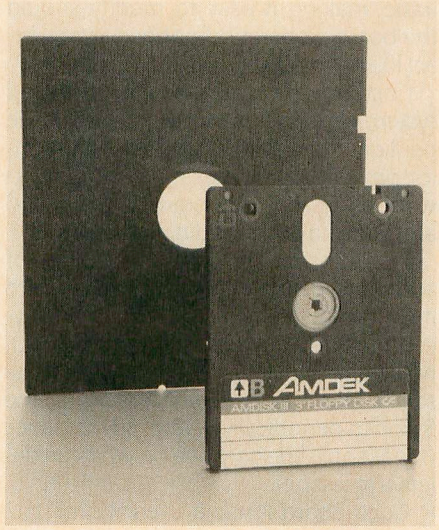

Photo 2. The Smaller Amdek Disk

Another nice feature is the hard, solid hub that mates with splines on the driving spindle. It's unlikely that this arrangement will ever wear out in the normal course of use (hub wear is an ongoing problem with common floppy disks).

The Amdisk-III uses permanently-mounted sliding tabs to write-protect each side of the disk individually. Each side has its own visual indicator that shows red if that side can be written on; to write-protect a side of the disk, simply move the tab towards the center of the disk.

Impressions

The Amdisk-III has a pleasing heft; its overall construction is stalwart and stout, but not a lot smaller than two 5¼-inch drives, although its capacity is greater, and it is less error-prone. My 3-inch disks have survived cross-country air transport in my luggage — including repeated x-ray examination at the airport and temperatures near freezing in flight — without the loss of a single byte of information.

Compatibility with other Color Computer systems, though, might be a problem (unless both systems have Amdisk-III units): if 3-inch disks are your sole means of mass storage, you won't be able to buy programs commonly available on 5¼-inch disks. Also, at $50 to $60 for a box of ten disks, you might need to revise your next budget when you run out of disks.

Still, Amdisk-III provides safe, convenient, high-density mass storage at a competitive price; and compatibility problems will disappear when 3-inch drives become popular — just think, you could be the first on your block to own 3-inch drives.

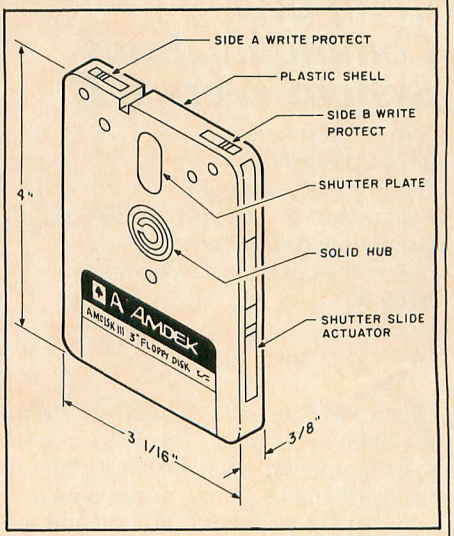

Figure 1. How The Disk Is Put Together

*—by C.P.F., **Color** Staff*

Coco Board II

Lee F. Blitch
507 Emory Circle N.E.
Atlanta, GA 30307
Headquarters system: (404)378-4410
Evenings and weekends
64K, two disk minimum
$75.00

BEE Color BBS (Vers 1.2)

Bee Color Computer and Software
2830 S.W. 219th, Aloha, OR 97006
Headquarters system: (503)629-8343
64K, two disk minimum
$134.95

The Color-80 BBS System (Vers 4.13)

Silicon Rainbow Products
1111 W. El Camino Real, Suite 109
Sunnyvale, CA 94087
Headquarters system: (408)733-6809
24 hours
64K, two disk
$150.00

The Online Color Computer Communications System (Vers 1.2)

Tom Mix Software
3424 College N.E.
Grand Rapids, MI 49505
Headquarters system: (816)358-6222
Evenings and weekends
64K, three disk suggested minimum
$180.00

LOCAL BULLETIN BOARD SYSTEMS (BBS) are popular. The BBS can be a social gathering point for local users, a handy reference library, or merely a service that lets a user look around and see what's new.

Each of the four systems reviewed in this article will let you become a *Sysop* (System Operator) on your own. Just take a 64K Color Computer with at least two disk drives, an automatic answering modem, the software of your choice, a telephone line, and away you go!

Each program was installed and operated for a time period of from one to three weeks, through the courtesy of a local Color Computer dealer, RFI Electronics of Fort Worth. This enabled us to get a "hands-on" feel for the program, and RFI Electronic's assistance is gratefully acknowledged.

One suggestion is worth mentioning. Before purchasing a bulletin board package, it would benefit prospective operators to call each of the headquarters systems for the programs under consideration to get a feel for how the user interfaces with the program. "User friendliness" is at best hard to describe and is a very subjective measurement of a program's success. The money spent in long distance calls to each of the systems can be easily justified if a Sysop cares about his users.

Coco Board II

The least expensive of the four, Coco Board II is an upgrade of one of the earliest BBS programs available for the Color Computer, Coco Board. Written by Lee F. Blitch, Coco Board II is written entirely in Basic, making it easy to modify should the board's operation not be to your exact liking.

Coco Board II is a password protected system enabling users to read and leave public and private messages, view graphics pictures (with the appropriate software such as Colorcom/E or Videotex) and access a downloading database.

The message base has a capacity of 100 messages at a time. When the 100th message has been entered, the ten lowest numbered messages are deleted, making room for another set of 10 messages. This makes it unnecessary for the Sysop to periodically delete old messages (the Sysop is the only person who can delete a message).

Coco Board II has a capacity for 102 users in the log. It deletes an old user's name and information when the log is full. The first two membership records are protected from deletion, and are normally used by the Sysop.

RTD Version 2.8, by Interface Technology, is supplied with Coco Board II as the remote terminal driver. Additionally, programs to read the tape files generated for the Sysop (containing any log-off comments from users), to create and update the system bulletin, and a message base editing program are included.

The downloading section is a straight ASCII dump of a text file. It does not support any error correction scheme such as DFT, but does permit automatic buffer marking with the Control-R / Control-T protocol. Again, since the BBS program is written in Basic, the download section can be easily modified to accept a third or fourth disk drive, expanding the download capabilities greatly. There are no facilities to support user uploading of programs to Coco Board II.

A separate Sysop command table is provided, as in the other boards, to let the Sysop control the bulletin board from a remote location as well as from the computer itself. The Sysop may decide to enable or disable lowercase, or turn the database on or off, or change users' passwords.

Installation of Coco Board II went very smoothly on our test BBS, with no major problems occurring, and the small problems could have been prevented had we read the documentation more carefully and watched what we typed (? SN Error).

Program users seemed to receive it very well, with high marks going to the use of color graphics in the low-res mode that are sprinkled through the system.

Again, I must point out that since this program is written entirely in Basic, with the exception of the lowercase transfer program that either enables or disables lowercase and the remote driver program, it is very modifiable and extremely vulnerable to customization. Though the documentation is a bit sparse, a good programmer can get inside this program for whatever fine-tuning is desired.

BEE Color BBS

Written by Dale Rickert, the BEE Color BBS is the newest of the four entries in this review, and like the others, is designed to interface with a Hayes Smartmodem 300 as the auto-answer modem. As in the case of the Coco Board II, a third or fourth disk drive can be added to the system easily with the included documentation.

The BEE BBS is a password protected system, requiring new users to make an application for a password and user number. The systems operator then can verify the data given and accept or reject the application. Users without passwords are restricted from using the download section as well as the upload facility.

The system has the normal complement of facilities, including public and

private message exchange and up- and downloading of text files and Basic programs. It does not include any color graphics in either the high or low resolution mode.

The message database on a two-drive system will hold 60 messages at a time. When number 61 is entered, it overwrites message number 1, and continues in this fashion, overwriting the oldest message. The addition of a third drive allows over 100 messages to be retained on the board at a time.

The download database operation is straightforward, with no error correction possible during transmission. The program sends a CHR$($12) prior to sending the downloaded file, and ends the file with a CHR$($14), following the Control-R / Control-T protocol. This enables the user's terminal program to mark a portion of the received text with these capture characters. It is noted, however, that the BBS program instructs the user that to be able to download he must use a terminal program such as Colorcom/E, that uses the above capture protocol. However, any terminal program that has the ability to manually capture part of the receive buffer can also be used.

The program can also capture a file sent from a user, otherwise known as *uploading*. During this operation, the BBS program sends a series of control codes known as X-On and X-Off to the user, letting him know when the computer is ready to accept more data. X-On is set by the BBS program as a Control-B ($02) and X-Off as a Control-C ($03). Since the BBS program is largely written in Basic, this could be modified to use the more conventional Control-Q ($11) and Control-S ($13) as X-On and X-Off.

After a user submits a file, the Sysop can review the file remotely or at the computer. Adding the file to the download section requires modification of the Basic program that controls the BBS to add the new file to the downloadable list.

Creating and editing text files on the board is done with a supplied text editor/formatter.

A unique capability of this BBS program is the ability to maintain a printed file of all users. Included in this package is a membership editor which lets the Sysop edit user information, print labels or envelopes, or print out a listing of the membership.

The above features, combined with the on-line merchandise catalog of the BBS, make it appropriate for the vendor who wishes to have a 24-hour order-taker available. Users may choose to browse through the catalog of merchandise available, and have the option of ordering merchandise as well.

Again, since the majority of the BBS program is written in Basic, this feature could be deleted and replaced with something that may be more appropriate to a Sysop who wishes to keep the board non-commercial.

April Definitions:
RAM — a device used by highly-skilled technical editors to fit authors' programs into specified memory. Very dangerous.

The well-written documentation made the installation and operation of this program a snap, and no major problems were encountered in running the program. Due to deadlines, this program was run on a limited basis for a short time with just a few users. Comments from the users were generally favorable, with the lack of lowercase being the major complaint. In fairness to the author of the program, the enabling of lowercase is discussed in the documentation, but involves changing the data in a control byte of the remote driver program. Since this program does not include a Sysop function to enable/disable the lowercase, I chose not to attempt modification of the control bit.

The Color-80 BBS System

As the name might imply, Color-80 is more of a system approach to a bulletin board than a single program. Written by Jeff Francis of Silicon Rainbow, Color-80 is the only BBS of the four that supports both 300 baud (standard) and 1200 baud communications.

Upgraded from the earlier versions of Color-80, this program has added an extension to Disk Extended Basic called Bulletin Board Operating System (BBOS). It is this system that adds additional functions to Disk Basic, and lets the RS-232 activity take place, adding such commands as ANSWER, DUMP, ON ERROR, HANGUP and RESUME. It also includes a software driven real-time clock.

Color-80 is also password protected, requiring the new user to make an application for a password that must be acted upon by the Sysop. In this program the password, or lack of one, does not restrict the user from any functions except reading private messages.

The message base size in the default settings on a two-drive system is set at 64 messages, older messages overwritten as new space is required. According to the author, a three-drive system can easily support 127 messages at one time.

Specific information for modifying the program to support a third or fourth drive is not included in the documentation, but the author is working on an additional instruction set for such modifications, and is available to system operators for technical assistance.

The user log easily supports approximately 200 users in the default settings, dependent on the amount of disk space available on the system disk. Again, the documentation gives examples of ways that disk space can be increased to support users in the permanent log.

Color-80 supports both the low resolution block graphics (CHR$128 – 255) normally found on Color Computer BBS systems, as well as the medium resolution graphics available when using PMODE 0 (128 × 96 pixels — two color) in Basic. These graphics can be received by any user who has either the Videotex or CompuServe Vidtex terminal programs. Included in the BBS package is a program for creating the medium resolution picture files.

The database section of Color-80 supports uploading and downloading. Uploads must be enabled manually by the Sysop before they become available to system users. The documentation for this package does not include any information on error-correction facilities nor any automatic marking of receive buffers, nor does it indicate whether the board supports any X-On/X-Off protocol.

Color-80 also has provisions for an on-line merchandise catalog, though no provisions are made for a customer to order items through the merchandise section itself. Such orders could be ac-

commodated through private mail to the Sysop.

Installation and operation of Color-80 went fairly well, considering the complexity of this program. In some cases the documentation is not clear about what options are available. In the case of the database section, documentation that should be there isn't, and the user is left to go searching through the program to find answers to his questions.

In other areas, though, the documentation shines like a beacon, giving the Sysop a list of variables used throughout the program, as well as information on the various buffers used. The documentation on the BBOS operating system is extensive and includes the set of RAM locations used. The source code for BBOS is not included.

Since Color-80 redefines the Color Computer's serial I/O port to completely use the facilities of a Hayes Smartmodem or the Radio Shack auto-answer modem, there is documentation dealing with the modified cable required for use with the BBS, and a user should have no problems getting the modem to work with the program if directions are followed.

This version of Color-80 is very user-friendly, and the comments of the users who tried the test BBS were very positive, especially since Color-80 supports lowercase as a user option (a large percentage of the test BBS users did not use a Color Computer, but rather may have accessed the test BBS on a terminal or a different computer system).

About the only negative feelings I have about Color-80 are towards the documentation. With such a fine programming effort as this, I wish the distributors had gone into the inner workings of the program a bit more. As I mentioned earlier, the author is available for technical assistance by telephone, and that helps a bit. The documentation is more than adequate to support running the BBS in the default modes.

The On-Line Color Computer Communications System

The OCCCS is written by Steve Odneal, and like his other products, includes one of the better sets of documentation for a comparable product that I've ever seen, a total 50 pages jam-packed with all you'd ever need to know about the program, short of a complete listing of the code.

Like Color-80, a password protection scheme is used in OCCCS. A password is not required for use of the system; however, without the password, a user cannot read private messages addressed to him, or delete his messages. Additionally, the use of a password/user number combination greatly speeds up the log-on procedures if the user log is greater than a few callers. A new caller is asked to assign himself a password, which can be changed by the user at any time.

OCCCS supports the standard message database entry and retrieval functions, as well as uploading and downloading text files and Basic programs. RTD3.0 by Interface Technology is included in the package and acts as the remote terminal driver for the BBS.

The message database holds 123 messages at a time. An individual user may delete only messages which were entered by him or addressed to him. The Sysop may delete any message on the board.

An interesting aspect of the message database is that an automatic formatter is used, letting the system user enter lines up to 255 characters long, instead of the

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normal 60 – 64 characters accepted by most other systems. If a line in a message exceeds 64 characters, a word-wrap feature comes into play, formatting the message for the user.

OCCCS is the only one of the four BBS programs reviewed here that really needs a third disk drive to function well. In this case, the third drive is used to contain the files for the downloading section, which can't be supported on either of the other two drives due to space limitations. The third drive, however, is completely free for containing downloads, so quite an extensive download library can be maintained on-line.

The downloading database supports the Control-R / Control-T protocol of opening and closing a user's buffer (hex 12 = open / hex 14 = close). Uploading to the system is assisted by the use of the standard X-On/X-Off characters of hex 11 and 13, respectively.

Additional Sysop commands are provided for messages deletion, displaying system errors, and accessing the user log, including the deletion of a user from the log. This could be useful if the log has many nonsense log-ins.

OCCCS also provides for listing a merchandise file for on-line shopping. Since the majority of the board is written in Basic, this feature can be deleted if not desired.

OCCCS has included provisions for working with a hardware real-time clock, which is not included in the BBS package. The addition of the hardware clock would be desirable if accurate time is required, since software clocks do not keep very accurate time over a long period of time due to the hardware limitation of the Color Computer.

Installation and operation of the OCCCS package went very well, and no problems were experienced. User comments were all quite favorable, and since lowercase is supported by the program, the "other computer users" of the test group were happy.

As mentioned before, the documentation is massive and well-prepared. About the only thing we might have wished for that wasn't included is a list of the various variables and definitions used within the BBS program itself, which would be invaluable for customization.

Summary

One of the more enjoyable tasks that I've undertaken in a long time, I found operating these four BBS systems on a local computer is quite different from being the Sysop of The Color SIG on CompuServe, where most the programming is standardized among many different special interest groups.

Along with that, though, is the possibility of creating a customized version of a BBS that would not be possible on a system such as CIS. As each of these programs is largely written in Basic, a systems operator with a good understanding of Basic and the program he's running can create a highly individualized system, or if he wishes, can run the default version of the BBS and probably be very satisfied with its operation.

Each of the four BBS systems has its advantages and disadvantages when compared to the other programs, but in something like this, where we're dealing with very highly personalized feelings, the bottom line is that each of these programs performs well, allowing Color Computer (and of course, non-Color Computer) users to communicate, effectively and efficiently. After all...communications is what these programs are all about.

— by Wayne Day, Communications Editor

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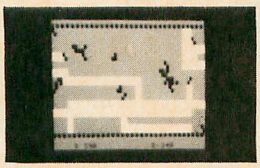

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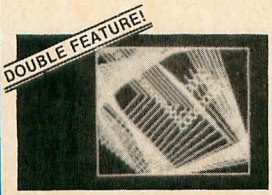

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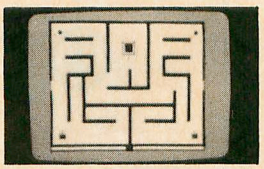

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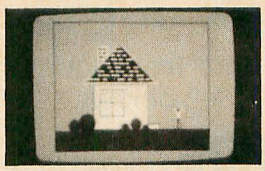

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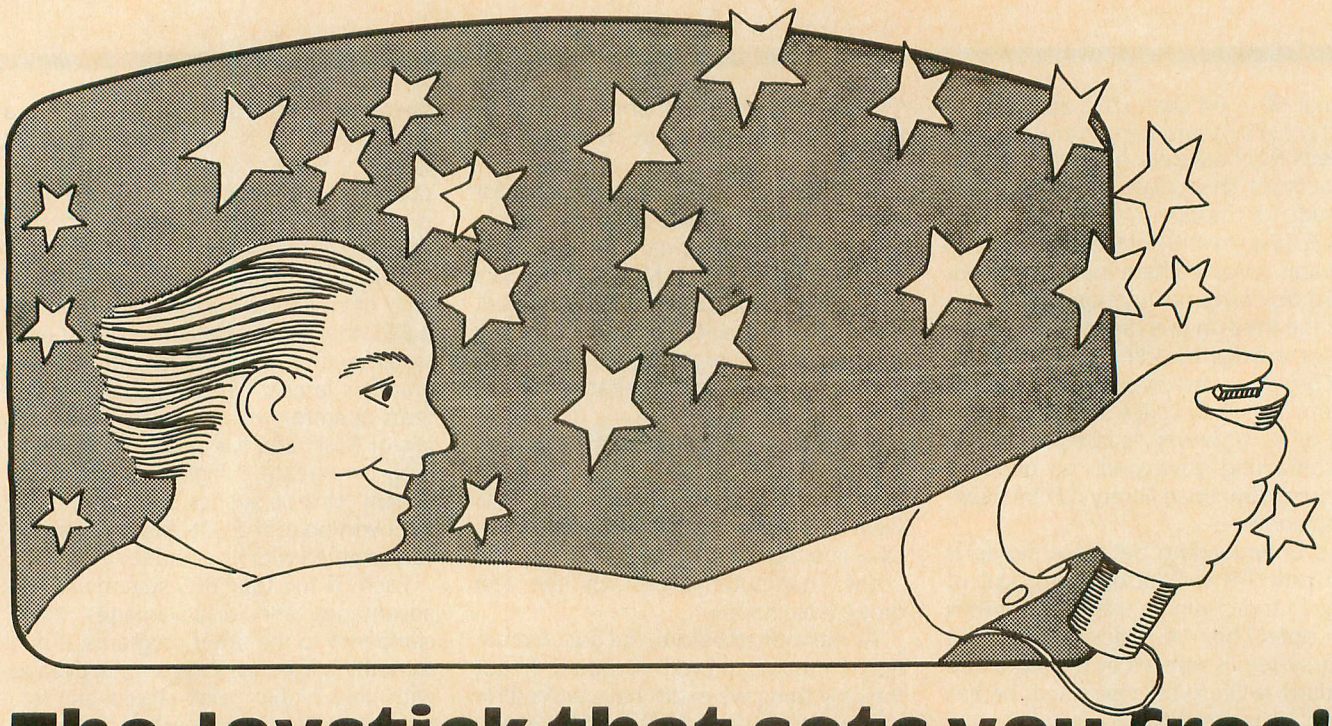

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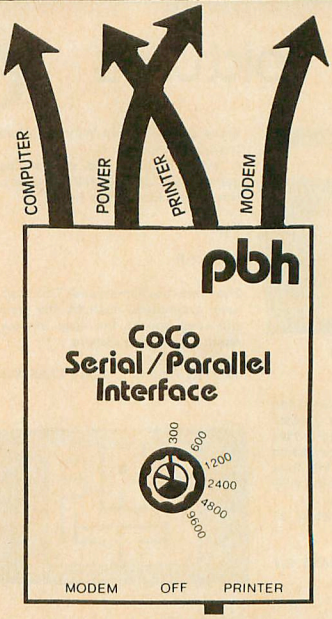

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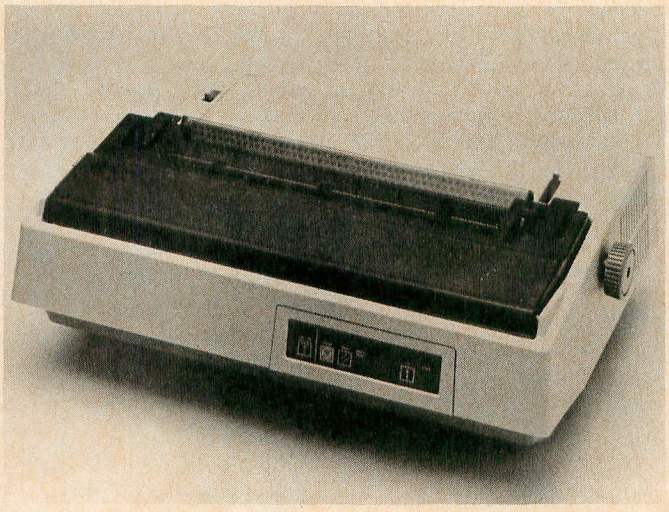

The Ricoh RP1600Q.

Ricoh Printers

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Pocket Guide to Microsoft Basic

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Margot Critchfield and Thomas Dwyer's *Pocket Guide to Microsoft Basic* is designed to literally stand by your computer for quick, easy reference. It does stand alone. It also helps users by listing complete examples of computing intricacies that can be run on your machine. It assumes readers have some programming knowledge, but not necessarily Basic knowledge. Critchfield and Dwyer, University of Pittsburgh professors, define Microsoft Basic syntax and vocabulary in line-by-line explanations and include a summary of ASCII codes. The book is paperbound, 102 pages, and costs $7.25.

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Boulder, CO 80301
(303)444-6809

Robot-1 is the prototype of a line of three robotic arms Analog Micro expects to be producing within a few months. Robot-1, a computer servo controlled Armatron arm capable of lifting four ounces, is already in production. It comes in two versions. One version is a plug-in compatible device designed for the Color Computer, controlled by either keyboard or joystick input. First you "teach" the arm what you want it to do, then tell the computer to remember how to tell it to do that, then save the instructions to tape or disk. With its own software package, power supply, six channel servo controller, TV camera and cables this first version, Robot-1C, costs $395. Version number two, the Robot-1S, uses an SS-50 bus. Different interface electronics will let users upgrade applications to multi-robot systems with the same software Robot-1C uses. The 1S uses a 16-address, 30-pin input-output connector to control a six-axis servo controller and power supply interface card. Up to eight arms are to be used interactively and simultaneously. Movement sequences are to be saved and source code will be provided to enhance experimentation. (Third party software is actively solicited by Analog Micro.) A modified MicronEye digital television camera is part of each Robot-1 package. The Robot-2 and Robot-3 arms, which Analog Micro says are slated for production, will use the same operating techniques, but instead of being used for entertainment, education, and research, they are intended for circuit board production, chassis assembly, painting, and the handling of dangerous substances. All system components are modular for infinite configuration possibilities. Also slated for production are programs to allow biofeedback control of the arms and a mobile base.

Voice Pak

Spectrum Projects
93-15 86th Drive
Woodhaven, NY 11421
(212)441-2807

The Voice Pak is a phoneme based voice system that uses the Votrax SC01 synthesizer chip in a cartridge. It provides an unlimited vocabulary with automatic or user supplied inflection, a variable voice level adjustment, and four programmable levels of pitch. With a single line of code. The Voice Pak adds speech to any Basic program in minutes. The system comes with a user instruction manual, demo programs, text to speech scanner and a word manager that constructs custom user dictionaries. It costs $69.95

Morse Code Tutor

Cynwyn
4791 Broadway, Suite 2F
New York, NY 10034
(212)567-8493

Morse Code Tutor helps operators increase their transmission and recognition speed. It's a follow up to Cynwyn's Morse Code Teacher program and designed for users, already familiar with the Code, who are shooting for 27 words per minute. The Tutor generates and sends random characters in code from user-determined groups of letters only, letters and numbers, or letters, numbers, and punctuation. Sending speeds and copying session lengths are also user determined. Characters sent are displayed on the screen after each session. The Tutor costs $15.

THE Color Computer MAGAZINE

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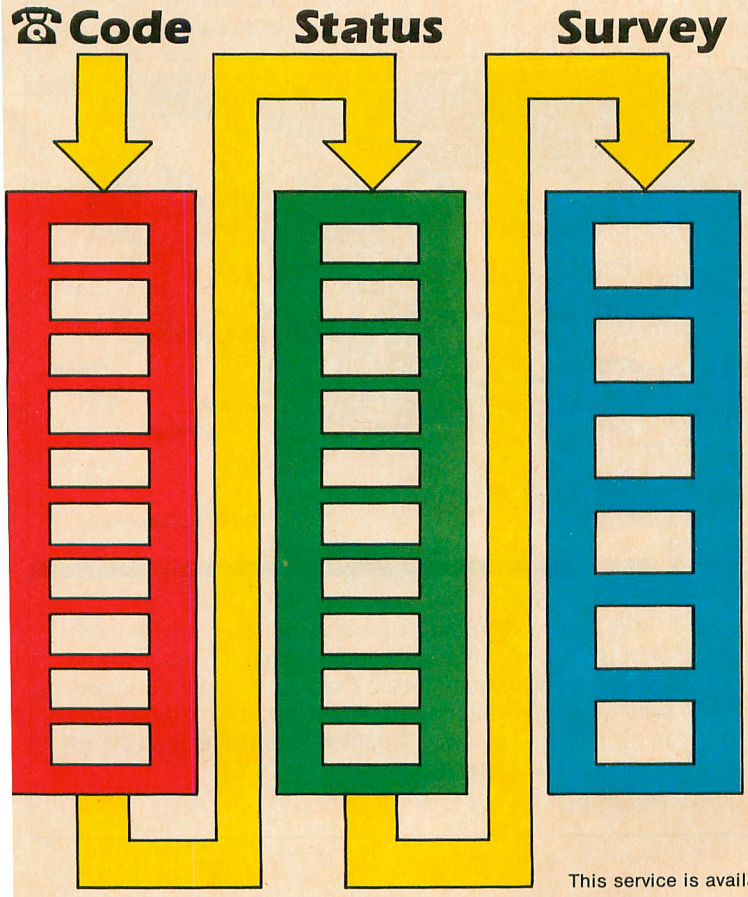
This is Issue #10-04



Reader Survey

A. What is your present system's memory capacity?
   1. 64K 2. 32K 3. 16K 4. 4K

B. Is your system configured for: 1. Color Basic
   2. Extended Color Basic 3. OS/9 4. Basic 09?

C. Do you own: 1. Disk drives 2. Printer
   3. Modem 4. Joysticks 5. Multi-pak interface
   6. Plotter 7. Light pen?

D. What do you plan to buy during the next six months?
   1. More memory 2. Upgraded ROM 3. Printer
   4. Modem 5. Disk drives 6. Multi-pak interface

E. What do you use your computer for?
   1. Adult learning tool 2. Child's learning tool
   3. Small business or home management
   4. Games 5. Programming

F. In reading **The Color Computer Magazine,** what are your major editorial interests?
   1. Educational programs
   2. Home management and small business applications
   3. Hardware projects 4. Games
   5. Telecommunications 6. Peripheral information

This service is available in the continental U.S. only. Readers in other areas may call 207-596-0501.

END OF FILE

I am a survivor of the Ma Bell break-up. Goodness knows I didn't expect to be. Don't misunderstand my situation — I am not an AT&T stockholder (rats). My only connections to the company are the phones in my house and office and my revulsion at the size of the check I write AT&T every month.

"Who do we know in Nome, Alaska?" I ask my wife accusingly. "No one," she answers, "you called the Nome General store looking for a Cabbage Patch™ doll before Christmas, remember?" "Oh." I was trying to get one for Otis, my dog. "When Otis grows up he's supposed to guard the farm animals," I say softly enough so my wife won't hear me and laugh, "I'll deduct that one." I file the bill under Farm Expenses in my tax preparation filing cabinet.

Still, I was fearful of the break-up. Every magazine I read had feature articles with titles something like, "AT&T Divestiture: What It Means to You." Every TV news program, from David Hartman to Ted Koppel, staged countless interviews on the theme, "AT&T Divestiture: What It Means to You." Every radio talk show held discussions on the topic, "AT&T Divestiture: What It Means to You." *The Wall Street Journal* published countless features: one introducing the CEO's of the newly about-to-form little Bells; another on phone rate impact, rural vs urban; the new long-distance phone companies and how they differ from the Ma Bell we've grown to resent; whether individuals and companies should now buy or continue to rent their phones.

I was surprised to not see a weeping Ma Bell on the cover of *People* magazine as she sends her little Bells off into the mean, cruel world. "It's a jungle out there, be careful." Poor babies.

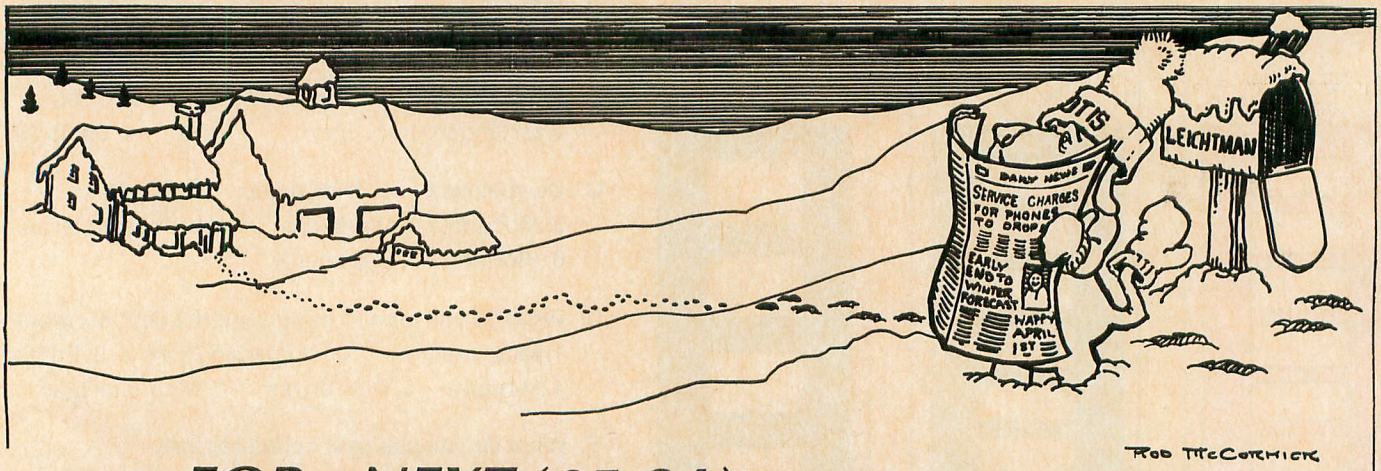
I tried to read and listen to some of the divestiture press. I tried real hard. I live in a small town in Maine: my phone bill will go up because of my rural situation. I've read enough. I've heard enough. Even though the phone company does not deliver a phone book covering all listings in the nation, they are going to charge me 75 cents to ask Information for a number in Nome, Alaska, and then charge me a great deal more to use that information. I'll be forced to buy some entrepreneur's *National Phone Book* and then subscribe to weekly supplements to keep the mammoth reference up-to-date. Or I'll have to pay the phone company *and* a computer database to access a universal collection of phone listings. A few dollars of phone charges and a few dollars of database charges later, my computer's voice box will tell me in a nasal voice that, "There is no listing for a Barry Leichtman L–I–E–G–T–M–A–N in Nome, Alaska. Have a nice day." The database, no doubt, will have a subroutine in its main program programmed to ignore your spelling of the requested name in favor of something vaguely similar. Or maybe, after typing in my brother's name, it will prompt IS THAT G LIKE IN GRATUITOUS OR C LIKE IN CIRCUMSTANTIAL?

Enough. I don't need reams of paper and hours of radio and TV to tell me what divestiture will mean to me. It will cost me...dearly.

What is strangest about all the attention AT&T *divestiture* is receiving is that hardly any energy is expended indignantly explaining that AT&T's brave new world was brought about because of antitrust suits filed against it by the US government. They were caught with both hands in a solitary cookie jar.

That's what is strangest; what is most ironic is that antitrust laws are, to a large degree, supposed to protect consumers from being charged more than a particular service (or product) is worth. So the government comes in and says, "Hold it, you're not allowing other companies to compete with you. That's not good for the consumer." If you follow the logic you're a step or two ahead of me.

— K.L., Editor-in-Chief
With Divested Interest

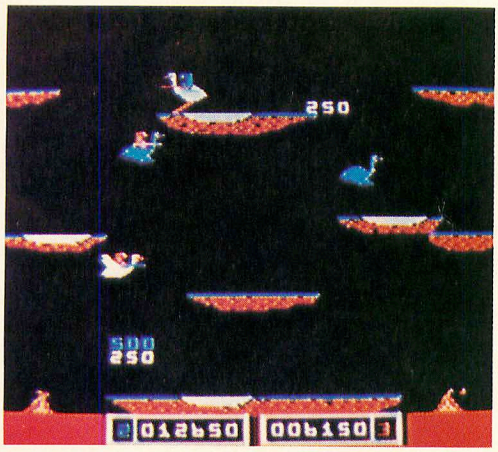


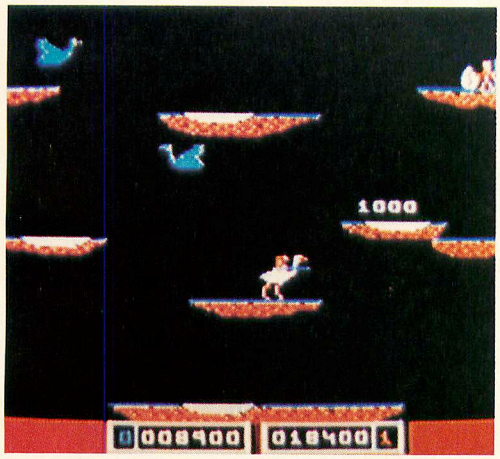
ROD McCORMICK

FOR...NEXT (05,84)

Foreign languages are always hard to learn, even when it's just a computer language you're unfamiliar with. We'll take a look at several languages available for the Color Computer, and also present an overview of languages in general — why *are* there different computer languages, anyway? We'll also review some language compilers.

Bob Jack has written a German tutor program for those of you needing help with your human languages; and with the conclusion of Kitsz's Color Burner, we'll also present Clements' alternate EPROM burner method. And that's not all — you won't want to miss all the good things planned for our May issue!





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