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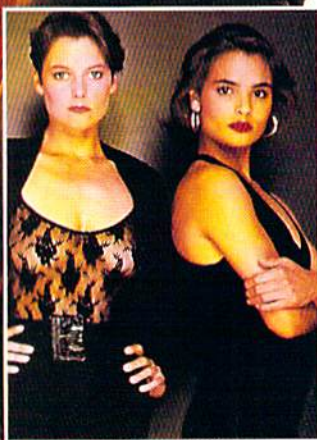
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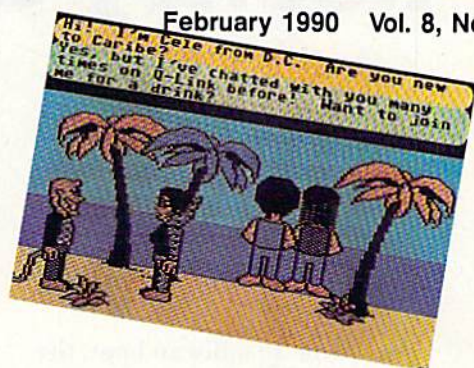
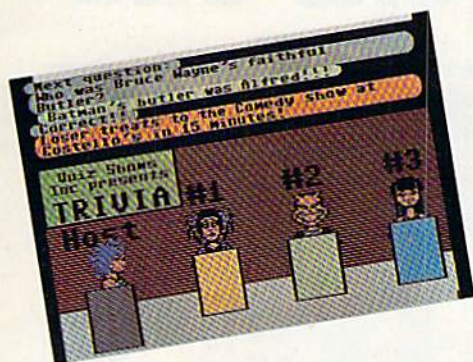
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GAZETTE

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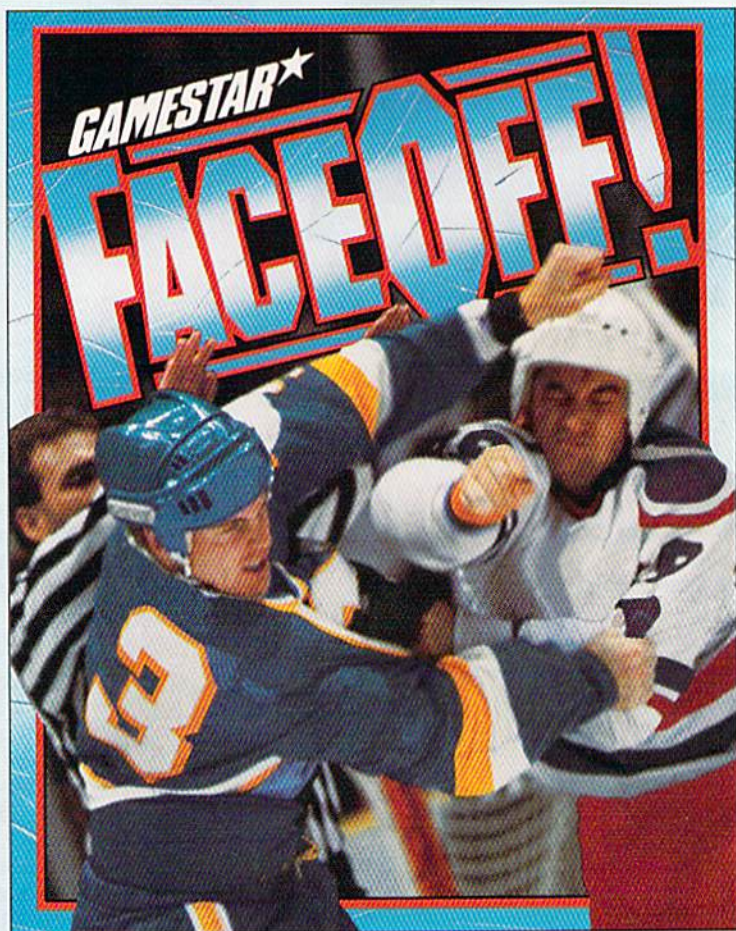
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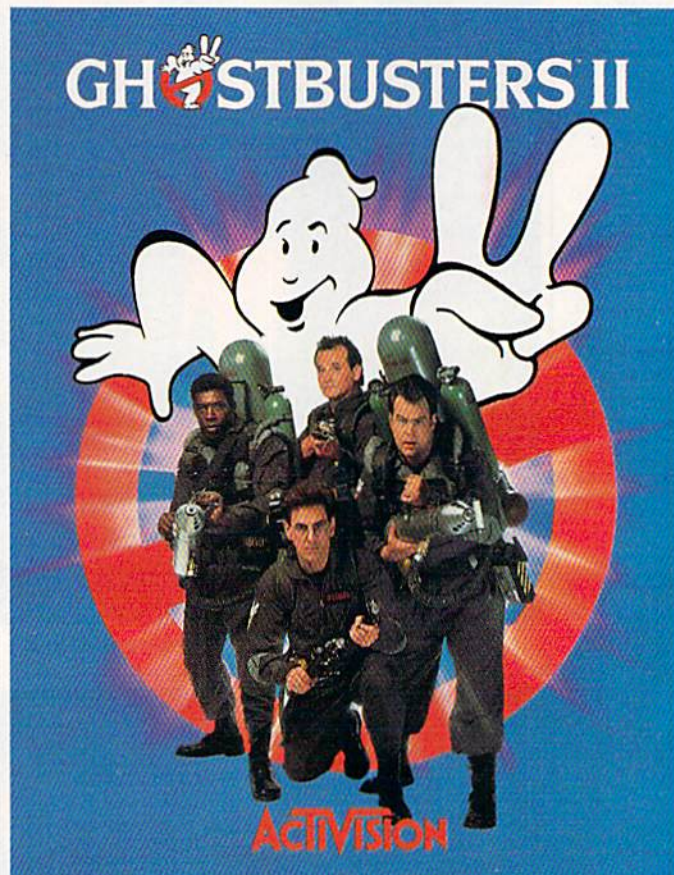
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EDITOR'S notes

We've just returned from Las Vegas, where we spent several days at Fall COMDEX (COMputer Dealers EXposition). This trade show has grown tremendously since its start more than ten years ago—there were an estimated 115,000 attendees at this year's gathering. Nearly everyone in the hardware industry was there: IBM, Compaq, Sony, NEC, Toshiba, Hewlett-Packard, Panasonic, you name 'em. Commodore was there, touting its Amiga line. The show directory was as thick as a phone book. The number of exhibitors was so large that nine remote locations (hotels and sports complexes) were used to house the booths that wouldn't fit in the Las Vegas Convention Center. In fact, the COMPUTE! booth was grouped with 150 or so others in a baseball-stadium complex five miles from the convention center.

As you probably suspect, the focus of COMDEX is not on the 64 and 128. In my wanderings, I heard not one mention of either machine. If you're interested in mainframes, MS-DOS machines and compatibles, UNIX, desktop publishing, Macs, scanners, laser printers, LANs, workstations, high-resolution monitors, and so on, this is the place to be. New products are announced so fast that it makes your head spin.

As computer technology evolves faster than you can say *gigabyte*, you have to force yourself to stop, get your balance, and try to make sense of what's happening. Ziff Davis's venerable *PC Magazine* is turning away from coverage of PC XT's and even the faster AT's (or 286's). Last May, *PC Magazine* noted that it has been heralding the demise of the 80286 since early 1988. The newer 386 and 486 technology will be touted. *PC Magazine's* claim that the AT (286) machine is *passé* technology is, in terms of state-of-the-art personal computing, true, of course.

To put things in perspective for the Commodore 64 and 128 user, consider this. The 64 has a clock speed of 1 MHz, and the 128 (in Fast mode) can run at 2 MHz. AT-class computers have a clock-speed range of 10–20 MHz. And *PC Magazine* is reportedly considering the AT to be a dinosaur. There's much more than clock speed to compare. We

could contrast the differences between AT's and 64's or 128's in display resolutions, expandability, and so on. But the speed differences are enough to make the point here.

If AT's are being regarded as dinosaurs, what does that make 64's and 128's? Answer: That's the wrong question to ask. If you drive a Ferrari and travel in 55-mph speed zones, what's the point of owning it? Of course, the performance of 386-, 486-, or even 68000-based machines is a boon to computing technology. They're great machines—if you need that much computing power. But, if your 64 or 128 serves you well, if you're happy with your software, and if you're productive with your machine, that's all you need. Don't be lured by power you can't use.

We hear time and again from readers who use powerful PCs or full-blown Macs at work and are delighted to come home to their humble Commodore 8-bit machines. If you're a veteran Commodore user, you've invested a lot in hardware and software . . . not to mention time.

Trade shows like COMDEX are overwhelming. Here, the temptation for bigger, faster, and more powerful is reinforced by the minute. But reality beckons. You don't need a Ferrari when you drive 55.

Lance Elko
Associate Publisher/Editorial

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feedback

Do you have a question or a problem? Have you discovered something that could help other Commodore users? We want to hear from you. Write to Gazette Feedback, COMPUTE's Gazette, P.O. Box 5406, Greensboro, North Carolina 27403. We regret that, due to the volume of mail received, we cannot respond individually to programming questions.

Inference Engine

I'm attempting to write a simple artificial-intelligence program on my 64 and have gotten as far as teaching the computer a few facts and having it answer some questions. For example, it will do the following (my input is in uppercase, the computer's response is in lowercase):

```
A BEAR IS A MAMMAL
understood
WHAT IS A BEAR
mammal
A MAMMAL IS AN ANIMAL
understood
WHAT IS A BEAR
mammal
```

To the last question, the computer should respond, *mammal* and *animal*, but I can't get it to do that. I've enclosed my program. Any ideas or suggestions?

Ron Poulton
Langley, B.C., Canada

You're using the right approach, but you don't take it far enough. You display all the information directly linked to a noun, but you fail to account for the indirect links. The example program below shows how this can be done.

```
SX 100 PRINT "{CLR}{DOWN}INFERENCE ENGINE"
SA 110 PRINT "{DOWN}ENTER FACTS IN THIS FORM:"
HB 120 PRINT "{5 SPACES}A BEAR {SPACE}IS A MAMMAL"
XX 130 PRINT "{DOWN}QUESTIONS LIKE THIS:"
FE 140 PRINT "{5 SPACES}WHAT IS A BEAR"
RC 150 PRINT "{DOWN}ENTER BYE TO EXIT"
MG 160 DIM B$(100),FA(100,20),FL(100),STK(100)
RM 170 NA=4:FOR L=1 TO NA:READ ART$(L):NEXT DATA A,AN,IS,WHAT
XK 180 PRINT:INPUTA$:FOR L=1 TO H:T$(L)="":NEXT:H=1
XE 190 REM PARSE THE LIST
```

```
XP 200 FOR L=1 TO LEN(A$):J$=MID$(A$,L,1)
SH 210 REM LOOK FOR SPACES
JK 220 IF J$=" " THEN H=H+1:GOTO240
MM 230 T$(H)=T$(H)+J$
AD 240 NEXT:IF T$(1)="EXIT" OR T$(1)="QUIT" OR T$(1)="BYE" THEN PRINT "{CLR}":END
SM 250 NN=1
ES 260 FOR I=1 TO H:F=0
SD 270 FOR L=1 TO NA
AB 280 IF ART$(L)=T$(I) THEN F=1
JM 290 NEXT L
MR 300 IF F=0 THEN W$(NN)=T$(I):NN=NN+1
PK 310 NEXT I
JE 320 IF T$(1)="WHAT" THEN440
BK 330 IF NN<3 THEN PRINT"MUST HAVE TWO NOUNS":GOTO180
RH 340 REM BUILD FACT TABLE
AG 350 N=1:GOSUB570:I1=I
JR 360 N=2:GOSUB570:I2=I:J=0
FQ 370 IF FA(I1,J)=0 THEN FA(I1,J)=I2:GOTO410
CQ 380 IF FA(I1,J)=I2 THEN PRINT"ALREADY KNOW THAT":GOTO180
AR 390 J=J+1:IF J>20 THEN PRINT"FA ARRAY FULL, ERROR"
RS 400 GOTO370
AJ 410 PRINT"UNDERSTOOD"
MX 420 GOTO180
GB 430 REM RESPOND TO QUESTION
FP 440 IF NN>2 THEN PRINT"USE {SPACE}ONE NOUN IN QUESTIONS":GOTO180
XJ 450 N=1:GOSUB570:I1=I
JF 460 REM CLEAR STACK
BX 470 FOR I=1 TO 100:STK(I)=-1:FL(I)=-1:NEXT:SP=0
HX 480 REM DISPLAY FACTS
JM 490 J=0:K=1:IF FA(K,J)=0 THEN PRINT"NO KNOWLEDGE {SPACE}ABOUT "W$(1):GOTO180
EH 500 FL(K)=1:IF FA(K,J)=-1 THEN HEN540
FR 510 T=FA(K,J)
FS 520 IF FL(T)=-1 THEN FL(T)=1:PRINT "{2 SPACES}"B$(T):;SP=SP+1:STK(SP)=T
RB 530 J=J+1:IF J<=20 THEN500
AA 540 IF SP>0 THEN K=STK(SP):SP=SP-1:J=0:GOTO500
CQ 550 REM STACK IS EMPTY, SO {SPACE}WE ARE DONE
RA 560 GOTO180:REM GO FOR MORE INPUT
BX 570 A$=W$(N):I=1
DX 580 IF B$(I)="" THEN B$(I)=A$:RETURN
XA 590 IF B$(I)=A$ THEN RETURN
EB 600 I=I+1:IF I>100 THEN PRINT"B$ ARRAY FULL, ERROR":RETURN
RR 610 GOTO580
```

The program begins with no "knowledge"; it "learns" through the facts that you enter. Before you ask it any questions, you must enter a few facts. If, for example, you ask a question about a horse before entering any facts about horses, the program prints the message NO KNOWLEDGE ABOUT HORSE. You can enter complex facts by entering hyphens between each word (for example, A mammal is warm-blooded). Also, there is no provision for deleting or saving facts to disk.

The program stores facts (nouns) in B\$() and the fact links in the two-dimensional array FA. Each time you ask a question, the program displays each related piece of information and then pushes it onto a stack (STK array). When the program can't find any more references to the item you asked about, it takes a related item from the stack and continues searching. All the information has been displayed when the stack is empty.

To better understand how the program works, let's look at an example. Run the program and type in the statements below.

```
A CAT IS A MAMMAL
A CAT IS A FELINE
A MAMMAL IS AN ANIMAL
AN ANIMAL IS NOT-A-PLANT
A FELINE IS WARM-BLOODED
```

As each statement is entered, the facts are stored in B\$() and the relationships between the facts (fact links) are stored in FA().

When you enter the question, WHAT IS A CAT?, the program searches the array B\$() for the noun, CAT. When it finds CAT, it follows the link from CAT to MAMMAL and prints MAMMAL. It then pushes MAMMAL onto the stack and searches for CAT again. (The program actually stores the fact links—not the facts—on the stack. To simplify the discussion, we'll say that the facts are stored on the stack.) It finds CAT for a second time, follows the link to FELINE, and prints FELINE.

FELINE is pushed onto the stack, and the program searches for CAT once more. This time it doesn't find CAT, so it pulls FELINE from the top of the stack and searches for that. It finds FELINE and follows the link to WARM-BLOODED. Next, it prints WARM-BLOODED on the screen, pushes it onto the stack, and searches for FELINE again. There aren't any more references to FELINE, so it pulls WARM-BLOODED from the stack and searches for that. It can't find WARM-

BLOODED either, so it pulls MAMMAL from the stack, searches for it, and finds it.

The program then follows the link from MAMMAL to ANIMAL, prints ANIMAL on the screen, and pushes it onto the stack. Next, it searches for MAMMAL again. Failing to find it, the program pulls ANIMAL off of the stack and searches for that. Finding ANIMAL, it follows the link to NOT-A-PLANT, prints it, and then pushes NOT-A-PLANT onto the stack. Now, the program searches for ANIMAL again. It doesn't find it, so it pulls NOT-A-PLANT from the stack, searches for it, and doesn't find it, either.

The program tries to pull another fact from the stack, but the stack is empty, so the search is complete. Here's what the output looks like:

MAMMAL FELINE WARM-BLOODED
ANIMAL NOT-A-PLANT

Bicycle-Log Program

I'm looking for a 64 program that will log the number of miles I ride my bicycle. I am in a weight-loss program and believe that keeping a record would help me stick with it. Thanks.

Rick Duguay
Athal, MA

Here's a simple program designed to keep track of as many as 100 bicycle trips.

```
AF 10 POKE53281,0:POKE53280,11
PM 20 MX=100:DIM DT$(MX),MI(MX)
,H$(MX),M$(MX),SS(MX),C
M$(MX),SP(MX):HR=0:RN=0
BM 30 PRINT"{CLR}{8} BIKE LOG"
KJ 40 PRINT
BF 50 PRINT"{2 SPACES}DATE
{2 SPACES}-MILES-
{2 SPACES}TIME{2 SPACES}
-SPD - COMMENTS"
FM 60 SP$="":L$="{LEFT}":R$="
{RIGHT}":D$="{DOWN}"
RB 70 FOR I=1 TO 6:SP$=SP$+SP$:
L$=L$+L$:R$=R$+R$:D$=D$+
D$:NEXT
CX 80 C2$="*****+*****+*****
*****+*****+*****":PR
INTC2$
AQ 90 T=0:M2=M1+9:IF M2>HR THE
N M2=HR
DK 100 FOR I=M1 TO M2
JD 110 PRINT"{8 SPACES}-
{5 SPACES}-{8 SPACES}-
{4 SPACES}-{UP}"
CF 120 T=T+1:IF T=6 THEN T=0:P
RINTC2$:I=I-1:GOTO240
EA 130 T$=DT$(I):L=8:P=0:IF T$
=" THEN240
PJ 140 GOSUB670:T$=STR$(MI(I))
:P=9:L=5:GOSUB670
XA 150 T$="":IF H$(I)=0 THEN17
0
CD 160 T$=STR$(H$(I))+ "H"
SJ 170 IF M$(I)>=1 THEN T$=T$+
STR$(M$(I))+ "M"
SQ 180 IF H$(I)>0 THEN210
ES 190 IF SS(I)<10 THEN T$=T$+
" "
RG 200 T$=T$+STR$(SS(I))+ "S"
SC 210 P=15:L=8:GOSUB670
AH 220 T$=STR$(SP(I)):P=24:L=4
:GOSUB670
```

```
KR 230 T$=CMS(I):P=29:L=10:GOS
UB670
GQ 240 PRINT:NEXT
FF 250 PRINT"{2 DOWN}NEXT
{6 SPACES}F1"
PB 260 PRINT"PREVIOUS
{2 SPACES}F3{3 SPACES}E
XIT{2 SPACES}F4"
KB 270 PRINT"UPDATE{4 SPACES}F
5"
GE 280 PRINT"LOAD{6 SPACES}F7
{3 SPACES}SAVE
{2 SPACES}F8"
ES 290 IF RN>MX-3 THEN PRINT"
{DOWN}WARNING, ARRAYS A
LMOST FULL"
HB 300 GETA$:IF A$="" THEN300
HQ 310 A=ASC(A$):IF A<133 OR A
>140 THEN300
KH 320 ON A-132 GOSUB610,630,4
80,340,30,650,30,410
XJ 330 GOTO30
PM 340 P$="LOAD FILENAME":GOSU
B660:F$=T$
GD 350 IF T$="" THEN RETURN
RQ 360 OPEN2,8,2,F$
HC 370 INPUT#2,R$:HR=VAL(R$):R
N=HR+1
HB 380 FOR I=0 TO HR
JX 390 INPUT#2,DT$(I),MI(I),H$
(I),M$(I),SS(I),SP(I),C
M$(I)
SC 400 NEXT:CLOSE2:RETURN
XM 410 IF F$<>"" THEN PRINT"CU
RRENT FILE:";F$
KG 420 P$="SAVE FILENAME":GOSU
B660:IF T$="" THEN F$="
":RETURN
HR 430 F$=T$:OPEN1,8,1,F$:PRIN
T#1,HR
MF 440 FOR I=0 TO HR
HX 450 PRINT#1,DT$(I),"",MI(I)
AQ 460 PRINT#1,H$(I),"",M$(I),"
",SS(I),"",SP(I),"",CHR$(
34) CMS(I) CHR$(34)
CQ 470 NEXT:CLOSE1:PRINT"SAVE
{SPACE}COMPLETE":RETURN
PJ 480 PRINT"{CLR}ENTER NEW IN
FO (BLANK DATE TO CANCE
L)"
FC 490 P$="DATE (10/12/89)":GO
SUB660:IF T$="" THEN RE
TURN
XB 500 DT$(RN)=T$
MB 510 P$="MILES (IE.: 10.5)":
GOSUB660:IF T=0 THEN510
RQ 520 MI(RN)=T
SE 530 PRINT"ENTER TIME (IN 3
{SPACE}PARTS)"
CX 540 P$="{6 SPACES}HOURS":GO
SUB660:H$(RN)=T
RB 550 P$="{6 SPACES}MINUTES":
GOSUB660:M$(RN)=T
PB 560 P$="{6 SPACES}SECONDS":
GOSUB660:SS(RN)=T
HQ 570 SP(RN)=MI(RN)/(H$(RN)+M
$(RN)/60+SS(RN)/3600)
MM 580 P$="COMMENTS":GOSUB660
:CMS(RN)=LEFT$(T$,10)
SB 590 P$="IS THIS CORRECT (Y/
N)":GOSUB660:IF T$<>"Y"
THEN490
DJ 600 RN=RN+1:HR=RN-1:RETURN
BS 610 M1=M1+10:IF M1>HR THEN
{SPACE}M1=HR-10:IF M1<0
THEN M1=0
XR 620 RETURN
EH 630 M1=M1-10:IF M1<0 THEN M
1=0
HS 640 RETURN
JQ 650 PRINT"{CLR}":END
AG 660 T$="":PRINTP$;:INPUT T$
:T=VAL(T$):RETURN
```

```
FP 670 IF P>0 THEN PRINTLEFT$(
R$,P);
JG 680 IF LEFT$(T$,1)=" " THEN
T$=RIGHT$(T$,LEN(T$)-1)
QA 690 PRINTLEFT$(T$,L){UP}":
RETURN
```

To enter data for a trip, press f5. You'll be prompted for the date of the trip, the distance you rode, the time required, and a brief comment. When you've entered this information, the program displays the average speed for the trip.

Continue this process until you've logged each trip. If there are more than ten entries, use f1 (show next ten entries) and f3 (show previous ten) to move through the data display. When you've entered the data for all your trips, press f8 to save the data to disk; to load a data file, press f7.

Notice that the program doesn't allow you to insert, delete, edit, or print the data. Adding these features would be a good project for budding programmers.

Missing Color?

I'm a beginning BASIC programmer with a Commodore 128D. I found that I can use only one color at a time in graphics mode 1 and 2, and no more than three colors at once in graphics mode 3 and 4. I thought that modes 1 and 2 offered two color choices and that modes 3 and 4 offered four. Could you please show me how to get these extra colors? Is there something wrong with my computer?

Arif Mohamed Salem
Abu Dhabi, United Arab Emirates

There is nothing wrong with your computer; you didn't include the background color in your count. In graphics mode 1, standard hi res, and in graphics mode 2, split-screen standard hi res, you control two color sources, the foreground color and the background color. In graphics mode 3, multicolor hi res, and in graphics mode 4, split-screen multicolor hi res, you control four color sources, the foreground color, multicolor 1, multicolor 2, and the background color.

To display a pixel in the background color, specify color source 0 when you plot it. The background color is the same throughout the entire bitmap; the other colors can vary for each pixel. The following two-liner illustrates this concept for graphics mode 1:

```
10 COLOR 0,5:GRAPHIC 1,1
20 COLOR 1,1:DRAW 1,0,0 TO 319,199
```

The first command in line 10 sets the background color register to purple. The second command clears the hi-res screen to the color specified in the background color register. Line 20 sets the foreground color register to black and then draws a line in this color.

LETTERS to the editor

Send questions or comments to *Letters to the Editor*, COMPUTE!'s Gazette, P.O. Box 5406, Greensboro, North Carolina 27403. We reserve the right to edit letters for clarity and length.

Why Change?

My secretary has an \$800 PC compatible, a \$400 monitor, and a \$400 printer. After she learned to use the system, she was bragging about what it did. She was shocked to learn that my inexpensive 64 system did the same thing. I familiarized her with my 64 and got her started on a database for my accounts/sales. She admitted that working with the 64 was easier than with her more expensive computer.

The point I'd like to make is this: Why switch to another system unless there's really a need to? Let's stop worrying about what's going to happen to Commodore. Let's take advantage of the existing machines and really utilize them. Let the quitters "upgrade" to a "better" system and pay heavily for it.

Dave Rich
Santa Maria, CA

Save \$ with Mail Order

In "Cartridge Power" (November 1989), you state that you can purchase The Final Cartridge III for \$69.95. Tenex Computer Express (P.O. Box 6578, South Bend, Indiana 46660-6578) sells it for only \$49.95. I recently purchased it from them. Buyers should request information first.

Andy Orthmann
La Center, WA

When we publish prices for products in features or reviews, we always list the suggested retail price. We're very much aware that users can nearly always get a product for less through mail-order houses. Also, we noticed in a recent issue that one of our advertisers, Briwall, was selling The Final Cartridge III for \$49.

Color Quest

Didn't Commodore make a color printer and a color plotter? If so, are they still available?

Robert McLain
Irwin, PA

Commodore announced a \$200 plotter at the 1983 Winter Consumer Electronics

Show (see last month's feature "'80s Ups & Downs"). When the plotter finally became available, Gazette reviewed it in the August 1984 issue. Dubbed the 1520 Printer/Plotter, it hit the market with a suggested retail price of \$125, and it featured four special ballpoint, colored pens. The product never sold very well and has not been available for several years. We have heard of the MPS-1500C, a fairly new Commodore color printer which is available only in Europe. Two color printers currently available for the 64 are Okidata's Okimate-20 (which requires the optional 64 Plug 'N' Print Kit) and Star Micronics' NX-1000C Rainbow, which is a Commodore-ready printer.

Vehicle Tracks

I have four vehicles, and I've been searching for a program I can use to keep track of all my scheduled maintenance, plus all repairs and general costs of running the vehicles. None of the local software stores know of any commercial program that does this. Do you?

John T. Mahoney
Lincoln Park, NJ

No, we don't. But we suggest that you try using a spreadsheet or database to log in, organize, and store your information. A database will allow you to search for dates, names, and so on; and a spreadsheet will allow you to plug in formulas when you need to calculate costs. The beauty of using these applications is that you can set them up any way you like, tailoring them to suit the needs of your situation.

Modem Maneuvers

I just purchased a 1670 modem for my 64. It seems to me that the only thing I can do with it is to go online with QuantumLink. What else can I use my modem for?

Shon Ward
Oxon Hill, MD

You can use your modem in a couple of new ways: telecommunicate with a friend who has a modem, and call up bulletin boards to chat, browse, and upload and download programs. Also, there are a few commercial games, such as Electronic Arts' new Modem Wars, that are designed for play by modem.

QLink is an excellent online service, especially for Commodore users, but there are a number of other good ones as well

(CompuServe, GENie, and People/Link, for example) that you can check out. We publish some user group bulletin board numbers in our monthly "User Group Update" column, but the best comprehensive resource we have for user group bulletin boards is in our "Guide to Commodore User Groups," which appears annually in the May and June issues.

Miffed by GIF

Are there any GIF picture-viewer programs around for the 128? I've searched a lot of bulletin boards to no avail.

Robert M. Lutke
Pekin, IL

We know of GIF file viewers for the 64 and 128 on CompuServe's Graphics Support Forum. For those who don't know what we're talking about, GIF (Graphics Interchange Format) is a data-storage format designed for storing high-quality color graphics images so they can be exchanged between users with different hardware. A 128 or 64 user can, for example, view a GIF file created on a PC, an Amiga, an ST, and so on, if he or she has a GIF file viewer.

Out of Sight

I've subscribed to Gazette for many years and have found it to be the ultimate in information. I'm an advanced BASIC programmer, thanks to your magazine. For a while, however, I tried to follow your instructions on learning machine language, but I got lost. I understand that COMPUTE! published a book on the subject. I'd like to purchase that book. I've checked several bookstores without success.

George Salley
Willingboro, NJ

You're no doubt thinking of the book Machine Language for Beginners, by Richard Mansfield, published by COMPUTE! Books in 1983. (COMPUTE! Books is a separate company from our magazine group.) This bestseller sold 90,000 copies before it went out of print several years ago. It's an excellent tool for learning machine language. We suggest that you contact a local user group or your local library to see if either has a copy. A few staff members here have copies that they use; if we find an extra one lying around the office, we'll send it off to you. No guarantees, however, so check out the sources mentioned above. G

power BASIC

Font Magic

Shao-Tien Pan

Add enlarged or underlined characters to your programs with this short machine language utility for the 64.

Many programs have messages or instructions that require special emphasis. There are several ways to provide this; you can print the message in inverse, in several colors, in a scrolling banner, and so forth.

Font Magic gives you one more way to make your text stand out: it prints it as double-width, double-height, or underlined. And it works with both the built-in ROM sets and with custom character sets. Furthermore, since it's short, Font Magic can easily be added to your BASIC programs.

Getting Started

Although written in machine language (ML), Font Magic is listed in the form of a BASIC loader. To avoid typing errors, enter the program using The Automatic Proofreader, found elsewhere in this issue. When you've finished typing, be sure to save a copy of the program to tape or disk before you run it.

To get started, simply load the program and type RUN. Font Magic POKES the ML into memory and then displays some sample text using each routine.

Using the Program

Font Magic contains four separate ML routines: a main subroutine at locations 49152-49357; a horizontal, or x-, expander at 49438-49505; a vertical, or y-, expander at 49358-49437; and an underliner at 49506-49545.

To use Font Magic, first select a source character set that you wish to alter with the following command:

POKE 53272,n

The parameter n can be one of four values: 20 for the uppercase/graphics ROM set, 22 for the lower-/uppercase ROM set, 28 for a custom character set at 12288, or 30 for a custom set at 14336. If you use some other value, Font Magic defaults to 22 (the lower-/uppercase set).

The source set will be copied by the program in an expanded or underlined form beginning at 14336. If your source set is already located at 14336 (a value of 30 is POKEd into 53272), it will

be overwritten by the destination set.

After you've indicated which character set to use, SYS to the appropriate routine to create and activate the new character set. For example, to turn on the x-expanded set, enter SYS 49438; to activate the y-expanded set, enter SYS 49358; and to turn on the underlined set, type SYS 49506.

The expander routines make characters either twice as wide (the x-expander) or twice as tall (the y-expander). Each character is made up of two parts. Print a normal character to display either the left (x-expander) or the top half (y-expander) of a character; print the corresponding reverse character to display the remainder of the expanded character.

For instance, to expand the lower-/uppercase ROM set horizontally and print the letter A with it, enter the following:

```
POKE 53272,22:SYS 49438:PRINT"A  
{RVS}A"
```

The underliner routine replaces the inverse portion of the character set with underlined characters. To allow for a visible cursor, the inverse space appears as an underlined space. If you wish to print a normal space, use SHIFT-SPACE. Lines 750-780 in the program show how to access and print underlined characters.

Font Magic

```
HQ 10 REM COPYRIGHT 1990 COMPU  
TE! PUBLICATIONS, INC. -  
ALL RIGHTS RESERVED  
QE 20 POKE53280,6:POKE53281,6  
DX 30 PRINT"{CLR}{WHT}"TAB(14)  
"{RVS} FONT MAGIC {OFF}"  
:PRINTTAB(13)"COPYRIGHT  
{SPACE}1990"  
RX 40 PRINTTAB(7)"COMPUTE! PUB  
LICATIONS, INC.":PRINTTA  
B(11)"ALL RIGHTS RESERVE  
D"  
BS 50 REM MAIN  
KR 60 FORA=49152TO49357:READAA  
:POKEA,AA:NEXT  
CD 70 DATA173,24,208,41,14,168  
,201,14  
KJ 80 DATA240,124,162,0,152,20  
1,12,208  
QP 90 DATA30,189,0,48,157,0,56  
,189,0,49  
AA 100 DATA157,0,57,189,0,50,1  
57,0,58,189  
KG 110 DATA0,51,157,0,59,232,2  
08,229,76
```

```
AH 120 DATA129,192,169,0,141,1  
4,220,169  
CG 130 DATA51,133,1,162,0,152,  
201,4,208  
BR 140 DATA30,189,0,208,157,0,  
56,189,0  
SA 150 DATA209,157,0,57,189,0,  
210,157,0  
XQ 160 DATA58,189,0,211,157,0,  
59,232,208  
DR 170 DATA229,76,120,192,189,  
0,216,157,0  
DE 180 DATA56,189,0,217,157,0,  
57,189,0  
AQ 190 DATA218,157,0,58,189,0,  
219,157,0  
CH 200 DATA59,232,208,229,169,  
55,133,1  
JM 210 DATA169,1,141,14,220,16  
9,30,141,24  
KG 220 DATA208,169,248,141,199  
,192,141  
MF 230 DATA203,192,169,59,141,  
200,192,169  
JD 240 DATA63,141,204,192,32,2  
25,192,173  
GS 250 DATA199,192,56,233,8,14  
1,199,192  
MS 260 DATA141,203,192,176,239  
,206,200  
HP 270 DATA192,206,204,192,173  
,200,192  
DE 280 DATA201,55,208,226,96,1  
69,189,141  
RE 290 DATA198,192,76,198,192,  
168,169,157  
FS 300 DATA141,198,192,152,189  
,248,59,96  
AS 310 DATA157,248,63,96  
JX 320 REM Y-EXPANDER  
DC 330 FORA=49358TO49437:READA  
A:POKEA,AA:NEXT  
EQ 340 DATA169,225,141,153,192  
,169,192  
AP 350 DATA141,154,192,32,0,19  
2,169,255  
RH 360 DATA141,7,61,96,169,7,1  
41,234,192  
CR 370 DATA141,242,192,162,7,2  
06,234,192  
SX 380 DATA32,183,192,162,7,20  
6,242,192  
GE 390 DATA206,242,192,32,202,  
192,202,32  
XE 400 DATA202,192,173,242,192  
,16,228,162  
BA 410 DATA3,32,183,192,168,13  
8,10,170  
PS 420 DATA152,32,191,192,232,  
32,191,192  
DQ 430 DATA202,138,74,170,202,  
16,234,96  
RH 440 REM X-EXPANDER  
AA 450 FORA=49438TO49505:READA  
A:POKEA,AA:NEXT  
GG 460 DATA169,49,141,153,192,  
169,193,141  
XJ 470 DATA154,192,32,0,192,16  
9,255,141,7  
MK 480 DATA61,96,162,7,32,183,
```

192,72,41

EG 490 DATA15,168,185,82,193,32,202,192
 ED 500 DATA104,41,240,74,74,74,168,185
 FX 510 DATA82,193,32,191,192,202,16,226
 CB 520 DATA96,0,3,12,15,48,51,60,63,192
 DG 530 DATA195,204,207,240,243,252,255
 CS 540 REM UNDERLINER
 DJ 550 FORA=49506TO49545:READAA:POKEA,AA:NEXT
 BQ 560 DATA169,117,141,153,192,169,193
 XK 570 DATA141,154,192,32,0,192,169,0,141
 KD 580 DATA7,63,96,162,7,32,183,192,73
 DD 590 DATA255,32,202,192,202,32,183,192
 QR 600 DATA32,202,192,202,16,247,96
 BH 610 REM ** DEMO ***
 PF 620 PRINT "{CLR}"
 GE 630 POKE53272,20:SYS49438:REM X EXPAND
 HE 640 FORX=65TO90
 JH 650 PRINTCHR\$(X);
 PH 660 PRINT "{RVS}";CHR\$(X);"{OFF}";:NEXT
 CF 670 PRINT:PRINT "{2 DOWN}X{RVS}X{OFF}
 {SPACE}E{RVS}E{OFF}X{RVS}X{OFF}P{RVS}
 {OFF}A{RVS}A{OFF}N{RVS}N{OFF}D{RVS}D
 {OFF}"
 GS 680 FORX=1TO2000:NEXT:PRINT "{CLR}"
 CR 690 POKE53272,20:SYS49358:REM Y EXPAND
 CK 700 FORX=65TO90
 FP 710 PRINTCHR\$(X);
 BX 720 PRINT "{DOWN}{LEFT}{RVS}";CHR\$(X);"
 {OFF}{UP}";:NEXT
 AP 730 PRINT:PRINT "{3 DOWN}Y{SPACE}EXPAND":PR
 INT "{RVS}Y{SPACE}EXPAND"
 KM 740 FORX=1TO2000:NEXT:PRINT "{CLR}"
 KC 750 POKE53272,20:SYS49506:REM UNDERLINE
 MQ 760 FORX=65TO90
 SX 770 PRINT "{RVS}";CHR\$(X);:NEXT
 MB 780 PRINT:PRINT "{3 DOWN}{RVS}UNDERLINE
 {SPACE}TEXT"
 CH 790 FORX=1TO2000:NEXT:PRINT "{CLR}"

6

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THE geos column

DirQuick

John P. Young

Examine disks and delete files without leaving your current application with this desk accessory for GEOS and GEOS 1.28, versions 1.3 and higher.

The deskTop is great for managing disks and swapping applications, but it also has its limitations. For instance, suppose you want to search through your disk collection for the latest version of a program. Using the deskTop, this process is infinitely slow.

Now with *DirQuick*, this task—and others like it—can be accomplished quickly and easily. This program lets you examine the files on any drive, including RAM Expansion Units (REUs), and it even gives you information about the disk itself. But best of all, you don't have to leave the current application to use it.

Typing It In

DQGen is a machine language program that creates the *DirQuick* desk accessory on your GEOS disk. Use *MLX*, the machine language entry program listed elsewhere in this issue, to enter it. The *MLX* prompts, and the values you should enter, are as follows:

Starting address: 0801
Ending address: 1678

Be sure to save a copy of the program to a GEOS work disk before leaving *MLX*.

To create a copy of *DirQuick*, boot GEOS and open DQGen from the deskTop. (You open a file by double-clicking on its icon or by clicking on its icon and then selecting Open from the file menu. See your GEOS manual for more information.) DQGen displays a dialog box containing the message *DirQuick will be written to the disk in DQGEN's drive*. Place the disk to contain *DirQuick* in the drive containing DQGen and click on OK. If *DirQuick* is written to the disk successfully, the program returns you to the deskTop. If there's a problem, it redisplay the dialog box. You can click on the Cancel button to return to the deskTop at any time.

Getting Started

DirQuick is a GEOS desk accessory, so you can run it by double-clicking on its icon or selecting its name from the geos menu. When you first run *DirQuick*,

you'll see a dialog box containing the names of the files on the current disk. In addition, the dialog box contains four gadgets: up arrow, down arrow, question mark, and Exit. Selecting the up- and down-arrow gadgets allows you to scroll through the filenames. You can also use the up- and down-cursor keys. If you click on the question-mark gadget or type ?, *DirQuick* prints more information about the disk or a file. Selecting the Exit gadget returns you to the deskTop.

To display information about the current disk, click on the question-mark gadget. *DirQuick* shows the name of the disk, the disk type, the free space on the disk, and the number of files on the disk. If you select a file before clicking on the question-mark gadget, *DirQuick* shows information about the file. To select a file, click on its name with the mouse. The file is deselected when you click on its filename again or select another file.

You can delete a file with *DirQuick* by selecting the file and typing X. The program asks you to confirm that you wish to delete the file. Press Y to delete the file or N to abort. *DirQuick* won't delete its swap file or its buffer, but you can delete any other file on the disk. Be careful not to delete the application that you were using prior to entering *DirQuick* or a data file that may have been used by the application. Deleting these files will cause the system to crash when you exit *DirQuick*. If you're using GEOS 2.0, you can recover a file deleted by *DirQuick* with the undo-delete option under the file menu.

To change disks with *DirQuick*, press D; to change drives, press SHIFT-D. If you're running *DirQuick* from an REU, you can access all the drives visible to GEOS. If you're not using an REU, *DirQuick* can only access drives of the same type as the one containing *DirQuick*.

DQGen

```
0801:0B 08 0A 00 9E 32 30 36 2E
0809:31 00 00 00 AD 1E 85 8D 30
0811:AD 08 20 71 C2 20 53 C2 15
0819:20 88 40 00 08 01 A9 16 11
0821:85 05 A9 79 85 04 A9 0B 9C
0829:85 03 A9 A8 85 02 20 78 69
0831:C1 A9 08 85 03 A9 AE 85 87
0839:02 20 56 C2 A5 02 C9 02 14
0841:F0 61 20 8D C1 20 4B C1 E5
0849:20 A1 C2 8A D0 E3 20 A8 D1
0851:C1 05 00 01 FF 00 7F 03 95
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0859:40 00 20 07 FF 00 7F 06 03
0861:46 00 30 18 43 72 65 61 2C
0869:74 69 6E 67 20 44 69 72 A9
0871:51 75 69 63 6B 20 64 65 F4
0879:73 6B 20 61 63 63 65 73 1F
0881:73 6F 72 79 21 00 A9 08 71
0889:85 03 A9 F3 85 02 20 38 3E
0891:C2 A9 00 85 16 A9 08 85 B2
0899:15 A9 FC 85 14 20 ED C1 55
08A1:8A D0 8E AD AD 08 8D 1E 9E
08A9:85 4C 2C C2 00 81 0B 10 6D
08B1:10 C0 08 0B 10 20 DD 08 70
08B9:01 01 48 02 11 48 00 18 75
08C1:44 69 72 51 75 69 63 6B 35
08C9:20 77 69 6C 6C 20 62 65 C9
08D1:20 77 72 69 74 74 65 6E 63
08D9:20 74 6F 00 64 69 73 6B 20
08E1:20 69 6E 20 44 51 47 45 67
08E9:4E 27 73 20 64 72 69 76 91
08F1:65 00 44 69 72 51 75 69 01
08F9:63 6B 00 F3 08 03 15 BF 0C
0901:7F FF FE C0 00 03 80 08 D3
0909:01 80 08 81 80 1F 01 9F F6
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0921:01 9C CB 01 80 0B 01 80 17
0929:4B 01 80 EB 01 B9 FE 01 DD
0931:81 3C 01 80 08 01 80 08 88
0939:01 C0 00 03 7F FF FE 83 A9
0941:05 00 FC 09 20 22 FC 09 92
0949:44 69 72 51 75 69 63 6B BE
0951:20 20 20 20 56 31 2E 31 86
0959:00 00 00 00 4A 6F 68 6E BA
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0969:67 20 20 20 20 00 00 BE
0971:00 00 00 00 00 00 00 83
0979:00 00 00 00 00 00 00 8B
0981:00 00 00 00 00 00 00 93
0989:00 00 00 00 00 00 00 9B
0991:00 00 00 00 00 00 00 A3
0999:00 00 00 00 00 00 00 AB
09A1:00 00 00 00 00 00 00 B3
09A9:00 00 00 00 00 00 00 BB
09B1:00 00 00 00 00 00 00 C3
09B9:00 00 00 00 00 00 00 CB
09C1:00 00 00 00 00 00 00 D3
09C9:00 00 00 00 00 00 00 DB
09D1:00 00 00 00 00 00 00 E3
09D9:00 00 00 00 00 00 00 EB
09E1:00 00 00 00 00 00 00 F3
09E9:00 00 00 00 00 00 00 FB
09F1:00 00 00 00 00 00 00 04
09F9:00 00 00 A5 16 8D 79 16 56
0A01:2C 79 16 10 20 A9 16 85 A6
0A09:15 A9 16 85 14 A9 00 85 F9
0A11:16 20 ED C1 8A F0 0E A9 EF
0A19:16 85 03 A9 0B 85 02 20 27
0A21:38 C2 4C 3E C2 20 B7 C1 37
0A29:F0 8C 88 16 08 02 20 C5 99
0A31:13 A9 00 85 FC A9 14 85 CD
0A39:FB A9 8C 85 FE A9 FA 85 B9
0A41:FD A2 0D AD 1E 85 85 06 91
0A49:A5 FC 85 03 A5 FB 85 02 7A
0A51:A5 FE 85 05 A5 FD 85 04 2D
0A59:20 7B C1 CA FD 0E 18 A9 DA
0A61:28 65 FD 85 FD 90 02 E6 18
0A69:FE B8 50 D7 20 F8 12 A9 65
0A71:80 85 2F 20 A8 C1 05 00 65
0A79:01 50 00 30 03 EF 00 97 94
0A81:07 50 00 30 01 51 00 31 AE
0A89:07 EE 00 96 01 57 00 37 E2
0A91:07 E8 00 7F 06 9F 00 8E 98
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0A99:18 44 69 72 51 75 69 63 B5 0D41:7B 16 B0 07 EE 7E 16 C6 89 0FE9:8D A4 84 A9 0D 8D A3 84 8D
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0AA9:85 02 20 5A C1 20 46 0B D0 0D51:13 20 AE C1 87 00 57 1B F4 0FF9:16 20 91 0D A5 03 85 FC 6F
0AB1:A9 13 8D A4 84 A9 EF 8D 93 0D59:45 6D 70 74 79 20 44 69 05 1001:A5 02 85 FB 20 81 12 A9 B9
0AB9:A3 84 A9 0B 8D AA 84 A9 70 0D61:73 6B 21 00 60 20 91 0D E7 1009:40 85 2E A9 42 85 05 20 5D
0AC1:FB 8D A9 84 20 C9 A0 60 51 0D69:20 81 12 AD 7E 16 38 ED BB 1011:D8 0D 20 48 C1 A5 FC 85 8D
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0AE1:D0 03 4C BA 0B A9 01 8D E2 0D89:A9 5B 85 18 20 48 C1 60 87 1031:31 A9 84 85 15 A9 00 85 12
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0B09:20 0F 0B 4C 32 0B A9 80 AA 0DB1:A0 04 A2 02 20 63 C1 A9 4D 1059:81 85 03 A9 04 85 02 20 F0
0B11:85 0B A9 00 85 0A 20 E4 5B 0DB9:90 18 65 02 85 02 A9 18 8E 1061:22 11 AD 16 84 85 02 C9 F5
0B19:C1 8A D0 12 20 75 0B AD 88 0DC1:65 03 85 03 EE 7E 16 60 2E 1069:10 B0 27 A2 02 A9 0D 85 23
0B21:00 80 F0 0A 85 04 AD 01 AE 0DC9:20 A8 C1 05 00 01 58 00 5B 1071:04 A0 04 20 60 C1 A9 30 CB
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0B49:B8 84 A9 96 8D B9 84 A9 81 0DF1:FE A6 FD 20 B1 C1 98 18 D4 1099:85 19 A9 7E 85 18 AD 18 DF
0B51:00 8D BB 84 A9 51 8D BA F2 0DF9:6D 80 16 8D 80 16 A4 FE 2B 10A1:84 85 02 A9 00 85 03 A9 06
0B59:84 A9 00 8D BD 84 A9 EE 37 0E01:C8 B8 50 DC A5 37 38 E5 E7 10A9:C0 20 84 C1 A9 11 85 03 7E
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0B69:58 85 35 A9 00 85 38 A9 7E 0E11:38 ED 80 16 4A 18 65 35 E8 10B9:19 84 85 02 A9 00 85 03 B3
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0B81:91 0D A5 03 85 05 A5 02 16 0E29:35 85 17 60 A5 05 18 69 25 10D1:AD 17 84 85 02 A9 00 85 B3
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0BB1:18 69 20 85 FD B8 50 C0 BE 0E59:8D A9 84 A9 00 8D A4 84 D5 1101:A9 00 85 19 A9 5F 85 18 28
0BB9:60 A9 00 85 10 85 FD A9 FE 0E61:A9 00 8D A3 84 A9 FF 8D 96 1109:A9 C0 20 84 C1 A9 11 85 D8
0BC1:90 85 11 AD 7B 16 8D 7E 4C 0E69:7A 16 20 C9 0D 20 A8 C1 E4 1111:03 A9 38 85 02 20 48 C1 61
0BC9:16 A9 00 85 17 A9 00 85 92 0E71:01 58 00 38 07 E7 00 7E FD 1119:60 A9 11 85 03 A9 3F 85 13
0BD1:16 A5 11 48 20 91 0D 68 CC 0E79:00 AD 7D 16 D0 03 4C 12 4F 1121:02 A9 03 85 06 A9 15 85 ED
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0C09:A9 7D 85 07 A9 00 85 09 D7 0EB1:A9 00 80 7A 16 A9 0B 8D FE 1159:C7 81 80 F8 01 80 78 01 5B
0C11:A9 58 85 08 A9 00 85 0B A8 0EB9:AA 84 A9 FB 8D A9 84 A9 07 1161:80 00 01 80 00 01 8F 6C 7B
0C19:A9 E7 85 0A 20 B3 C2 F0 97 0ECL:13 8D A4 84 A9 EF 8D A3 73 1169:01 8C 0C E1 8C 6D B1 8F DB
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0C31:08 AD 7F 16 85 0A A9 00 B1 0ED9:46 00 60 06 5A 00 50 18 11 1181:09 BF AD 7D 16 F0 74 20 23
0C39:85 0B A0 08 A2 0A 20 69 52 0EE1:53 74 61 74 75 73 3A 10 36 1189:8D C1 AD 7D 16 8D 7E 16 6A
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0C61:8D 15 85 4C 52 0E 20 8F 95 0F09:74 69 6E 75 65 2E 2E 2E 4F 11B1:00 58 18 59 65 73 20 6F 2B
0C69:8C A9 00 8D 7D 16 A9 1E 80 0F11:00 A9 13 8D A4 84 A9 FE 5E 11B9:72 20 4E 6F 3F 10 06 5C 80
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0C79:7D 16 F0 03 20 8F 0C AD 29 0F21:20 98 C2 20 81 12 A9 42 B9 11C9:20 00 A5 FC 85 03 A5 FB FF
0C81:7E 16 8D 7D 16 20 8F 0C 44 0F29:85 05 A9 40 85 2E 20 D8 82 11D1:85 02 20 81 12 20 48 C1 B6
0C89:A9 1E 8D 15 85 60 AD 7D 87 0F31:0D 20 48 C1 A9 0E 85 03 96 11D9:A5 FC 85 03 A5 FB 85 02 19
0C91:16 F0 39 38 ED 7C 16 8D B6 0F39:A9 DC 85 02 20 36 C1 A9 3B 11E1:A9 16 85 05 A9 00 85 04 BB
0C99:7F 16 20 CE 0C AD 7F 16 14 0F41:00 85 2E A9 00 85 36 A9 4D 11E9:20 02 12 F0 0E A9 16 85 B6
0CA1:18 69 38 8D 7F 16 AD 7F 2F 0F49:84 85 35 A9 00 85 19 A9 3E 11F1:05 A9 0B 85 04 20 02 12 71
0CA9:16 85 06 AD 7F 16 18 69 B7 0F51:84 85 18 A9 58 85 05 AD 41 11F9:F0 01 60 20 8A C1 4C AB 82
0CB1:09 8D 7F 16 AD 7F 16 85 20 0F59:C6 88 D0 0B A9 0F 85 03 5F 1201:0E A2 02 0A 04 A9 0A 20 1A
0CB9:07 A9 00 85 09 A9 58 85 3D 0F61:A9 BF 85 02 B8 50 08 A9 D5 1209:6E C2 60 AD 04 85 C9 79 3F
0CC1:08 A9 00 85 0B A9 E7 85 F4 0F69:0F 85 03 A9 CA 85 02 20 FB 1211:F0 04 C9 59 D0 64 A5 FC DD
0CC9:0A 20 2A C1 60 AD 7F 16 1F 0F71:48 C1 A9 82 85 0D A9 00 35 1219:85 03 A5 FB 85 02 20 38 E1
0CD1:0A 0A 18 6D 7F 16 0A 8D 41 0F79:85 0C 20 DB C1 A2 0A A0 6C 1221:C2 8A D0 56 AD 7D 16 CD 26
0CD9:7F 16 60 AD 7B 16 F0 1D 51 0F81:02 20 62 C2 A5 0B 85 03 88 1229:7B 16 B0 39 AD 7B 16 8D 4F
0CE1:AD 7C 16 C9 01 FE 16 AD F4 0F89:A5 0A 85 02 A9 C0 20 84 E2 1231:7E 16 EE 7E 16 20 91 0D 41
0CE9:7D 16 F0 0B 38 ED 7C 16 9D 0F91:C1 A9 0F 85 03 A9 D7 85 29 1239:A5 03 85 07 A5 02 85 06 58
0CF1:C9 06 90 03 CE 7D 16 CE 1A 0F99:02 20 48 C1 AD 7B 16 85 F2 1241:A5 FC 85 05 A5 FB 85 04 A4
0CF9:7C 16 20 1C 0D 60 AD 7C 5D 0FAl:02 A9 00 85 03 A9 C0 20 E3 1249:A5 FB 18 69 11 85 02 A5 21
0D01:16 18 69 06 CD 7B 16 B0 F2 0FA9:84 C1 A9 0F 85 03 A9 DF 0C 1251:FC 69 00 85 03 A5 06 38 9A
0D09:11 AD 7D 16 CD 7C 16 D0 85 0FB1:85 02 20 48 C1 A9 00 85 D5 1259:85 02 85 06 A5 07 E5 03 1A
0D11:03 EE 7D 16 EE 7C 16 20 2F 0FB9:36 A9 58 85 35 60 57 6F 0A 1261:85 07 20 7E C1 CE 7B 16 4C
0D19:1C 0D 60 AD 7A 16 F0 06 7F 0FC1:72 6B 20 44 69 73 6B 0D 39 1269:A9 00 8D 7D 16 CE 7C 16 E6
0D21:20 AB 0E B8 50 03 20 2B 7D 0FC9:00 4D 61 73 74 65 72 2D DC 1271:AD 7C 16 D0 05 A9 01 8D B9
0D29:0D 60 AD 7B 16 F0 22 A9 B1 0FD1:44 69 73 6B 0D 00 6B 20 F0 1279:7C 16 20 8A C1 4C AB 0E B2
0D31:07 85 FD AD 7C 16 8D 7E A0 0FD9:66 72 65 65 0D 00 20 66 D9 1281:A0 10 88 B1 02 F0 16 C9 EF
0D39:16 20 6D AD 7E 16 CD 65 0FE1:69 6C 65 73 0D 00 A9 14 83 1289:20 B0 02 A9 1B C9 A0 D0 D6

The GEOS Column

1291:02 A9 00 C9 80 90 06 38 48	13E1:16 85 FB AD 85 16 85 FE 5D	1531:4F 54 20 47 45 4F 53 00 9E
1299:E9 80 B8 50 EA 99 AE 12 1C	13E9:AD 84 16 85 FD 60 A9 12 F9	1539:00 00 00 00 42 41 53 49 6A
12A1:C0 00 D0 DE A9 12 85 03 D1	13F1:85 04 A9 14 85 03 A9 4A 28	1541:43 00 00 00 00 00 00 00 0D
12A9:A9 AE 85 02 60 00 00 00 22	13F9:85 02 4C 1C 14 A9 09 85 8D	1549:00 41 53 53 45 4D 42 4C 93
12B1:00 00 00 00 00 00 00 00 D5	1401:04 A9 14 85 03 A9 5C 85 6D	1551:59 00 00 00 00 00 44 41 F1
12B9:00 00 00 00 00 AD 8D C6	1409:02 4C 1C 14 A9 0C 85 04 96	1559:54 41 00 00 00 00 00 00 FD
12C1:84 18 69 08 85 02 AC 89 F2	1411:A9 A4 85 03 A9 65 85 02 E3	1561:00 00 00 53 79 73 74 65 A8
12C9:84 C8 C4 02 90 02 A0 08 F0	1419:4C 1C 14 AD 04 85 F0 25 09	1569:6D 00 00 00 00 00 00 00 4A
12D1:B9 86 84 29 0F CD 87 16 6C	1421:8D 81 16 A0 00 B1 02 CD D5	1571:44 65 73 6B 20 41 63 63 6C
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12E9:EE 89 84 B8 50 D0 20 A1 AB	1439:02 8D 48 14 C8 B1 02 8D AE	1589:00 00 41 70 70 6C 2E 20 94
12F1:C2 8A D0 CA 4C C9 0A AD 2C	1441:49 14 B8 50 01 60 4C FF 51	1591:44 61 74 61 00 00 00 46 21
12F9:89 84 8D 86 16 AB B9 86 6B	1449:FF 11 FF 0C 10 DC 0C 78 FA	1599:6F 6E 74 00 00 00 00 00 A5
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1319:17 29 0F 85 02 AD 8E 84 B7	1469:83 11 11 FF 0C 10 DC 0C 20	15B9:72 69 76 65 72 00 44 69 22
1321:29 0F C5 02 F0 07 AD C4 3C	1471:04 5C 00 87 0D 15 0B 83 81	15C1:73 6B 20 42 70 6F 72 61 83
1329:88 29 40 F0 03 EE 8D 84 68	1479:02 10 FF 0C EA 14 0E 83 AE	15C9:72 00 00 53 79 73 74 65 4A
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1349:20 0B C2 8A F0 03 4C C9 39	1499:C0 00 03 80 00 01 80 00 8F	15E9:6F 2D 45 78 65 63 00 00 FF
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1359:20 AE C1 6F 00 58 43 6F C1	14A9:00 61 9E DB 71 9E DB 61 DA	15F9:31 32 38 00 00 00 00 1B 6B
1361:70 79 72 69 67 68 74 20 E8	14B1:98 73 61 9E DB 61 9E DB 96	1601:53 77 61 70 20 46 69 6C 41
1369:28 63 29 20 31 39 39 30 B4	14B9:31 80 00 01 80 00 01 C0 71	1609:65 00 1B 44 51 20 42 75 94
1371:00 20 AE C1 6E 00 65 43 13	14C1:00 03 7F FF FE 06 BF 90 BA	1611:66 66 65 72 00 0B 16 03 39
1379:4F 4D 50 55 54 45 21 27 B1	14C9:7F FE C0 03 80 01 80 01 C3	1619:15 BF FF FF FF 80 40 01 43
1381:73 00 47 61 7A 65 74 74 2F	14D1:83 C1 86 61 80 61 80 C1 5F	1621:80 60 01 80 60 01 80 60 36
1389:65 00 AD 8D 84 C9 03 90 D2	14D9:04 81 8C 80 01 81 81 80 8F	1629:00 80 50 35 80 50 D9 80 D2
1391:05 A9 02 8D 8D 84 2C 79 0E	14E1:01 80 01 C0 03 7F FE 04 EE	1631:53 21 80 5C C1 80 59 01 E8
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13B1:85 02 20 38 C2 20 B7 C1 6A	1501:83 C1 80 01 80 01 C0 03 0A	1651:80 38 01 80 00 01 FF FF F7
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13C9:16 A5 FB 8D 82 16 A5 FE 73	1519:Cl 83 C1 83 C1 8F F1 87 2D	1669:53 63 72 61 70 20 56 31 5E
13D1:8D 85 16 A5 FD 8D 84 16 82	1521:E1 83 C1 81 81 80 01 80 FD	1671:2E 31 00 00 00 00 00 00 01
13D9:60 AD 83 16 85 FC AD 82 6B	1529:01 C0 03 7F FE 04 BF 4E 32	

6

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So, the facts are on the table . . . you decide for yourself. By the way, they say that "imitation is the highest form of flattery" . . . thanks guys!

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Rhett Anderson

Periodically, I encourage "Horizons" readers to send me mail. I enjoy hearing what you have to say. As a bonus, if I get enough mail, I can get away with letting my readers do my work for me. That's what has happened this month. I hereby dedicate this column to those authors who have contributed to it.

But first, a bit of "Horizons" history for those who may have missed some recent columns.

In September, I thanked Berkeley Softworks for its support of the 8-bit Commodore market at a critical time. I also pointed out that Berkeley was leaving the market to head for greener pastures. Well, as it turns out, the company has not made a full retreat. A letter from Berkeley (see "RAM and More from Berkeley") clarifies the situation.

In November, I declared open season on the less-than-aesthetic Commodore 64 case. I offered three prizes for readers who sent in photos of their overhauls. Amazingly, no one wrote in defense of the Commodore 64's looks. As I write this, the deadline for entries draws near. (I'm writing this on November 14, 1989, and the deadline is January 31, 1990.) I've received one entry so far, and it's a worldbeater. I look forward to seeing more entries. I won't spoil Dennis Joslin's chances in the contest by giving away any details, but just to give you a taste of the scope of his design, I've printed the first and last paragraphs of his letter (see "The Computer's New Clothes").

In December, I made the offhand remark "Do you think that the shampoo instructions 'Wet hair. Lather. Rinse. Repeat.' form an infinite loop?" Staff programmer Tim Midkiff let me know that David Letterman has already covered this ground. Regrettably, I missed that show, but I learned plenty about the subject after receiving *Gazette* reader T. D. Winter's treatise on the subject, parts of which I excerpt here.

The Shampoo Loop

This letter delves deeply into the mystery of misleading product labels. You may never look at a shampoo bottle in the same way again.

You brought up a very interesting subject in your December 1989 "Horizons" column—one that has been bugging

me for a long time. Are the shampoo instructions 'Wet hair. Lather. Rinse. Repeat.' an infinite loop? At first it seemed to be a very trivial question, but the more I thought about it, the more I realized that the problem addressed some very important influences of modern computer technology on mankind. Have computers taught us to organize our thinking processes into logical, systematic patterns, or have we lost that special, irrational SOMETHING that makes us human? Let's analyze the problem from the start.

The simple instructions "Wet hair. Lather. Rinse. Repeat." are obviously clear enough for the majority of shampoo users, because they are not literally followed. If they were, people would be stuck in their showers until their shampoo ran out. The loop has no test condition.

According to the book Learning Pascal, by Niedelman and Carnine, "If some portion of the test condition is not changed inside the loop, the test will have the same result each time it is encountered and an infinite loop will result" (p. 234). This is obviously the case with our shampoo problem.

But not all shampoos are created equal. St. Ives Laboratories was more elaborate in its instructions: "Apply Swiss Formula Jojoba Shampoo to damp hair and work up a rich, cleansing lather. Rinse thoroughly and repeat if necessary." They included a legitimate test condition; however, they still leave it up to the user to define his or her own criteria of when exactly enough is enough. The loop has indeed the potential of becoming infinite, because the possibility exists that the user will never achieve the desired results.

Why is this not acceptable anymore? Are we subconsciously trying to implement the pure number-logic of the computer? I think so, and I also think it will only get worse (or better, depending on your point of view) as mankind advances into the increasingly more computerized world of tomorrow.

Some people may feel threatened by this, but I think it is the logical next step in the eternal process of natural selection. "Artificial Intelligence" is progressing in a negative direction—computers should not be taught to think like us, but vice versa.

The author of this letter, T. D. Winter of Pocatello, Idaho, went into more depth than I can print here, but thanks, T. D., for a well-thought-out and interesting letter.

The Computer's New Clothes

Here are the first and final paragraphs of the letter that accompanied Dennis Joslin's 64-overhaul entry.

Enclosed is a picture of my redesigned Commodore system. I call it the Commodore 64-AS for Awesome System or Advanced System, based on personal preference.

[Details of construction omitted.]

And there you have it, my secret formula for making the Commodore 64-AS for about six bucks.

Exciting, isn't it? Let's see more entries, folks.

RAM and More from Berkeley

I'd like to thank Leland Llevano from Berkeley Softworks (the GEOS folks), who read my September column and sent me the following letter.

First, I want to thank you for complimenting our efforts in your September column.

Second, I'd like to clear up a few misconceptions.

Berkeley Softworks is still committed to the Commodore market. Granted, it's not 100 percent of our focus, but we are doing what we can to stimulate continued interest in the Commodore 64/128. A few points:

- The fire-sale prices at the World of Commodore Show were only on older, discontinued titles. There are still a lot of people out there who haven't caught the GEOS "fever," and we wanted to make the price of entry as low as possible.*
- We've already produced applications in all the major productivity categories and substantially upgraded our flagship products GEOS and GEOS 128.*
- geoBasic, a reportedly axed product, is still alive. Our current plan is to release it through mail order in 1990.*
- Look for a new product from us in December [1989], geoRAM 512, our own RAM Expansion Unit.*

We appreciate the plaudits, but don't close the curtain on us yet. Where we can, we plan to keep the show going.

Enclosed with the letter was an ad for the geoRAM expansion board; 512K is a lot of RAM, and the price (\$124.95) is a bargain. Good work, and merci, Berkeley. Readers can call (800) 888-0848 to order. **G**

d'iversions

Design-a-Robot Contest

Fred D'ignazio

When I was a little kid, the only robots I saw were on TV and in the movies. Back then there were no real robots, only robots of fantasy and science fiction—robots like Robbie, Tobor, Klaatu, and Gog. That didn't stop me from trying to build a robot of my own. I scavenged parts from old bicycles, washing machines, photocopiers, and toasters. I once even used a bedpan as a robot's body. During school, I day-dreamed about building a robot of my own—a man Friday, a servant, a buddy, a friend. At night, robots invaded my dreams.

When I grew up, I learned that while I was dreaming up make-believe robots, real robots were being built in laboratories and plants in the U.S., Europe, and Japan. The real robots looked like long, skinny sea monsters with pliers for jaws. They were called robot arms and were bolted to factory floors. They were programmed to paint cars, do spot welding, and lift heavy objects.

Other robots were built by our fledgling space program, NASA, and launched into outer space. Whether in space or on Earth, robots journeyed into places where humans could not go—into the poisonous atmosphere of Venus, the crushing gravitational pressure of Jupiter, deep under the oceans, into the cores of nuclear reactors, into cells held by rioting prisoners, or into bus depots evacuated by a bomb threat. Robots could be manipulated by humans from as close as a few feet or as distant as several million miles. They were humans' remote eyes, ears, and bodies. They became a sort of human *telepresence* that could explore the universe and take risks we humans dared not take.

Robot designers began looking for "3-D" (Dull, Dirty, and Dangerous) jobs for robots to fill. Robots never got sick, they didn't take coffee breaks, they had an infinite attention span, and they could work three 8-hour shifts without dropping. Bosses liked them because they never talked back, they didn't go on strike, and they didn't belong to a union.

The Rise and Fall of Personal Robots

All of these outer-space, undersea, and factory robots were neat, but they

weren't what I really wanted. I wanted a personal robot—a robot sidekick like C3PO or R2D2, or like Vincent in Walt Disney's *The Black Hole*.

For a while, in the early 1980s, it looked as if I would get my wish. As personal computers grew in popularity, a new field of personal robotics emerged. An International Personal Robotics Congress was held in Albuquerque, New Mexico, in April 1984. The following two years, personal robots were everywhere. Every week new robots came to my house in Roanoke, Virginia, so that I could review them for *Gazette* or for the TV program I was on, "The New Tech Times." When the show's TV crew arrived, I would plug the robots into my Commodore 64, turn them on, and let them roam around the house. For one of the TV shows, I had 27 robots (monkeys, turtles, dogsters, catsters, bootsmen, robo-balls, Heros, Topos, Robies, and others) all running at once.

That's when I wrote the *Gazette* cover story, "My Robot Hotel." My robot guests were yipping, beeping, bumping into walls, talking to trash cans, and chasing the family cat. The house was a mess, my wife was alarmed, and my children were running after the robots, giggling. And me? I was in seventh heaven. My childhood dreams had (almost) come true.

But then the bottom fell out in the personal robotics business. No new guests came to stay at my robot hotel. The hotel was empty and silent. I was sad. I missed the whirr and buzz of the robots' little motors, their tire tracks across my scrambled eggs in the morning, the occasional wandering robot who ended up stuck in the bathtub, wedged under the toilet, or lost among the galoshes in the back of the closet. I missed their chipper voices, their songs (like "Old MacDonald Had a Robot"), and their clever remarks when they encountered the broom or the cat. ("Hi!" they'd say. "Are you a human being?")

Robots Reborn

I can wait no longer. If the robot revolution doesn't happen on its own, I'll have to make it happen myself. I'm officially launching the Great Design-a-Robot Contest. It begins right now—as you read these words.

Entering the contest is easy. All

you have to do is invent a new *personal* robot. It can be completely original or a combination of all the robots you've seen, dreamed about, or imagined.

You have to draw a picture of the robot. Label all of its interesting parts and describe what each does. Furthermore, I want you to show me how the robot relates to your Commodore 64 or 128 computer. Does the computer control the robot? Does it program the robot? If so, how? How are the signals and commands transmitted and received? What kind of programming language should the robot use? Can you invent some commands on your own?

Along with the robot's diagram, I would like a short description of what robots mean to you. Reach down into your heart. What would you do if you had a robot just like the one you've designed? Be specific. Be imaginative. Be wild.

The Winners?

Please send your contest entry to

The Great Design-a-Robot Contest
COMPUTE!'s Gazette
324 W. Wendover Ave.
Suite 200
Greensboro, NC 27408

It's not mandatory, but I'd like to see your entries (text, pictures, diagrams, and so forth) all done on a Commodore 64 or Commodore 128. I don't care if you do some cutting and pasting on real paper at the end, just as long as it looks neat.

I'll judge all the entries myself and send them around to a few other robot maniacs to evaluate. The contest winner and ten runners-up get the following:

1. Their robots will be featured in a future column in *Gazette*.
2. I will send their robot designs to Commodore, Nintendo, and others, and I will personally lobby the companies to get busy building them.
3. I will award the first-place winner a big personal robot and each of the runners-up a little personal robot (of current design).

So let's get busy. If you love robots as much as I do, please help me jumpstart a new robot revolution. As we enter the 1990s, let's pioneer a new Age of Personal Robots. **G**

THE programmer's page

Bugs

Randy Thompson

"The Programmer's Page" is interested in your programming tips and tricks. Send all submissions to The Programmer's Page, COMPUTE!'s Gazette, P.O. Box 5406, Greensboro, North Carolina 27403. We'll pay \$25-\$50 for each tip we publish.

It's 1:00 a.m. and you're busy tracking a bug that's been plaguing your program for weeks. After checking and double-checking your code for typos, logical mishaps, and errant subroutines, you suddenly realize that the flaw is not in your program at all, but in the computer itself. You've just discovered a bug in Commodore BASIC.

It's true: Commodore BASIC isn't perfect. Listed below are two programs that exemplify this fact. Type in and run the following program on a 64 to observe the unexpected results:

```
10 A = 8388608.88
20 PRINT A * 1
30 PRINT 1 * A
```

As you can see, the answers given by this program are not entirely accurate. This mathematical slipup is caused by the computer's binary-to-decimal conversion routines. Certain decimal numbers, such as 8388608.88, are simply too difficult for the 64's floating-point routines to handle reliably.

Now try this one:

```
10 A$ = "1E99":REM DISAPPEARING
REMARK
20 PRINT VAL(A$)
```

When you run this two-line program, the computer responds with an overflow error. Then, when you relist it, the remark statement and ending quotation mark in line 10 are missing. This has to do with a bug in the VAL statement.

Here's a brief explanation of what's going wrong: Before VAL evaluates strings, it stores a zero byte after the last character in the string to signify the end of the string. Because A\$ is explicitly defined in line 10, the storage space for A\$ is actually within the program itself. This type of variable is sometimes referred to as a *static* variable. When a 0 is placed after the character 9, it replaces the closing quotation mark. This quote, however, is preserved

so that it may be restored later on.

Because the number 1E99 (this is scientific notation for a 1 followed by 99 zeros) is too large for BASIC to handle, the computer returns an overflow error when the program is run. Here's where the bug comes in: When the VAL routine encounters an error, it immediately gives up, never bothering to restore the character replaced with a zero byte. In the case of the program above, this error effectively removes line 10's closing quotation mark from memory. And because a 0 marks the end of a BASIC line, VAL has truncated the last portion of the line.

I was originally alerted to these two bugs by volume 8, issue 9 of the 8-bit *Transactor*. Fortunately, I discovered them before they discovered me.

The 128 is not without its problems, either. Although many of the old 64 bugs have been removed from the 128, many new ones were introduced with the computer's enhanced BASIC. For example, INPUT# can no longer be used to input characters from device 3 (the screen); the SCNCLR command doesn't properly fill color memory on a GRAPHIC 4 screen; and DEF FN statements that appear prior to a GRAPHIC 1,1 (or 2,1 or 3,1 or 4,1) produce a syntax error when you try to use the function later on.

You're Not Alone

Don't think that as a Commodore owner you're the only one inflicted with such insidious programming obstacles. Microsoft—the software giant that created MS-DOS and several other PC-oriented products—wrote BASIC for the Apple II, TRS-80, and IBM PC, as well as for Commodore. As a result, anyone who uses BASIC on the Apple, TRS-80, PET, or VIC-20 has to deal with the same bugs that are demonstrated by the programs given above.

Actually, Commodore owners have it pretty good. The original BASIC for the Atari 800 series was rife with errors. Certain functions, such as NOT, simply didn't work. (It was actually stated in some manuals that you were *not* to use NOT.) And how about Atari ST BASIC? You can still crash an ST simply by printing the number 18.9 or any multiple of 18.9! As one COMPUTE! employee put it when he heard that Atari was late in coming out with an

ST BASIC upgrade, "They must still be trying to work in those last few bugs."

Calling All Bugs

Known bugs are relatively harmless. If you're aware of problems with a command, you can usually avoid them without difficulty. It's the unknown bugs that can cause hours of frustration.

If you know of any 64 or 128 bugs, please tell us about them. I'd like to compile a comprehensive list that I can share with other programmers. If you can, explain how to avoid the bug as well as how to create it. If I receive enough information, I'll print the list here, giving credit to all contributing bug-busters who filed their bugs first.

You don't have to limit your bug discoveries to BASIC. If there's a problem with a ROM routine, a disk command, or a compiler that you use, send it in. I'm looking for anything that can help programmers produce clean, error-free code without hassle.

Speaking of Bugs

Sean Ganess wrote in to point out a typo in his "Who's Out There?" tip from the December 1989 "Programmer's Page." When run, this program tells you how many and what types of disk drives are connected to your computer. As listed, however, the program only recognizes up to two drives. To fix the program so it recognizes one, two, three, or more disk drives, change line 40 of the program to read

```
40 DV=DV+1:GOTO 20
```

As before, the drives must have consecutive device numbers (8, 9, 10, and so on) in order for this routine to work.

```
FE 10 DV=8
GK 20 OPEN 15,DV,15:CLOSE 15
KR 30 IF ST THEN DV=DV-1:GOTO
{SPACE}50
XP 40 DV=DV+1:GOTO 20
GQ 50 FOR T=8 TO DV
EX 60 OPEN 15,T,15
EC 70 PRINT#15,"M-R"CHR$(198)C
HR$(229)CHR$(1)
FD 80 GET#15,A$:A$=A$+CHR$(0)
GK 90 PRINT "DRIVE";T;"IS A ";
FE 100 IF ASC(A$)=52 THEN PRIN
T "1541"
GR 110 IF ASC(A$)=55 THEN PRIN
T "1571"
AM 120 IF ASC(A$)=255 THEN PRI
NT "1581"
HJ 130 CLOSE 15:NEXT 6
```

BASIC for beginners

More Lesser-Known Commands

Larry Cotton

Last month we discussed the TAN and ATN functions, but didn't say much about about SIN and COS. Recall that we were trying to find out certain things about triangles. We stated that if we had a *right triangle* (a triangle with a 90-degree angle) and knew any two things about it, we could find out everything else about that triangle.

Look at the figure, which shows a triangle with a 90-degree angle, a 30-degree angle, and a 10-inch side. Knowing this much about the triangle, we can figure out the rest. We begin with the hypotenuse (the long side). Don't forget SOPH, which says that, where X is the angle:

Sine X = Opposite/Hypotenuse

Furnish values and cross-multiply:

SIN 30 × hypotenuse = 10 × 1

Divide both sides by SIN 30:

hypotenuse = 10/(SIN 30)

Here's a simple BASIC program that does the same thing:

```
10 OPP=10
20 RAD=30/(180/PI):REM CONVERT
  DEGREES TO RADIANS (SEE LAST
  MONTH)
30 HYP=10/SIN(RAD)
40 PRINT"HYPOTENUSE ="HYP
  "INCHES"
```

The hypotenuse should be 20 inches. To arrive at the third side, we can use the COS function (remember CASH):

Cosine X = Adjacent Side/Hypotenuse

Cross-multiplying:

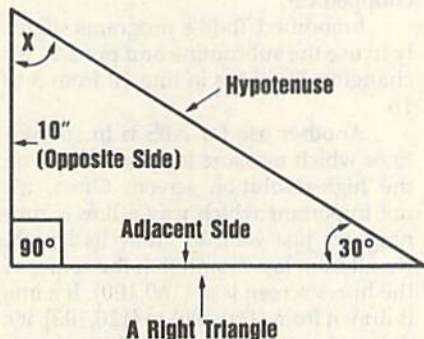
Adjacent = COS 30 × 20

Translated into BASIC:

```
10 HYP=20
20 RAD=30/(180/PI)
30 ADJ=HYP*COS(RAD)
40 PRINT"ADJACENT SIDE ="ADJ
  "INCHES"
```

The adjacent side is 17.3205081 inches. To check this, we can use the Pythagorean Theorem (see last month):

```
10 HYP=20:OPP=10
20 ADJ=SQR(HYP^2-OPP^2)
30 PRINT"ADJACENT SIDE ="ADJ
  "INCHES"
```



We know all three sides and two angles. The third angle can be found using trigonometry, but, as we pointed out in last month's column, there's a much easier way. All triangles share at least one common characteristic: The three angles add up to 180 degrees. Thus, subtracting 90 + 30 from 180 yields 60 degrees. Enough about trig already. Let's move on to the fun stuff—like ABS.

ABSolutely Positive

Who said ABS is fun? Well, at least ABS doesn't stand for *abstruse*; it means ABSolute. ABS gives the absolute value of a number; it leaves positive numbers as they are and changes negative numbers to positive. Its syntax requires parentheses around the number whose absolute value is to be found. Here's a simple example:

```
10 PRINT ABS(32)
20 PRINT ABS(-32)
30 PRINT 73-41
40 PRINT 41-73
50 PRINT ABS(73-41)
60 PRINT ABS(41-73)
```

When you run this program, you should see six 32s; the fourth one will be preceded by a negative sign. Plus signs are not printed in front of positive numbers, but minus signs are printed in front of negative numbers.

(Note also that the 32s without a sign are one space away from the left screen border. This simply indicates that they're positive numbers, not strings. If you typed N\$="32":PRINT N\$, you would see 32 jammed against the left screen border. It's not really a number when displayed this way. Make it a habit to look for the telltale space between the screen border and

the "number." If the space is there, it's actually a number and can be added, subtracted, multiplied, and so on; if not, it's a string.)

Technically, ABS should return a number without any sign. But this little demo shows that it actually yields positive numbers. Enter

```
10 PRINT 32+50
20 PRINT ABS(-32)+50
```

If you run this, you'll see two 82s, indicating that addition was performed between two positive numbers.

So what are some uses for ABS? Here's how to check if numbers are positive:

```
10 X=32:Y=-32
20 IFABS(X)=XTHENPRINT"X IS
  POSITIVE.":GOTO40
30 PRINT"X IS NEGATIVE."
40 IFABS(Y)=YTHENPRINT"Y IS
  POSITIVE.":END
50 PRINT"Y IS NEGATIVE."
```

Crash Prevention

ABS can be used to insure against a program crash should you attempt to take the square root of a negative number, as in this example:

```
10 X=-400
20 PRINT SQR(X)
```

If you run this, you'll get an illegal quantity error in line 20. To avoid this error, study the three-liner below. The value of X can be positive or negative; K will always be positive.

```
10 X=-400
20 K=ABS(X)
30 PRINT SQR(K)
```

Other Uses for ABS

ABS can also be used in a toggle routine. Todd Heimark, who was an assistant editor of *COMPUTE!'s Gazette*, wrote in the April 1984 issue:

"Let's say you want a variable to switch back and forth between two different values. You could use the following subroutine:

```
10 T=3
20 GOSUB 500:PRINT T:END
499 REM TOGGLE SUBROUTINE
500 IF T=3 THEN T=16: RETURN
510 IF T=16 THEN T=3: RETURN
```

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BASIC for Beginners

GOSUB 500. As you can see, T switches back and forth between 3 and 16. But the following routine will do the same thing. . . . Erase line 510 and change line 500 to

```
500 T=ABS(T-19):RETURN
```

"Line 500 does it all. If T is 3, 3 minus 19 is -16, and the ABS chops off the minus sign. But if T is 16, subtracting 19 yields -3, and the minus sign is chopped off."

I modified Todd's programs slightly to use the subroutine and print T. Try changing T's value in line 10 from 3 to 16.

Another use for ABS is in subroutines which measure lengths of lines on the high-resolution screen. Often, it's not important which way a line is running; we just want to know its length. Recall from last month that the center of the hi-res screen is at (160,100). If a line is drawn from (160,100) to (120,100), it's drawn from right to left. If it's drawn from (160,100) to (180,100), it goes from left to right. Here's how to find this particular line's length, using ABS:

```
10 X1=160:X2=180
```

```
20 L=ABS(X1-X2)
```

```
30 PRINT L
```

The variables X1 and X2 are the two x-coordinates of the ends of the line. Therefore, no matter whether X1 is more or less than X2, you'll always have the correct length L.

More Lesser-Knowns

Let's briefly discuss two more lesser-known BASIC commands this month, SGN and WAIT.

Think of SGN as the opposite of ABS. ABS removes the sign from the number; SGN removes the number but keeps the sign. It doesn't leave just a plus or minus sign hanging around. Rather, it has its own unique way of indicating signs.

SGN's syntax is similar to that of ABS in that the argument (the number) is parenthetical. If you type PRINT SGN(5) or any other positive number, the computer will print 1. If you enter PRINT SGN(-5) or any other negative number, the computer will print -1. And as you may expect, if you type PRINT SGN(0), the computer will print 0.

So how can we use this wonderful information? Let's borrow from Todd again:

```
10 FOR J=1 TO 5:READ K:PRINT K;
```

```
20 ON (SGN(K)+2) GOTO 30,40,50
```

```
30 PRINT"IS NEGATIVE.":GOTO 60
```

```
40 PRINT"IS ZERO.":GOTO 60
```

```
50 PRINT"IS POSITIVE."
```

```
60 NEXT
```

```
500 DATA 15,300,-4,0,-654.32
```

"Line 20 checks the sign of the number. SGN(K) yields -1, 0, or 1.

Add 2 to get 1, 2, or 3. The ON-GOTO then makes the program branch to line 30, 40, or 50. It's a quick way to check for positive or negative numbers and branch accordingly." Incidentally, don't confuse SGN and SIN.

WAIT

WAIT is unrelated to any of the lesser-known commands we've discussed in the last couple of months. If you'll consult your *Programmer's Reference Guide*, you'll find that WAIT has been given a lot of attention because it is a difficult command to comprehend. Fortunately, you can also use GET or PEEK in its place. But, let's take a look at it.

WAIT causes a program to be suspended as long as a certain memory location contains a particular value. When that address "sees" another value, program execution is resumed. The new value can come from within the computer, an external device, or—most likely—the keyboard.

The *Commodore 64 Programmer's Reference Guide* states this a little differently: "WAIT . . . causes program execution to be suspended until a given memory address recognizes a specified bit pattern. In other words, WAIT can be used to halt the program until some external event has occurred."

WAIT's syntax is WAIT A,B,C, where A is the memory location to be checked and B and C are so-called *masks*. The variable C and its leading comma may be left out if desired, in which case C is 0.

The most common use for WAIT is to look at the keyboard, as with GET. Enter this short program:

```
10 PRINT"{CLR}{DOWN}PRESS ANY KEY."
```

```
20 WAIT198,1:POKE198,0:PRINT"PRESS ANY KEY AGAIN."
```

```
30 GETA:IFAS="" THEN30
```

```
40 PRINT"END OF PROGRAM"
```

Before you run the program, try to guess what it does. Now run it and observe the results. Here's what's happening: Line 10 prints a message. Line 20 WAITs until the contents of memory location 198 is 1. (Memory location 198 on the Commodore 64 contains the number of characters in a special area of the computer's memory called the *keyboard buffer*.) When it contains a 1, we POKE a 0 to 198 to clear it and print the next message.

At line 30, we use the familiar GET statement to wait for a key to be pressed. When none is forthcoming, A\$ is a null string, and the program loops at line 30. When a key is pressed, A\$ is something other than a null string and control falls through to the next line. Note that you can follow WAIT on the same line with another command, as long as it's not GET.



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Tom Netsel



Club CARIBE

How humiliating! There I was, wandering around wearing my glasses, a dumb grin, and nothing else. Being caught naked in public is the stuff of nightmares, but I was wide awake without even a towel separating me from disgrace.

All I wanted to do was check out some of the features offered at Club Caribe, an online animation service created by Lucasfilm Games and Quantum Computer Services. I knew things could get a little zany at Club Caribe, but I didn't expect this. Let me tell you how I got into this predicament in the first place.

Club Caribe is a unique telecommunications experience that's just one of the many features found on QuantumLink, the online service for 64 and 128 owners. A blend of online chatting and interactive cartoon animation, Club Caribe takes you to a simulated vacation resort where you create and control an animated character that embodies real-life actions.

A feature that enjoys enormous popularity on Q-Link is People Connection. This is the area where subscribers from across the country gather to chat "live" via keyboard. Club Caribe takes this concept a step farther with the addition of animation. Now, you no longer are restricted to exchanging text-only messages. As a bonus, Club Caribe adds sound effects and music. The technology for Club Caribe came from *Habitat*, an online multiplayer fantasy-world simulation developed by Lucasfilm Games and Quantum Computer Services. *Habitat* was beta-tested on Q-Link in 1987 and 1988 but is not yet commercially available.

On my first visit to the club, I created this tall, good-looking character who bore a striking resemblance to, well, yours truly. For the fun of it, I added a beard. Select your character's sex, and then choose from a wide range of heads, hair styles, and colors. You'll find more clothing combinations than are stocked in your average mall. After selecting a coordinated outfit that was colorful, but not gaudy, I stepped out on a tour of the club and its entertaining attractions. Little did I know what was in store for me.

Use a joystick to move your character around the screen. Joystick and fire-button combinations allow you to Go, Put, Get, and Do. From the key-



There's a lot of entertainment—beaches, bars, hot tubs, games—scattered across Caribe's island, and some hold unexpected surprises, as I was to find out.

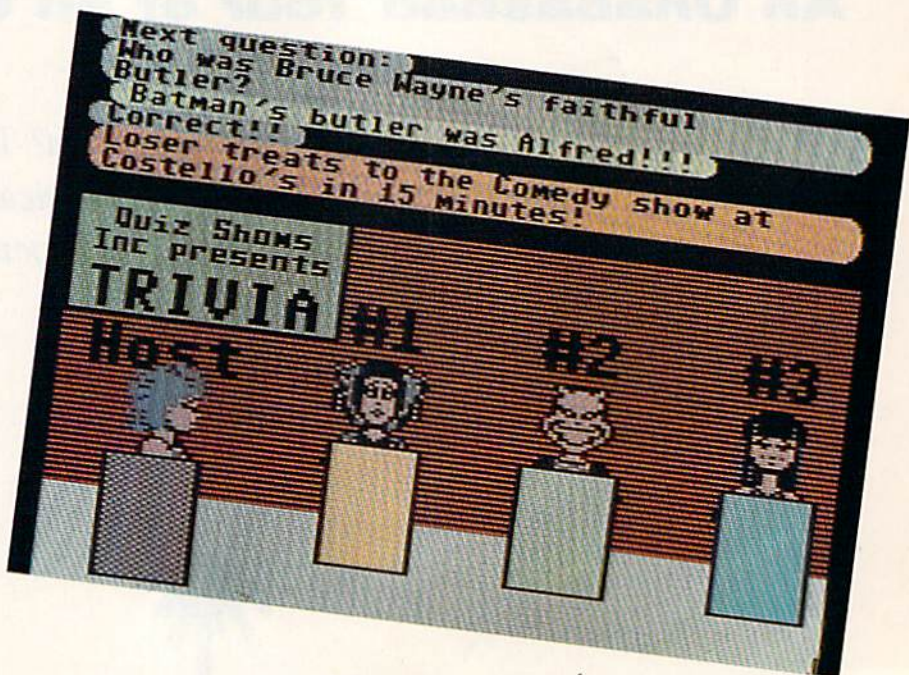
board you can wave, point, hand out, jump, face front or rear, bend, or even frown. Like life, however, Club Caribe is not a perfect environment. If someone rubs you the wrong way and tempers flare, you can throw a

punch at another character. Don't expect Mike Tyson's best, though, because punches don't really hurt.

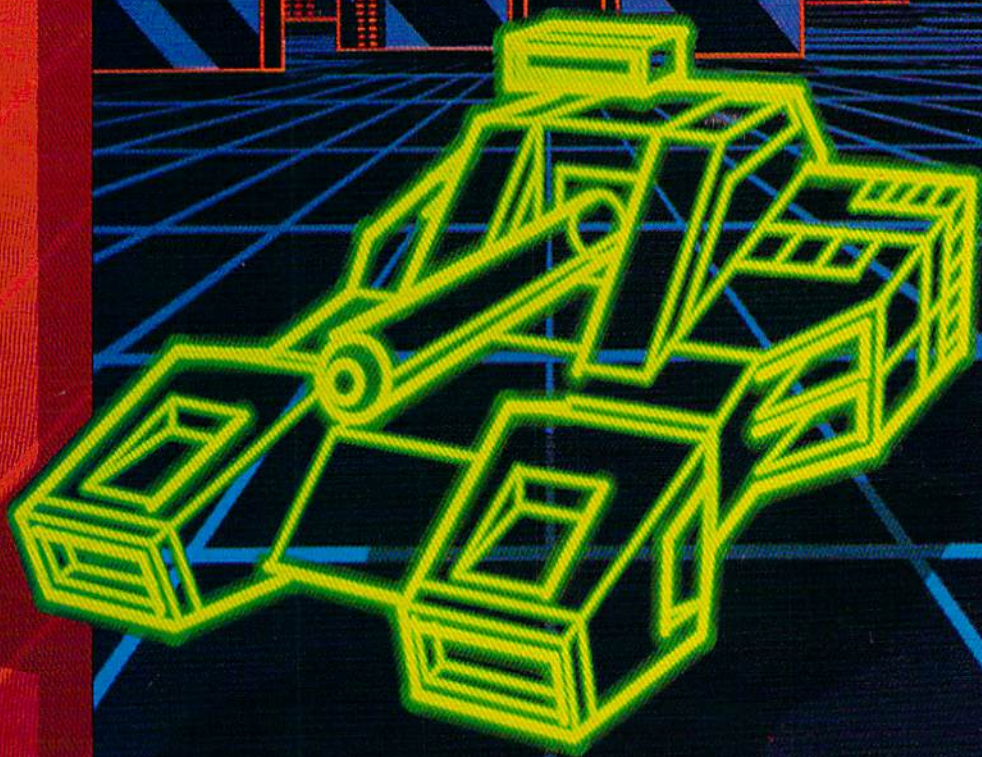
There are plenty of places to visit and explore, but the exciting part is seeing and interacting with other Club Caribe users—or *guests*, as they are called. As you walk along a beach or street, you may see up to five other characters on the same screen. An unlimited number of guests, using Spectator mode, can watch the action but not participate.

Your character can wave to others, walk up to them, and start a conversation just as in real life. Simply type a greeting on the keyboard and press RETURN. The words appear over your character's head in a balloon, similar to those used in comic strips. Balloons are color-coded for each onscreen character, and they scroll up the screen as the conversation progresses.

Other guests may walk by without speaking as they make their way to other areas of the resort. Guests can walk along Club Caribe's beaches, stop in for a drink at Spider's Web, share a hot tub at Cassie's Corner, or play a game of chess, checkers, or



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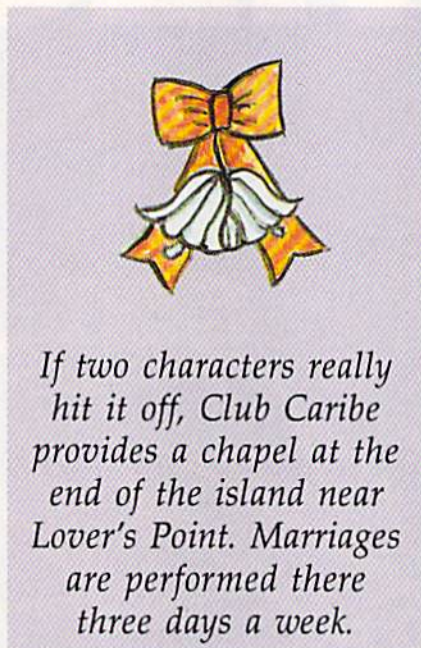
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Club CARIBE

backgammon in the arcade. There are numerous entertaining regions scattered across Club Caribe's island, and some contain unexpected surprises, as I was to find out.

Going from one region to another is similar to walking around a resort. Simply direct your character to the edge of a screen and it walks to the next area. Characters and scenery come from data on your Club Caribe disk, and commands to move the characters arrive via your modem. For speedier transportation to different parts of the island, try the teleport. Take a token from your pocket (you can carry up to five objects at a time, but buy a box or bag if you're the type who collects things) and put it into the teleport. When the booth starts to flash, type in your destination. Before you can say, "Beam me up, Scotty," you're there.

Teleports are popular and make ideal places to meet members of the opposite sex. Most guests are very friendly and are glad to stop and chat for a while, answer questions, or offer help. For longer conversations, pull up a chair or barstool at Kelly's Pub or one of the island's other watering



holes. If your conversations require privacy or if you want to chat with a guest in another region, use Club Caribe's ESP service. Electronic mail is another club feature.

If two characters really hit it off,

Club Caribe provides a chapel at the end of the island near Lover's Point. Marriages are performed there three days a week. I'm not sure how binding these marriages are, but what better place than Club Caribe for a honeymoon?

Regardless of your marital status, feel free to take in a show, tour the aquarium, try on costumes at the theater, or attend any of the resort's special events. The staff arranges tours for newcomers, spelunking in sea caves, games of Simon Says, treasure hunts, trivia contests, and other multi-player activities.

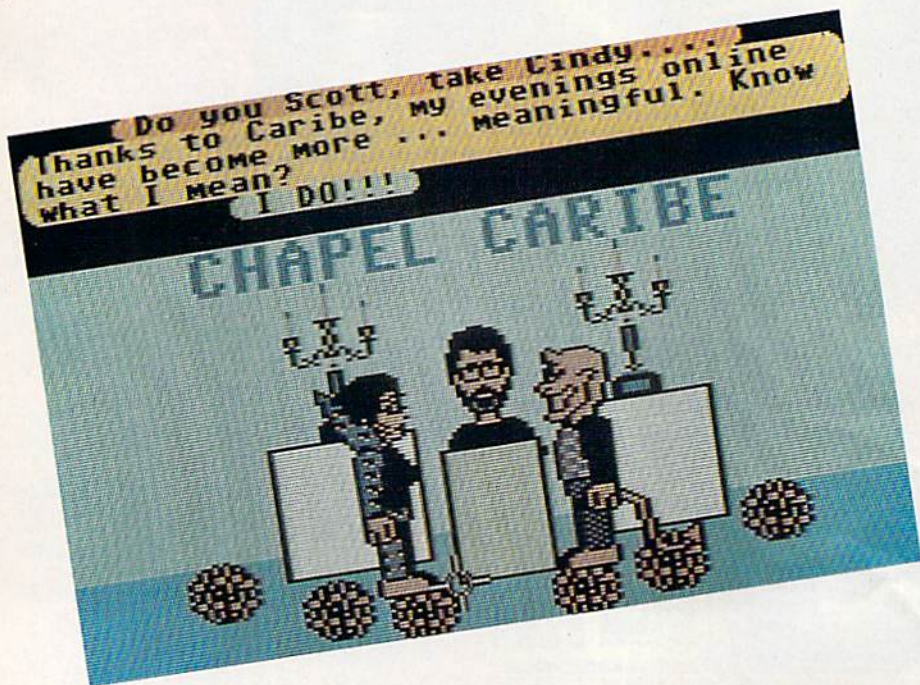
But Club Caribe is not all roses and moonbeams. Despite the staff's best efforts to ensure that guests have an enjoyable stay, unpleasanties can occur. My being left to wander around in the nude is one example. And then there's that warning I spotted in the sewer.

I was behind the club's shops one evening when I spotted an open manhole. Being curious, I decided to poke my nose into what goes on beneath the resort. After I climbed down a ladder, I noticed a sign posted on the sewer wall. It was a warning about getting lost in the sewer's meandering tunnels—lost so soundly that even the Club Caribe staff might not be able to help. There was also something about the area being inhabited by thieves, and if I ventured farther there was a good chance I'd be robbed.

I'm curious, yes, but no fool. I decided to skip the sewers until another day. Besides, I'd already seen examples of above-ground thievery. On more than one occasion, I'd seen unfortunate guests strolling around without their heads. Some may scoff at this notion, but it's true. Ask Razzman or Rebel Rat, two headless characters I encountered one evening.

Razzman had fallen victim to a reprehensible head-snatcher, while Rebel Rat's affliction was self-induced. He had hocked his head at a pawn shop. I'm not sure what he did with the money, but he seemed quite happy sometime later when I found him trying on theatrical heads backstage at a local theater. When he asked me what I thought of his new head, I told him he looked great. I lied. It was inferior to his original creation, but I hated to hurt his feelings.

At Club Caribe, guests have the curious ability to take off their heads. ▶



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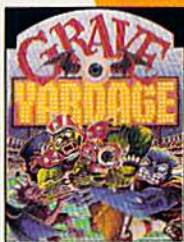
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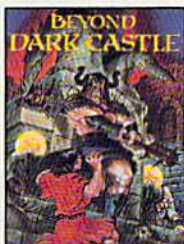
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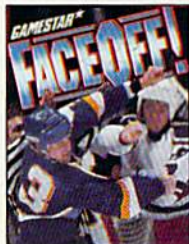
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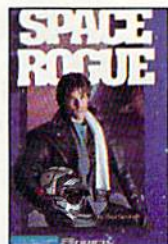
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Club CARIBE

You can carry them or put them on a table, just as you can any other object. Leave them unguarded, however, and some unscrupulous churl may make off with them. That's what happened to Razzman. I wonder if he ever got it back.

I suspect something like that happened to my clothes, which brings me to my own misfortune. While exploring the island, I happened to notice signs pointing to a nude beach. I didn't go because I wanted to, of course; I simply felt it was my journalistic duty to uncover as much as I could about this online resort.

As I followed the path to the beach, my clothing suddenly disappeared and I found myself in my birthday suit. Don't get too excited, though. Remember, these are cartoon-like characters, and I doubt that their nudity will arouse anyone's prurient interest.

I won't bore you with details of the beach—it's the usual sun, sand, and skin. If you've seen one nude beach, you've seen them all. When I left the beach, I fully expected my clothes to reappear just as they had vanished, but nothing happened. By



I saw signs for a nude beach. I felt it was my journalistic duty to uncover as much as I could about this online resort.

the time I walked a few screens farther from the beach, I realized I was stuck in the buff.

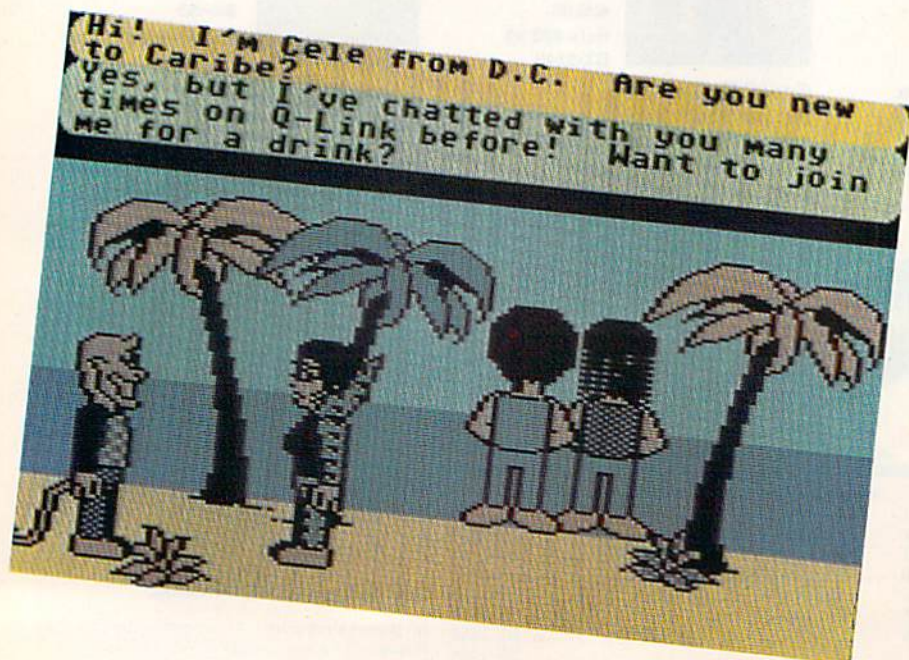
Fig leaves don't grow on trees at Club Caribe, and I needed more than a smile to hide behind. Swallowing my pride, I made my way to a nearby Club Caribe Help Desk, one of several scattered conveniently about the resort. Naturally, it was crowded, and I attracted some attention. Some clown shrieked, "Look, a naked bearded

lady!" Dignity won over violence, however, and I refrained from punching his lights out.

The friendly Club Caribe guide guessed what had happened and reminded me that I could get new duds—and even a new head—at a shop called La Vous New. But for now I could use a portable paint sprayer she carried with her in a box. Not wishing to waste time trying to find a tasteful color scheme, I took the first blast of paint the sprayer offered. Maybe I should have been more choosy.

Many outfits at Club Caribe tend to be of the striped or checked variety and are somewhat gaudy—but have you ever seen a brick suit? I now blend in with the buildings.

Rumor has it that my clothes would have been returned when I left the beach if I'd come and gone on the same path. Come to think of it, I did leave by a different route. Maybe if I stroll along the beach again I can work out a trade. If that doesn't work, I'd better plan on buying a new outfit. I think I have enough tokens for a new paint job, but if not, I can always hock my head. **G**



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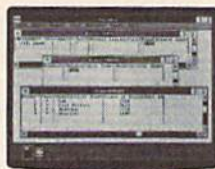
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T H E

Kevin Perdue put his 64 to work in a big way—and business is heating up fast.

Think of a 64 on the job and you'll probably picture it doing work in a white-collar office. But some 64s have blue-collar skills. In the suburbs of the nation's capital, about 100 of these machines work in boiler rooms, controlling the heating and cooling requirements of apartment buildings and complexes.

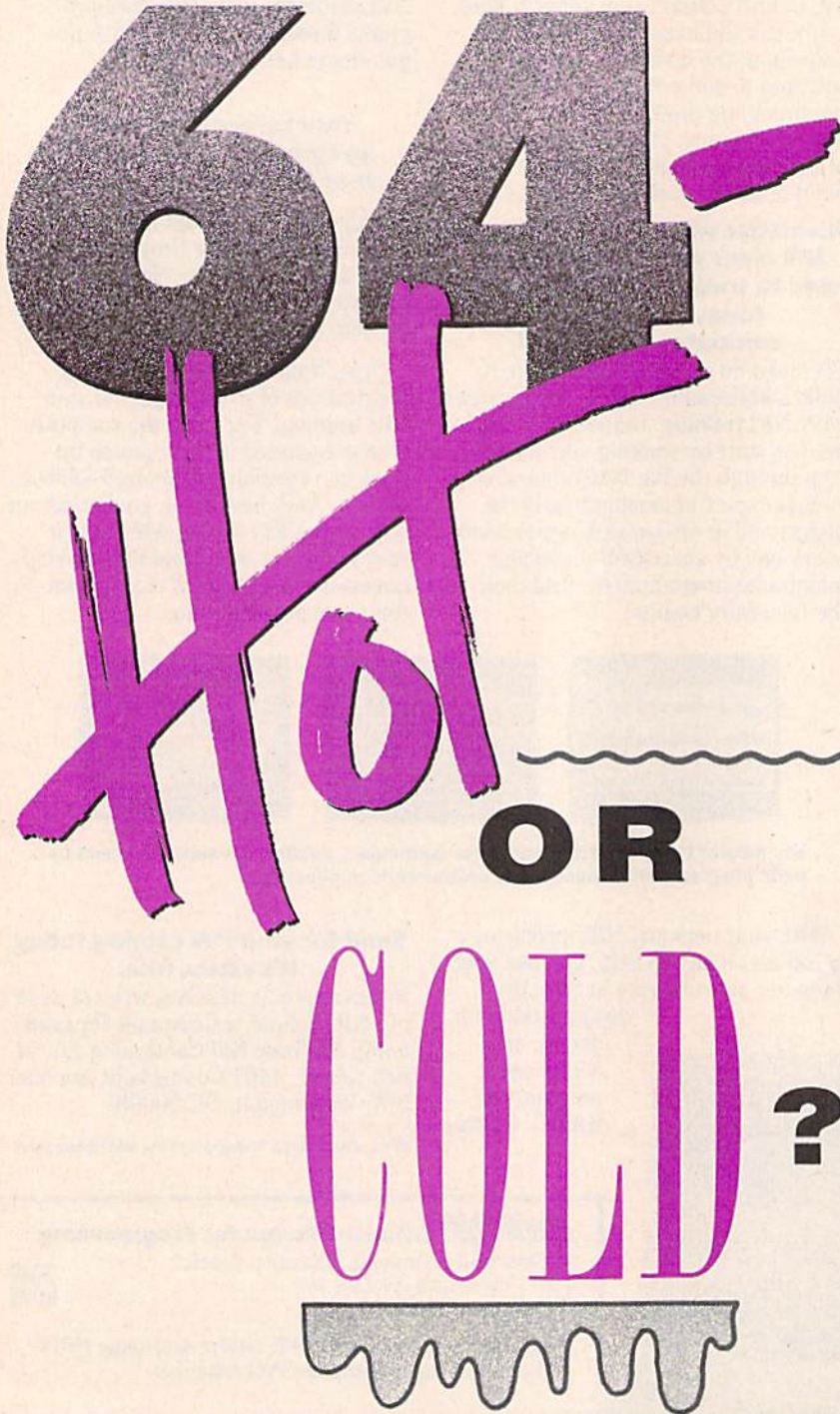
Kevin Perdue, president of HVAC Concepts in Rockville, Maryland, has built a heating, ventilation, and air conditioning business around the 64, and he uses the 8-bit workhorse as the heart of a rather sophisticated energy-management system.

"In every garden-style apartment project in this area, there is a boiler of some sort," Perdue says. "It makes the hot water that's used for heating and the domestic hot water that's used for dishwashers and showers."

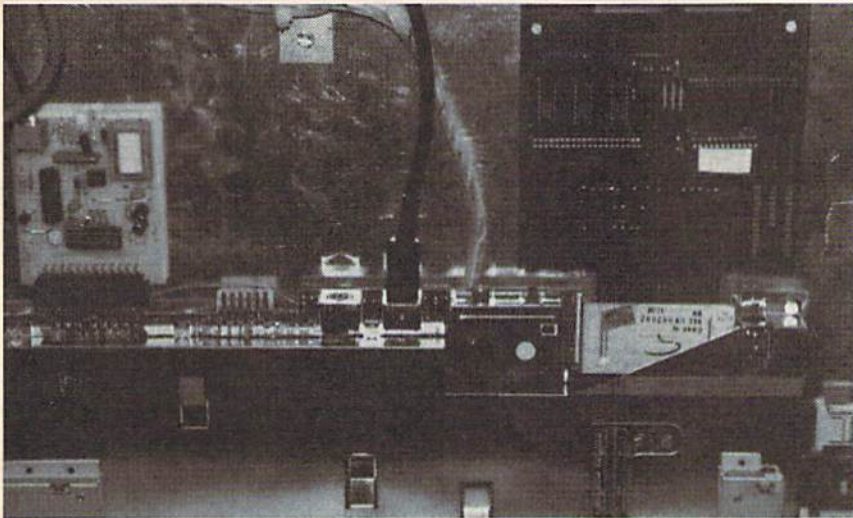
A device called a *chiller* makes cold water just like a boiler makes hot water. "They are the monsters that eat the kilowatts and cost big bucks to run," Perdue says. At the appropriate outdoor temperature, the computer starts these machines and regulates them to keep the tenant cool and comfortable without wasting energy and dollars.

Pumps need to be turned on and off at the proper time, and valves must be positioned properly for the process to work smoothly. Monitoring and controlling these items is vitally important to the successful management of an apartment complex. Managers must keep tenants comfortable, but they also have to keep an eye on heating and cooling costs.

Computers are the most accurate and effective means for controlling such systems, but they can be expensive. A large energy-management system can cost \$30,000, but Perdue has found a way to do the job for a fraction of that cost using a 64. In order to manage such a heating system, the computer first has to start several pumps, then make some minute adjustments. "These are fairly big pumps," Perdue says, "about the size of your desk."



Tom Netsel



The heart of Kevin Perdue's KPS-16 is a Commodore 64 motherboard. Alterations include a new power supply, a modem (on the left), and an EPROM board (right).

At first Perdue was not sure a 64 was up to the job, but about five years ago, he put a 64 in a boiler room just to see what it could do. He was working with his partner at Noyes Air Conditioning, HVAC Concept's parent company, and they had to talk a management firm into letting them try the experiment.

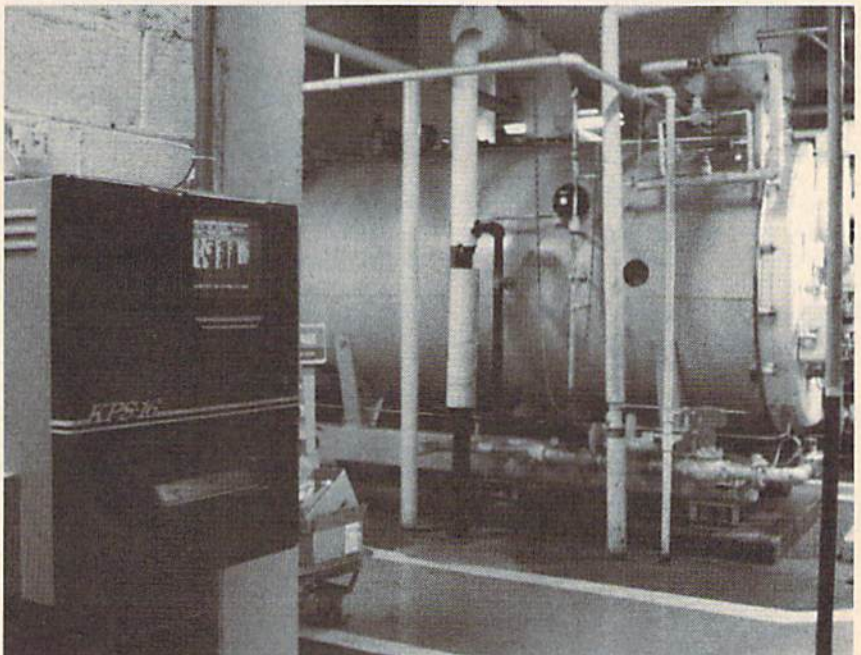
"The first one went in for Kay Management in 1984, and during the course of that summer it saved \$18,000," Purdue said. "The building manager saw the savings and wanted computers in all his buildings."

Perdue was as surprised as anyone at how well the 64 performed. "We were just goofing around and playing with it. Our first question was how long a 64 would last in a boiler room environment, but it just keeps on ticking." In order to get more data, Perdue installed computers in four additional complexes and achieved similar savings with all of them.

The following year, after changing the power supply and installing a backup battery, Perdue installed 22 computers and HVAC Concepts became a growing concern. Now there are about 100 installed units in the Maryland, Virginia, and Washington, D.C., area.

The 64's interior is modified only slightly, but the exterior bears little resemblance to units found in most homes. Perdue does not use the case or keyboard, so he buys only the motherboard (now in its E version) from Commodore. He connects a modem and plugs in an EPROM board. Sensors, control valves, thermostats, and other devices in a boiler room are connected to the 64 via input/output

A large energy-management system can cost \$30,000, but Perdue found a way to do the job using a 64.



The KPS-16 controls a large apartment building's heating and cooling requirements.

terminals on a board plugged into the 64's expansion port. A small monitor plus a couple of master switches are then added to the package, which is housed in a metal box. There is no disk drive—software is downloaded via modem. Perdue calls his unit the KPS-16. In its sturdy metal box, one could almost think of it as a 64 in a hard hat.

"On a newly installed unit, a program in the EPROM starts an autodial program that calls either a 128 or an IBM from our monitoring center," Perdue explains. "It identifies itself with its serial number and location and requests a download. We insert a disk into the 128 or IBM drive, send it its program, and tell it to run."

The program, customized to control the equipment at each site, can easily be monitored at HVAC headquarters. "We have burst communications that is encoded for speed," Perdue says, "and we can look at all the temperatures, see what's running and what's not running, and make any changes." There are 100 setpoints in a system, and all are easily controlled, monitored, or adjusted from the remote computer. "With just two keystrokes, we can turn a 600-ton chiller on or off or adjust it from 44 to 42 degrees."

In addition to handling the operating chores, Perdue's 64s maintain records for analysis. About once every two hours, the monitor system automatically calls each computer, logs on, and downloads all current information about which units have been on, their



temperatures, and any problems experienced.

For example, a small apartment project may have four water heaters set for 130 degrees. The computer keeps a log of how many times the heaters start and how long each one stays on. Suppose the manager and site engineer have the computer set the temperature for 135 degrees for certain hours during the day and then cut it back to 122 degrees at night. The system runs with those settings for a week and then the total number of run-hours for the heaters is examined.

For that week, the heaters may have run for 100 hours. The next week, with a couple of keystrokes, the manager or engineer decides to change the temperature during the day from 135 to 132 degrees, and perhaps adjust the time that the night temperature kicks in. At the end of the week, they'll look at the report and see that the heaters ran 97 hours. "That saved them three hours of run time at 300,000 Btu, which is 300 therms," Perdue says. "A therm costs 61 cents, so they saved \$180 that week by making that setpoint change."

Before the monitoring system was installed, managers never had access to this type of information. An engineer could make adjustments, but management never really knew how effective any change was.

If a problem develops at a site—a temperature goes too high, a pump fails, a boiler flames out, a chiller won't start—the 64 calls the monitoring center at HVAC Concepts, displays an alarm message, and identifies the problem.

"At that point, our monitors get on the horn and contact the engineer or dispatch a service truck to combat the problem," Perdue says. "And 90 percent of the time, we'll know about the problem and have it fixed before the tenants are discomforted." That's a big benefit for management companies.

Perdue worked with Micro World Electronix in Lakewood, Colorado, which came up with a board that plugs into the 64's expansion port to provide input and output terminals. This MW 611 board is modified to provide a 16-channel analog-to-digital conversion, a peripheral interface adapter—similar to what reads the keyboard in a 64—and 16 discreet outputs used to turn devices on and off.

In the event of a power distur-

KPS-16		HVAC CONCEPTS, INC.		ROCKVILLE, MD.		REV. 2.01	
JILLAGHBY CONDOS				00:59:AM		11/07/89 TUE	
MODE: WINTER		ALARMS: 00		POWER: ON		LEVEL: 1	
(POINT)	(READ)	(ADJ)	(FUNCTIONS)				
0 HEAT SUPPLY	111	112	1 HR. PT. HISTORY				
1 CHILLER #1 AMPS %	H	H	5 MIN. PT. HISTORY				
2 CHILLER #2 AMPS %	0	0	30 SEC. PT. HISTORY				
3 DOMESTIC WATER	136	135	ALARM HISTORY				
4 CHILLER #1 SUPPLY	75.3	0	ACTIVE ALARMS				
5 CHILLER #2 SUPPLY	74.8	H	PHASE MONITOR				
6 BLDG CHILLED SUPPLY	89.5	0	> DIGITAL ON/UPDATE				
7 OUTSIDE AIR	57	57	INPUT HISTORY				
8 CONDENSER IN	59	0	OUTPUT HISTORY				
9 CHILLER #1 PRESS.	2.8	H	COUNTER HISTORY				
10 CHILLER #2 PRESS.	1.4	0	MESSAGES				
11 CHILLER #1 EVAP.	72.9	H	SETPOINT CHANGE				
12 CHILLER #2 EVAP.	73.0	0	DISPLAY SETPOINTS				
13 OUTDOOR HUMIDITY	96	H	DIAGNOSTICS				
14 *	0	0	PASSWORD CHANGE				
15 *	H	H	SPECIAL FUNCTIONS				

Customized software for each building is downloaded from a Commodore 128 at HVAC Concepts office. Temperatures of hot and cold water and dozens of other boiler-room functions can be monitored and adjusted from a remote computer.

An apartment complex with more than 1000 units is controlled by one of Perdue's modified 64s.

bance, a two-part EPROM on the board immediately shuts equipment down to prevent damage and then waits for the power to be restored. If power is off for an hour, the 64 calls the monitoring center and notifies personnel of the power outage. The battery backup maintains the program and restarts the equipment when power is restored. If the power is off for more than eight hours, the on-board batteries fail; then the computer essentially is shut off.

When power returns, the 64 reads the EPROM and automatically calls the monitor center, asking for its software. It downloads a 15K-20K program in about eight minutes and reboots the system. Should lightning strike nearby or some other disturbance cause the program to crash, a built-in watchdog program detects the problem, reboots the machine, and downloads a fresh program.

The other half of the EPROM program is a wedge that Perdue wrote to add command words to the 64's 2.0 operating system. These commands are used for turning devices on and off, answering its telephone, and storing equipment histories. These are commands common to each site. By having them built into the operating system, they don't have to be downloaded each time.

As oil, gas, and electricity rates increase, energy-management systems in commercial applications become more popular. Most systems on the market are designed for large buildings, but to put one of them in a small boiler room would be overkill. With a 64 at the heart of Perdue's system, his units can handle similar chores in smaller boiler rooms and do it at a more than reasonable price.

The system is not limited to small buildings, however. Perdue says the largest apartment complex in his area, with more than 1000 apartments, is controlled by one of his modified 64s. Not bad for an 8-bit computer. So, the next time you visit a boiler room, take a look at its control unit and you may spot an old friend: a 64 wearing a hard hat.

Kevin Perdue would like to hear from anyone using a 64 for building automation. Contact him at HVAC Concepts, 5451 Randolph Road, Rockville, Maryland 20852; (301) 468-6454. Author Tom Netsel is also interested in hearing from readers who put their 64s or 128s to interesting uses. He can be reached at COMPUTE! Publications, 324 West Wendover Avenue, Greensboro, North Carolina 27408.

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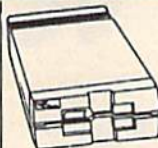
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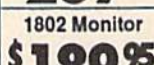
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Future Computing

Neural Networks

Part 2

Kevin E. Martin

In this month's installment, we'll look at some programs you can use to begin to understand this exciting branch of neural networks.

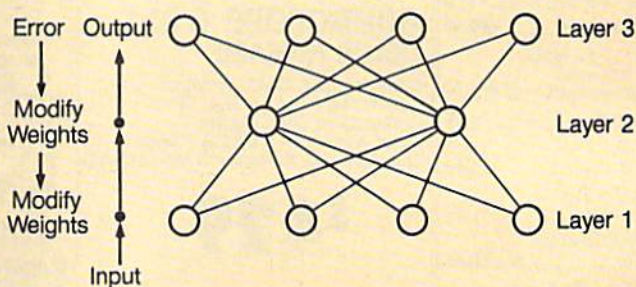
Last month we introduced the topic of neural networks with a general discussion, and we took a closeup look at the linear associator (LA) neural network. The LA is able to learn to associate different input and output patterns, but there are limitations. Only certain input patterns are learnable.

The number of input patterns the LA can learn is equal to the number of processing elements (PEs) in the first layer of the network. For example, take a network that contains ten PEs in the first layer. You can present 1024 different patterns to the input layer, but the network can learn only 10 of them exactly. If you try to force the network to learn more, the patterns it previously learned will become contaminated.

This limitation makes the back propagation (BP) neural network a better choice for practical applications. In fact, back propagation is the most commonly used neural network architecture used in the business world today. To get you started in your explorations of neural networks, I've included a machine language program with an interface to BASIC. The program, *BP*, implements the back propagation algorithm. Also listed are two examples to illustrate the power of this algorithm.

To overcome the limitations of the linear associator, back propagation introduces another layer in the middle of the network (see Figure 1). The middle layer allows the network to develop an internal representation of the problem it is assigned to solve. This internal representation is developed entirely within the network. As you can see in Figure 1, layer 2 receives input from layer 1

Figure 1



The layout of a back propagation network.

and outputs its results to layer 3. This means that it doesn't receive any inputs or outputs directly from the outside world, and therefore a learning algorithm that can develop this internal representation is required. The internal representation codifies the inputs into many different features. These features will be discussed in greater depth in the exclusive-OR example below.

The example programs are implemented using a three-layer BP neural network (so called because there are three layers of PEs in this implementation). For a back propagation network, the minimum number of lay-

ers is 3, but in more complex situations, the problem may require many more.

The linear associator was described in the previous article to introduce several important characteristics of all neural network architectures. The back propagation neural network is very similar to the linear associator, but some important differences exist, namely: the number of layers, the output function, and the teaching algorithm.

The number of layers affects the organization of the matrix in only a minimal way. In the LA, we had a single connection matrix for the network representing the connections between the PEs in the first and second layers. For the BP network, we have three layers of PEs and two layers of connections. To accommodate this new layer of connections, we need two connection matrices: one for the connections between layers 1 and 2, and one for the connections between layers 2 and 3. Layer 1 receives the inputs from outside, and layer 3 presents the resulting outputs.

The back propagation network may seem like two linear associators placed one on top of the other, but, in the BP network, there are output functions for each PE in each layer. In the LA, the output of each PE was simply its activation level (calculated by collecting the inputs from the previous layer, multiplying them through the connection matrix, and then summing them). In the BP network, the activation level is calculated in a similar manner, but then it is used as the parameter in an output function that actually generates the PE's output.

You no doubt have heard the saying *practice makes perfect*. This phrase is true for back propagation neural networks. For these networks to learn the patterns correctly, you need to present the input and teacher patterns many times (see Figure 1).

The more times you present the input and teacher patterns, the better the system learns to associate these patterns. The total error gives you an idea of the progress your system is making in learning the patterns. As you continue to present the patterns, the total error declines until it eventually reaches a minimum. If you plot the total error against the number of trials, you'll see the error start high, slowly lessen, and eventually reach a minimum value (see Figure 2).

An excellent way to picture this system is to use the analogy of a ball rolling down a hill. Hills generally descend, but they may contain small valleys. Figure 3 illustrates this idea. As the ball rolls down the error hill, it gains momentum. If it has enough momentum to escape the small, secondary valleys on its way down, it eventually ends up at the bottom of the hill.

Hands On

BP is a back propagation simulator that allows you to experiment with your own systems. It handles all of the processing for the network; you simply define the network's characteristics, teach it the patterns you wish it to

learn, and then save the network. When you want to have the system recognize these patterns, you simply load the network back into memory and present the input patterns; the system outputs the patterns you taught it. To help you get started, I've included two classic example problems that a back propagation network can learn but that earlier networks, such as the linear associator, cannot.

BP is written in machine language, so you'll need to use *MLX*, the machine language entry program found elsewhere in this issue, to enter it. The *MLX* prompts, and the values you should enter, are as follows:

Starting address: C000
Ending address: CFFF

Once you've finished entering the data, save a copy of the program with the name *BP.ML*. (The example programs expect to find a file with this name.)

XOR and *ENCODE* are example programs that demonstrate how to use BP to simulate a back propagation neural network. Both are written in BASIC, so use *The Automatic Proofreader*, also found in this issue, to prevent typing mistakes as you enter them. Save copies of the programs to the disk containing BP.

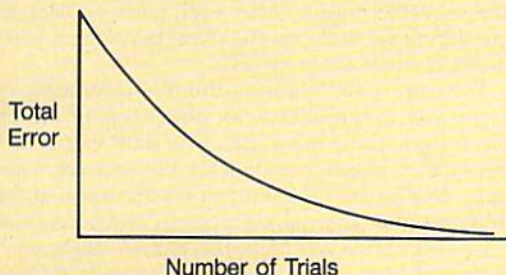
For a quick look at how BP works, load the *XOR* example program and type RUN. The program loads BP, sets up the network, and then begins learning the patterns. Once it has learned the patterns, the program presents each of the learned patterns to the system and displays the resulting output.

The Tools

BP has six commands for processing and managing a simple back propagation network. In the following paragraphs, you'll find descriptions of what each command does and how to use it. If you don't understand the commands at first, don't worry. You'll understand after we examine the *XOR* example.

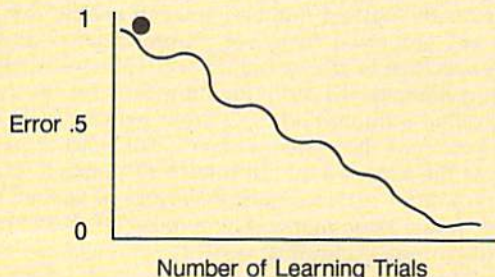
SYS 49152, fpe, spe, tpe, np, lr, momen, err Initialize the BP network. This command is used to set up a simple back propagation network. It initializes the system by creating eight BASIC variables and 11 arrays (see Table 1). These variables and arrays are used to hold the results generated by the network. Because they are BASIC variables, they are erased if you perform a NEW or CLR command, load another program, or change the existing program, so be careful. Next, *fpe*, *spe*, and *tpe* determine how many processing elements are in the first, second, and third layers of the network, respectively. Theoretically, these values can range from 1 to the maximum number of elements free memory will allow. In practice, training times for larger networks could be prohibitively long. The fourth argument, *np*, is the number of patterns that the network is to learn. This value and the number of PEs in

Figure 2



The error starts high but moves lower and eventually crosses a preset threshold.

Figure 3



The error in a neural network acts much like a ball rolling down a hill.

Future Computing

the second layer are interdependent. (If the network doesn't have enough PEs in the second layer to develop internal representations of the patterns, then the program will go into an endless loop.) The argument *lr* is the rate at which the network learns the patterns, and *momentum* is the momentum the system has as it learns a pattern. Both of these parameters will be discussed in more detail below. The last argument, *err*, is the maximum allowable error in the system. *BP* uses this value to determine when it has learned the patterns.

Table 1. Variables and Arrays Created by BP

Variable	Meaning
p1	Number of PEs in layer 1
p2	Number of PEs in layer 2
p3	Number of PEs in layer 3
np	Number of patterns for the system to learn
rate	Learning rate
momentum	Momentum of learning
epsilon	Maximum allowable error
te	Total error after each teaching trial
Array(Size)	Meaning
o2(p2)	Output from layer 2
o3(p3)	Output from layer 3
e2(p2)	Error at layer 2
e3(p3)	Error at layer 3
w1(p2,p1)	Connection weights between layers 1 and 2
w2(p3,p2)	Connection weights between layers 2 and 3
m1(p2,p1)	Momentum of the connection weights between layers 1 and 2
m2(p3,p2)	Momentum of the connection weights between layers 2 and 3
t(p3,np)	Teacher patterns
in(p1,np)	Input patterns
e(np)	Error from each pattern

SYS 49155,pat Recognize a pattern. After the system has learned the patterns you taught it, use this command to present a pattern for the network to recognize. The *pat* argument is a string of 0s and 1s that represents the pattern. It must contain the same number of 0s and 1s as there are PEs in the first layer.

SYS 49164,se Begin learning patterns. Use this command to tell *BP* to begin learning the patterns. Before you use this command, you must initialize the network with the command **SYS 49152** and present the training pairs with the command **SYS 49167**. The *show-error* argument, *se*, determines whether or not *BP* displays the total error after each learning trial. Set *se* to 1 to display the total error; otherwise, set it to 0.

SYS 49167,pn,ip,tp Initialize the training pairs. After you've set up your network, you must use this command to define the patterns the network is to learn. These patterns are given in pairs, called *training pairs*, that consist of an input pattern and a teacher pattern. In the command, *pn* is the pattern number. You can specify the patterns in any order you wish, but you must define all the patterns specified in the *np* parameter of the initialize *BP* network command. All of the training pairs for the system are called a *training set*. The input pattern, *ip*, is the pattern you want the system to learn. The teacher pattern, *tp*, is the expected output that corresponds to the input pattern. Both patterns must be strings of 0s and 1s enclosed in quotation marks. The number of characters in the input pattern string must equal the number of PEs in the first layer. The number of characters in the teacher pattern must correspond to the number of PEs in the third layer.

SYS 49170,filename Save network. This command saves the variables and arrays generated by *BP*. With it, you can recall a network quickly without having to wait for the system to relearn patterns. To save a network, simply type the command followed by the filename in quotation marks.

SYS 49173,filename Load network. This command loads a network saved with the save-network command above.

XOR

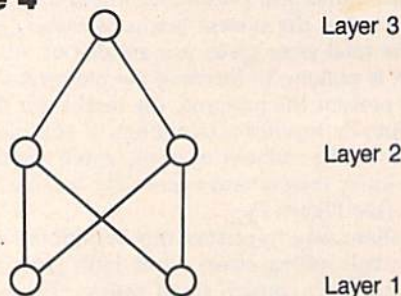
The XOR (exclusive or) function is a classic example of the type of problem the back propagation network can learn to solve. We'll go through *XOR* to show you how to use *BP*'s functions and to give hints on how to design your own systems.

Table 2. The Exclusive-OR Function

0	XOR	0	=	0
1	XOR	0	=	1
0	XOR	1	=	1
1	XOR	1	=	0

The XOR function operates on two input values and returns one output value (see Table 2). At the lowest level, the function combines two input bits to generate one output bit. The network represents the XOR function by having two PEs in the first layer and one PE in the third layer (see Figure 4). The number of PEs in the middle layer depends on how many patterns the system must learn. In this case, we want it to learn four patterns, so the second layer contains two PEs. (Two is the minimum number needed to learn four patterns.)

Figure 4



The layout of a BP network to solve the XOR problem.

In line 50 of *XOR*, we initialize the network with the command **SYS 49152**. The first three values following **SYS 49152** determine how many PEs are placed in the first, second, and third layers of the network (2, 2, and 1, respectively). The fourth value indicates that we want to teach the system four patterns.

The network learns the patterns by conducting learning trials. In each trial, the internal representation of a pattern is modified so that its output more closely matches the expected output. After each learning trial, the error is the difference between the expected output and the actual output from the network.

The fifth value following the **SYS** command, the learning rate, determines what percentage of the error is reduced for each learning trial. The sixth value, the momentum, also affects how quickly the network learns a pattern. In practice, you want to set the learning rate as high as possible and the momentum as low as possible. If the learning rate is too high, the system learns each pattern very quickly, but it destroys other patterns that it may have already learned. If the momentum is set too high, the system learns each pattern quickly, but it forgets the

pattern as soon as it attempts to learn the next. Your objective is to teach the network a set of patterns, not just one pattern. To achieve the best results, you want to maximize the learning rate while minimizing the momentum.

The last value following the SYS command is the total allowable error in the system. After each learning trial, the total error in the system is the sum of the errors for each training pair. When the total error becomes less than the total allowable error, the network has learned the patterns well enough. If you set this value too close to 0, BP may never stop trying to learn the patterns.

Learning Patterns

After the network has been initialized, the program initializes the training pairs. Lines 60-90 of the program present the input and teacher patterns.

Now BP is ready to run. The SYS 49164 command in line 140 tells it to start learning patterns. The 1 following the SYS command tells BP to print the total error after each learning trial. Learning all of the patterns might take quite awhile. You can break out of the program at any time by holding down the RUN/STOP key until the program completes the current trial.

After the network has learned a set of patterns, lines 170-280 display the output from the system. Line 170 presents the first pattern to the system with the command SYS 49155,"00." The pattern must be in quotation marks and should be exactly as long as the number of PEs in the first layer. After the SYS, the arrays o2 and o3 contain the output from layers 2 and 3, respectively.

Program 1. BP

```
C000:4C 18 C0 4C 4D C4 4C FE 9F
C008:C6 4C 4B CA 4C B0 CA 4C 1D
C010:04 CB 4C F7 CB 4C 63 CD B3
C018:20 FD AE 20 9E B7 8E A9 9B
C020:02 20 FD AE 20 9E B7 8E CE
C028:AA 02 20 FD AE 20 9E B7 4E
C030:8E AB 02 20 FD AE 20 9E AF
C038:B7 8E AC 02 20 FD AE A5 EA
C040:7A 8D A7 02 A5 7B 8D AB 56
C048:02 A9 8B 85 7A A9 CF 85 9E
C050:7B 20 8B B0 8D AD 02 8C C7
C058:AE 02 AD A7 02 85 7A AD AA
C060:A8 02 85 7B 20 8A AD AE 54
C068:AD 02 AC AE 02 20 D4 BB 07
C070:20 FD AE A5 7A 8D A7 02 0D
C078:A5 7B 8D AB 02 A9 8E 85 41
C080:7A A9 CF 85 7B 20 8B B0 20
C088:8D B1 02 8C B2 02 AD A7 E6
C090:02 85 7A AD AB 02 85 7B 72
C098:20 8A AD AE B1 02 AC B2 0F
C0A0:A8 20 D4 BB 20 FD AE A5 7D
C0A8:7A 8D A7 02 A5 7B 8D AB BE
C0B0:02 A9 91 85 7A A9 CF 85 C7
C0B8:7B 20 8B B0 8D AF 02 8C 38
C0C0:B0 02 AD A7 02 85 7A AD 14
C0C8:A8 02 85 7B 20 8A AD AE BC
C0D0:AF 02 AC B0 02 20 D4 BB 41
C0D8:A5 7A 8D A7 02 A5 7B 8D 23
C0E0:A8 02 A9 94 85 7A A9 CF EE
C0E8:85 7B 20 8B B0 48 98 48 E8
C0F0:AD A9 02 20 3C BC 68 A8 44
C0F8:68 AA 20 D4 BB A9 97 85 E3
C100:7A A9 CF 85 7B 20 8B B0 A1
C108:48 98 48 AD AA 02 20 3C 93
C110:BC 68 AB 68 AA 20 D4 BB E2
C118:A9 9A 85 7A A9 CF 85 7B 82
C120:20 8B B0 48 98 48 AD AB 1E
C128:02 20 3C BC 68 A8 68 AA 69
C130:20 D4 BB A9 9D 85 7A A9 AC
C138:CF 85 7B 20 8B B0 48 98 BE
C140:48 AD AC 02 20 3C BC 68 DC
C148:A8 68 AA 02 D4 BB A9 FC 77
C150:85 7A A9 CF 85 7B 20 8B 4D
C158:B0 8D D2 02 8C D3 02 A9 73
C160:2E 85 7A A9 CF 85 7B AD 7F
C168:2E CF 20 81 B0 A9 A6 85 12
```

```
C170:7A A9 CF 85 7B 20 8B B0 12
C178:8D B3 02 8C B4 02 A9 01 BA
C180:20 3C BC AE B3 02 AC B4 59
C188:02 20 D4 BB A9 AC 85 7A F0
C190:A9 CF 85 7B 20 8B B0 8D 63
C198:B5 02 8C B6 02 A9 01 20 4D
C1A0:3C BC AE B5 02 AC B6 02 D4
C1A8:20 D4 BB A9 00 8D 36 03 29
C1B0:A9 B2 85 7A A9 CF 85 7B 21
C1B8:20 8B B0 8D CF 02 8D 34 C3
C1C0:03 8C CA 02 8C 35 03 A9 4B
C1C8:01 20 3C BC AC 35 03 AE 17
C1D0:34 03 20 D4 BB EE 36 03 89
C1D8:AD AC 02 CD 36 03 90 23 7D
C1E0:A9 00 8D 38 03 AD 34 03 A8
C1E8:18 69 05 8D 34 03 AD 35 8A
C1F0:03 69 00 8D 35 03 EE 38 F4
C1F8:03 AD A9 02 CD 38 03 B0 C4
C200:E4 90 C4 A9 00 8D 36 03 F4
C208:8D 38 03 A9 BA 85 7A A9 E7
C210:CF 85 7B 20 8B B0 8D BF 4A
C218:02 8D 34 03 8C C0 02 8C B0
C220:35 03 A9 01 20 3C BC 20 D1
C228:97 E0 20 E2 BA 20 0C BC 0F
C230:A9 05 20 3C BC 20 53 B8 59
C238:AC 35 03 AE 34 03 20 D4 6F
C240:BB EE 36 03 AD 34 03 18 B2
C248:69 05 8D 34 03 AD 35 03 F4
C250:69 00 8D 35 03 AD AA 02 B5
C258:CD 36 03 B0 C5 EE 38 03 1B
C260:AD A9 02 CD 38 03 90 08 3B
C268:A9 00 8D 36 03 4C 22 C2 28
C270:A9 00 8D 36 03 8D 38 03 A1
C278:A9 C2 85 7A A9 CF 85 7B EE
C280:20 8B B0 8D C1 02 8D 34 4D
C288:03 8C C2 02 8C 35 03 A9 14
C290:01 20 3C BC 20 97 E0 20 33
C298:E2 BA 20 0C BC A9 05 20 B9
C2A0:3C BC 20 53 B8 AC 35 03 92
C2A8:AE 34 03 20 D4 BB EE 36 9E
C2B0:03 AD 34 03 18 69 05 8D D7
C2B8:34 03 AD 35 03 69 00 8D 6D
C2C0:35 03 AD AB 02 CD 36 03 C8
C2C8:B0 C5 EE 38 03 AD AA 02 9F
C2D0:CD 38 03 90 08 A9 00 8D 29
C2D8:36 03 4C 8F C2 A9 CA 85 94
C2E0:7A A9 CF 85 7B 20 8B B0 84
C2E8:8D B7 02 8C B8 02 A9 D0 1E
```

```
C2F0:85 7A A9 CF 85 7B 20 8B EF
C2F8:B0 8D B9 02 8C BA 02 A9 8E
C300:D6 85 7A A9 CF 85 7B 20 E9
C308:8B B0 8D C7 02 8C C8 02 85
C310:A9 DD 85 7A A9 CF 85 7B 4F
C318:20 8B B0 8D C3 02 8C C4 85
C320:02 A9 E5 85 7A A9 CF 85 C7
C328:7B 20 8B B0 8D C5 02 8C 06
C330:C6 02 A9 ED 85 7A A9 CF E8
C338:85 7B 20 8B B0 8D CB 02 73
C340:8C CC 02 AD B3 02 38 E5 58
C348:2F 8D B3 02 AD B4 02 E5 8B
C350:30 8D B4 02 AD B5 02 38 8A
C358:E5 2F 8D B5 02 AD B6 02 E1
C360:E5 30 8D B6 02 AD B7 02 3C
C368:38 E5 2F 8D B7 02 AD B8 1E
C370:02 E5 30 8D B8 02 AD B9 34
C378:02 38 E5 2F 8D B9 02 AD C3
C380:BA 02 E5 30 8D BA 02 AD AE
C388:BF 02 38 E5 2F 8D BF 02 07
C390:AD C0 02 E5 30 8D C0 02 F8
C398:AD C1 02 38 E5 2F 8D C1 F3
C3A0:02 AD C2 02 E5 30 8D C2 DA
C3A8:02 AD C3 02 38 E5 2F 8D 7A
C3B0:C3 02 AD C4 02 E5 30 8D 32
C3B8:C4 02 AD C5 02 38 E5 2F 21
C3C0:8D C5 02 AD C6 02 38 05 D5
C3C8:8D C6 02 AD C7 02 38 E5 80
C3D0:2F 8D C7 02 AD C8 02 E5 E6
C3D8:30 8D C8 02 AD C9 02 38 E5
C3E0:E5 2F 8D C9 02 AD CA 02 D3
C3E8:E5 30 8D CA 02 AD CB 02 2E
C3F0:38 E5 2F 8D CB 02 AD CC 5B
C3F8:02 E5 30 8D CC 02 AD CD 51
C400:02 38 E5 2D 8D AD 02 AD FC
C408:AE 02 E5 2E 8D AE 02 AD E1
C410:B1 02 38 E5 2D 8D B1 02 5D
C418:AD B2 02 E5 2E 8D B2 02 D2
C420:AD AF 02 38 E5 2D 8D AF DE
C428:02 AD B0 02 E5 2E 8D B0 08
C430:02 AD D2 02 38 E5 2D 8D E1
C438:D2 02 AD D3 02 E5 2E 8D 30
C440:D3 02 AD D4 02 85 7A AD 2D
C448:A8 02 85 7B 60 A9 00 8D 46
C450:BB 02 20 1C CB F0 18 20 70
C458:FD AE 20 9E B7 8E BB 02 EB
C460:E0 00 F0 8D AD AC 02 CD EA
C468:BB 02 B0 03 4C 48 B2 A9 29
```

Another Example

The encoding problem is another classic example of the type of problem the back propagation network can solve. The problem is this: You need to associate four different input patterns with four different output patterns. For the BP network to correctly learn these patterns, it needs to be able to store a representation of these patterns in its middle layer (that is, it needs to learn the correct internal representation). The minimum number of PEs the middle layer can have to represent the association of four different patterns is 2 (see Figure 1). ENCODE correctly learns to encode the four different patterns in its middle layer of PEs.

Although back propagation solves many of the problems of the linear associator, it does introduce many new ones. The major drawback of BP neural networks is the long training time. As you can see, the training times for a simple model, such as XOR, is one minute, 20 seconds. Unfortunately the times do not increase in a simple linear fashion, but rather in an exponential one, based on the number of PEs you have in each layer. The training time for the encoding example is 27 minutes, 49 seconds—nearly half an hour.

The most important problem to those in cognitive science is that the back propagation neural network is not based on neurophysiological data. It was developed to solve the problems of the linear associator. The next article in the series will examine a group of more biologically plausible models, competitive learning neural networks.

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Program 1. BP (cont.)

```

C470:01 8D 36 03 A9 00 8D 38 75
C478:03 20 3C BC A2 CD A0 02 6E
C480:20 D4 BB AD BF 02 18 65 3D
C488:2F 8D 34 03 AD C0 02 65 9D
C490:30 8D 35 03 AE 38 03 AC 75
C498:36 03 AD AA 02 20 AA C6 0B
C4A0:AD 34 03 AC 35 03 20 A2 D1
C4A8:BB AD C9 02 18 65 2F 8D 17
C4B0:34 03 AD CA 02 65 30 8D 0B
C4B8:35 03 AE BB 02 AC 38 03 65
C4C0:AD A9 02 20 AA C6 AD 34 CD
C4C8:03 AC 35 03 20 28 BA A9 96
C4D0:CD A0 02 20 67 B8 EE 38 DF
C4D8:03 AD A9 02 CD 38 03 0B AA
C4E0:9B A9 F2 A0 CF 20 50 B8 63
C4E8:20 ED BF 20 0C BC A9 01 9F
C4F0:20 3C BC 20 6A B8 A9 F7 B4
C4F8:A0 CF 20 0F BB AD B3 02 B9
C500:18 65 2F 8D 34 03 AD B4 6D
C508:02 65 30 8D 35 03 AD 36 14
C510:03 20 90 C6 AE 34 03 AC 9C
C518:35 03 20 D4 BB EE 36 03 59
C520:AD AA 02 CD 36 03 90 03 2C
C528:4C 74 C4 A9 01 8D 36 03 D7
C530:A9 00 8D 38 03 20 3C BC 93
C538:A2 CD A0 02 20 D4 BB AD 36
C540:CL 02 18 65 2F 8D 34 03 A1
C548:AD C2 02 65 30 8D 35 03 17
C550:AE 38 03 AC 36 03 AD AB 31
C558:02 20 AA C6 AD 34 03 AC 9F
C560:35 03 20 A2 BB AD B3 02 73
C568:18 65 2F 8D 34 03 AD B4 D5
C570:02 65 30 8D 35 03 AD 38 7E
C578:03 20 90 C6 AD 34 03 AC FC
C580:35 03 20 28 BA A9 CD A0 A6
C588:02 20 67 B8 EE 38 03 AD A1
C590:AA 02 CD 38 03 B0 A1 A9 F6
C598:F2 A0 CF 20 50 B8 20 ED 55
C5A0:BF 20 0C BC A9 01 20 3C 2F
C5A8:BC 20 6A B8 A9 F7 A0 CF B1
C5B0:20 0F BB AD B5 02 18 65 AD
C5B8:2F 8D 34 03 AD B6 02 65 A7
C5C0:30 8D 35 03 AD 36 03 20 0B
C5C8:90 C6 AE 34 03 AC 35 03 9F
C5D0:20 D4 BB EE 36 03 AD AB 2C
C5D8:02 CD 36 03 90 03 4C 30 29
C5E0:C5 A9 00 20 3C BC A9 01 E4
C5E8:8D 36 03 A2 CD A0 02 20 68
C5F0:D4 BB AD B5 02 18 65 2F 51
C5F8:8D 34 03 AD B6 02 65 30 4C
C600:8D 35 03 AD 36 03 20 90 6B
C608:C6 AD 34 03 AC 35 03 20 7B
C610:A2 BB AD C7 02 18 65 2F 7A
C618:8D 34 03 AD C8 02 65 30 FD
C620:8D 35 03 AD AB 02 AC 36 F1
C628:03 AE BB 02 20 AA C6 AD 61
C630:34 03 AC 35 03 20 50 B8 73
C638:A2 D8 A0 02 20 D4 BB A9 F6
C640:D8 A0 02 20 28 BA A9 CD F1
C648:A0 02 20 67 B8 EE 36 03 12
C650:AD AB 02 CD 36 03 B0 93 6F
C658:AD CB 02 18 65 2F 8D 34 A8
C660:03 AD CC 02 65 30 8D 35 D0
C668:03 AD BB 02 20 90 C6 AE F9
C670:34 03 AC 35 03 20 D4 BB BF
C678:A9 02 20 3C BC AD 34 03 2B
C680:AC 35 03 20 0F BB AE 34 0D
C688:03 AC 35 03 20 D4 BB 60 C5
C690:AA E8 CA F0 14 AD 34 03 D8
C698:18 69 05 8D 34 03 AD 35 44
C6A0:03 69 00 8D 35 03 4C 92 C3
C6A8:C6 F0 8D FD 03 98 48 E8 37
C6B0:CA F0 2C AC FD 03 C8 AD 6B
C6B8:34 03 18 69 05 8D 34 03 84
C6C0:AD F5 03 69 00 8D 35 03 0D
C6C8:88 F0 E5 AD 34 03 18 69 B5
C6D0:05 8D 34 03 AD 35 03 69 AC
C6D8:03 8D 35 03 4C B8 C6 68 1C
C6E0:4C 90 C6 20 DD BD A0 FF BA
C6E8:C8 B9 00 01 D0 FA C8 98 F5
C6F0:48 A9 00 85 22 A9 01 85 A4
C6F8:23 68 20 24 AD 60 20 57 EE
C700:C4 4C 07 C7 20 6F C4 A9 54
C708:01 8D 36 03 AD C7 02 18 1B
C710:65 2F 8D 34 03 AD C8 02 75
C718:65 30 8D 35 03 AD AB 02 93
C720:AC 36 03 AE BB 02 20 AA AF
C728:CC AD 34 03 AC 35 03 20 9D
C730:C6 BA AD B5 02 18 65 2F 30
C738:8D 34 03 AD B6 02 65 30 8F
C740:8D 35 03 AD 36 03 20 90 AD
C748:C6 AD 34 03 AC 35 03 20 BD
C750:A2 BB 20 53 B8 AD 34 03 41
C758:AC 35 03 20 28 BA A2 CD 2D
C760:A0 02 20 D4 BB AD 34 03 12
C768:AC 35 03 20 A2 BB A9 F7 4D
C770:A0 CF 20 50 B8 A9 CD A0 F5
C778:02 20 28 BA AD B9 02 18 32
C780:65 2F 8D 34 03 AD BA 02 C9
C788:65 30 8D 35 03 AD 36 03 1A
C790:20 90 C6 AE 34 03 AC 35 54
C798:03 20 D4 BB A9 00 8D 38 A8
C7A0:03 AD AD 02 18 65 2D 48 EB
C7A8:AD AE 02 65 2E A8 68 20 56
C7B0:A2 BB AD B9 02 18 65 2F 3C
C7B8:8D 34 03 AD BA 02 65 30 30
C7C0:8D 35 03 AD 36 03 20 90 2E
C7C8:C6 AD 34 03 AC 35 03 20 3E
C7D0:28 BA AD B3 02 18 65 2F 7E
C7D8:8D 34 03 AD B4 02 65 30 20
C7E0:8D 35 03 AD 38 03 20 90 5E
C7E8:C6 AD 34 03 AC 35 03 20 5E
C7F0:28 BA A2 CD A0 02 20 D4 96
C7F8:BB AD B1 02 18 65 2D 48 21
C800:AD B2 02 65 2E A8 68 20 B0
C808:A2 BB AD C5 02 18 65 2F 56
C810:8D 34 03 AD C6 02 65 30 E9
C818:8D 35 03 AD AB 02 AC 36 ED
C820:03 AE 38 03 20 AA C6 AD FC
C828:34 03 AC 35 03 20 28 BA 21
C830:A9 CD A0 02 20 67 B8 AE FC
C838:34 03 AC 35 03 20 D4 BB 8B
C840:AD C1 02 18 65 2F 8D 34 12
C848:03 AD C2 02 65 30 8D 35 7B
C850:03 AD AB 02 AC 36 03 AE 57
C858:38 03 20 AA C6 AD 34 03 CD
C860:AC 35 03 20 67 B8 AE 34 A7
C868:03 AC 35 03 20 D4 BB EE 38
C870:38 03 AD AA 02 CD 38 03 F9
C878:90 03 4C A1 C7 EE 36 03 D2
C880:AD AB 02 CD 36 03 90 03 D2
C888:4C 0C C7 A9 01 8D 36 03 84
C890:A9 00 A0 05 99 CC 02 88 E7
C898:D0 FA A9 01 8D 38 03 AD 97
C8A0:B9 02 18 65 2F 8D 34 03 04
C8A8:AD BA 02 65 30 8D 35 03 7B
C8B0:AD 38 03 20 90 C6 AD 34 B8
C8B8:03 AC 35 03 20 A2 BB AD 7E
C8C0:C1 02 18 65 2F 8D 34 03 28
C8C8:AD C2 02 65 30 8D 35 03 9D
C8D0:AD AB 02 AC 38 03 AE 36 90
C8D8:03 20 AA C6 AD 34 03 AC A6
C8E0:35 03 20 28 BA A9 CD A0 0D
C8E8:02 20 67 B8 A2 CD A0 02 8B
C8F0:20 D4 BB EE 38 03 AD AB 03
C8F8:02 CD 38 03 B0 A1 AD B3 51
C900:02 18 65 2F 8D 34 03 AD 2B
C908:B4 02 65 30 8D 35 03 AD 1B
C910:36 03 20 90 C6 AD 34 03 E4
C918:AC 35 03 20 A2 BB A9 F7 01
C920:A0 CF 20 50 B8 AD 34 03 E8
C928:AC 35 03 20 28 BA A9 CD 0F
C930:A0 02 20 28 BA AD B7 02 19
C938:18 65 2F 8D 34 03 AD B8 B1
C940:02 65 30 8D 35 03 AD 36 54
C948:03 20 90 C6 AE 34 03 AC DC
C950:35 03 20 D4 BB A9 00 8D A2
C958:38 03 AD AD 02 18 65 2D C1
C960:48 AD AE 02 65 2E A8 68 17
C968:20 A2 BB AD B7 02 18 65 62
C970:2F 8D 34 03 AD B8 02 65 6F
C978:30 8D 35 03 AD 36 03 20 CA
C980:90 C6 AD 34 03 AC 35 03 3F
C988:20 28 BA AD C9 02 18 65 54
C990:2F 8D 34 03 AD CA 02 65 D7
C998:30 8D 35 03 AD A9 02 AC 43
C9A0:38 03 AE BB 02 20 AA C6 4F
C9A8:AD 34 03 AC 35 03 20 28 69
C9B0:BA A2 CD A0 02 20 D4 BB 04
C9B8:AD B1 02 18 65 2D 48 AD 6F
C9C0:B2 02 65 2E A8 68 20 A2 87
C9C8:BB AD C3 02 18 65 2F 8D 80
C9D0:34 03 AD C4 02 65 30 8D D4
C9D8:35 03 AD AA 02 AC 36 03 5A
C9E0:AE 38 03 20 AA C6 AD 34 3C
C9E8:03 AC 35 03 20 28 BA A9 C0
C9F0:CD A0 02 20 67 B8 AE 34 85
C9F8:03 AC 35 03 20 D4 BB AD 89
CA00:BF 02 18 65 2F 8D 34 03 6A
CA08:AD C0 02 65 30 8D 35 03 60
CA10:AD AA 02 AC 36 03 AE 38 85
CA18:03 20 AA C6 AD 34 03 AC E9
CA20:35 03 20 67 B8 AE 34 03 77
CA28:AC 35 03 20 D4 BB EE 38 6F
CA30:03 AD A9 02 CD 38 03 90 ED
CA38:03 AC 5A C9 EE 36 03 AD 4E
CA40:AA 02 CD 36 03 90 03 4C 75
CA48:90 C8 6D A9 00 20 3C BC B4
CA50:AD D2 02 18 65 2D 8D D4 03
CA58:02 AD D3 02 65 2E 8D D5 C9
CA60:02 AE D4 02 AC D5 02 20 3E
CA68:D4 BB A9 01 8D BB 02 20 1C
CA70:04 C7 AD CB 02 18 65 2F D6
CA78:8D 34 03 AD CC 02 65 30 86
CA80:8D 35 03 AD BB 02 20 90 1C
CA88:C6 AD 34 03 AC 35 03 20 04
CA90:A2 BB AD D4 02 AC D5 02 09
CA98:20 67 B8 AE D4 02 AC D5 F7
CAA0:02 20 D4 BB EE BB 02 AD AD
CAA8:AC 02 CD BB 02 B0 C0 60 3F
CAB0:20 FD AE 20 9E B7 8E FC 9B
CAB8:03 AD AF 02 18 65 2D 8D 8F
CAC0:D6 02 AD B0 02 65 2E 8D 92
CAC8:D7 02 20 4B CA 20 E1 FF 1E
CAD0:F0 2D AD FC 03 F0 11 AD 5B
CAD8:D4 02 AC D5 02 20 A2 BB DD
CAE0:20 E3 C6 A9 0D 20 D2 FF 81
CAE8:AD D4 02 AC D5 02 20 A2 2F
CAF0:BB AD D6 02 AC D7 02 20 B3
CAF8:5B BC 90 01 F0 CC 60 A0 D0
CB00:00 4C 38 A8 20 FD AE 20 B2
CB08:9E B7 8E BB 02 E0 F0 EE
CB10:08 AD AC 02 CD BB 02 B0 DE
CB18:03 4C 48 B2 20 FD AE 20 EE
CB20:9E AD 20 8F AD 20 A6 B6 61
CB28:CD A9 02 D0 EC 8E CD 02 9D
CB30:8C CE 02 A9 00 8D 36 03 42
CB38:A2 01 AC 36 03 AD CD 02 C6
CB40:85 22 AD CE 02 85 23 B1 E3
CB48:22 C9 31 F0 02 A2 00 8A BD
CB50:20 3C BC AD C9 02 18 65 65
CB58:2F 8D 34 03 AD CA 02 65 A3
CB60:30 8D 35 03 AD A9 02 AC 0F
CB68:36 03 C8 AE BB 02 20 AA B0
CB70:C6 AE 34 03 AC 35 03 20 2E
CB78:D4 BB EE 36 03 AD A9 02 CE
CB80:CD 36 03 D0 B3 AD BB 02 C7
CB88:F0 69 20 FD AE 20 9E AD B7
CB90:20 8F AD 20 A6 B6 CD AB 2B
CB98:02 D0 59 8E CD 02 8C CE D7
CBA0:02 A9 00 8D 36 03 A2 01 80
CBA8:AC 36 03 AD CD 02 85 22 03
CBB0:AD CE 02 85 23 B1 22 C9 59
CBB8:31 F0 02 A2 00 8A 20 3C 36
CBC0:BC AD C7 02 18 65 2F 8D 7D
CBC8:34 03 AD C8 02 65 30 8D 11
CBD0:35 03 AD AB 02 AC 36 03 66
CBD8:C8 AE BB 02 20 AA C6 AE FF
CBE0:34 03 AC 35 03 20 D4 BB 3A
CBE8:EE 36 03 AD AB 02 CD 36 F7
CBF0:03 D0 B3 60 4C 48 2 20 C3
CBF8:0E CF 20 FD AE 20 9E AD 50
CC00:20 8F AD 20 A6 B6 8D 36 A6
CC08:03 A0 00 B1 22 99 DD 02 9B
CC10:C8 CC 36 03 F0 04 C0 14 65
CC18:D0 F1 A9 2C 99 DD 02 C8 9F
CC20:A9 57 99 DD 02 C8 98 A2 7C
CC28:DD A0 02 20 BD FA A9 01 5D
CC30:A2 08 A0 02 20 BF AF 20 5D
CC38:C0 FF A2 0F 20 C6 FF 20 B3
CC40:CF FF C9 30 F0 03 4C AD 77
CC48:CD 20 CC FF A2 01 20 C9 8D
CC50:FF AD A9 02 20 D2 FF AD A4
CC58:AA 02 D0 D2 FF AD AB 02 09

```


Program 1. BP (cont.)

```
CC60:20 D2 FF AD AC 02 20 D2 1A
CC68:FF AE AD 02 AC AE 02 20 C7
CC70:F9 CC AE B1 02 AC B2 02 55
CC78:20 F9 CC AE AF 02 AC B0 B4
CC80:02 20 F9 CC AD BF 02 85 25
CC88:22 AD C0 02 85 23 AC AA 93
CC90:02 AE A9 02 20 11 CD AD BA
CC98:C1 02 85 22 AD C2 02 85 68
CCA0:23 AC AB 02 AE AA 02 20 D0
CCA8:11 CD AD C3 02 85 22 AD 48
CCB0:C4 02 85 23 AC AA 02 AE D2
CCB8:A9 02 20 11 CD AD C5 02 6F
CCC0:85 22 AD C6 02 85 23 AC E0
CCC8:AB 02 AE AA 02 20 11 CD B9
CCD0:AD C9 02 85 22 AD CA 02 AB
CCD8:85 23 AC A9 02 AE AC 02 54
CCE0:20 11 CD AD C7 02 85 22 D6
CCE8:AD C8 02 85 23 AC AB 02 49
CCF0:AE AC 02 20 11 CD 4C 20 C7
CCF8:CF 8A 18 65 2D 85 22 98 D2
CD00:65 2E 85 23 A0 00 B1 22 47
CD08:20 D2 FF C8 C0 05 D0 F6 A7
CD10:60 A5 2F 18 65 22 85 22 8D
CD18:A5 30 65 23 85 23 C8 8C 48
CD20:36 03 8C CD 02 E8 8E 38 0F
CD28:03 A0 00 A2 05 B1 22 20 EA
CD30:D2 FF C8 D0 02 E6 23 CA 18
CD38:D0 F3 A2 05 CE 36 03 D0 04
CD40:EC AD CD 02 8D 36 03 CE B1
CD48:38 03 D0 E1 60 20 D2 FF 22
CD50:20 CF FF C9 0D D0 F6 20 46
CD58:D2 FF 20 E7 FF 20 7A A6 FB
CD60:4C 74 A4 20 0E CF 20 FD C3
CD68:AE 20 9E AD 20 8F AD 20 CC
CD70:A6 B6 8D 36 03 A0 00 B1 6E
CD78:22 99 DD 02 C8 C0 36 03 50
CD80:F0 04 C0 14 D0 F1 A9 2C BC
CD88:99 DD 02 C8 A9 52 99 DD DC
CD90:02 C8 98 A2 DD A0 02 20 32
CD98:BD FF A9 01 A2 08 A0 02 D0
CDA0:20 BA FF 20 C0 FF A2 0F 57
CDA8:20 C6 FF 20 CF FF C9 30 4A
CDB0:D0 9B 20 CC FF A2 01 20 19
CDB8:C6 FF 20 CF FF 8D A9 02 44
CDC0:20 CF FF 8D AA 02 20 CF A6
CDC8:FF 8D AB 02 20 CF FF 8D 2B
CDD0:AC 02 20 B9 CE AE AD 02 71
CDD8:AC AE 02 20 65 CE AE B1 2E
CDE0:02 AC B2 02 20 65 CE AE 02
CDE8:AF 02 AC B0 02 20 65 CE A7
CDF0:AD BF 02 85 22 AD C0 02 37
CDF8:85 23 AC AA 02 AE A9 02 80
CE00:20 7D CE AD C1 02 85 22 05
CE08:AD C2 02 85 23 AC AB 02 EA
CE10:AE AA 02 20 7D CE AD C3 38
CE18:02 85 22 AD C4 02 85 23 93
CE20:AC AA 02 AE A9 02 20 7D FC
CE28:CE AD C5 02 85 22 AD C6 48
CE30:02 85 23 AC AB 02 AE AA CC
CE38:02 20 7D CE AD C9 02 85 99
CE40:22 AD CA 02 85 23 AC A9 8F
CE48:02 AE AC 02 20 7D CE AD 8A
CE50:C7 02 85 22 AD C8 02 85 3F
CE58:23 AC AB 02 AE AC 02 20 94
CE60:7D CE 4C 20 CF 8A 18 65 3A
CE68:2D 85 22 98 65 2E 85 23 DD
CE70:A0 00 20 CF FF 91 22 C8 B2
CE78:C0 05 D0 F6 60 A5 2F 18 51
CE80:65 22 85 22 A5 30 65 23 08
CE88:85 23 C8 8C 36 03 8C CD 38
CE90:02 E8 8E 38 03 A0 00 A2 FB
CE98:05 20 CF FF 91 22 C8 D0 32
CEA0:02 E6 23 CA D0 F3 A2 05 AA
CEA8:CE 36 03 D0 EC AD CD 02 64
CEB0:8D 36 03 CE 38 03 D0 E1 41
CEB8:60 A5 37 A4 38 85 33 84 E3
CEC0:34 A5 2D A4 2E 85 2F 84 3C
CEC8:30 85 31 84 32 A5 7A 8D F8
CED0:A7 02 A5 7B 8D A8 02 A9 EB
CED8:8B 85 7A A9 CF 85 7B 20 33
CEE0:8B B0 8D AD 02 8C AE 02 9E
CEE8:A9 8E 85 7A A9 CF 85 7B 6A
CEF0:20 8B B0 8D B1 02 8C B2 D1
CEF8:02 A9 91 85 7A A9 CF 85 2C
```

```
CF00:7B 20 8B B0 8D AF 02 8C 9D
CF08:B0 02 20 E2 C0 60 A9 00 8D
CF10:20 BD FF A9 0F A2 08 A0 7D
CF18:0F 20 BA FF 20 C0 FF 60 03
CF20:20 CC FF A9 01 20 C3 FF AD
CF28:A9 0F 20 C3 FF 60 4F 32 F2
CF30:28 50 32 29 2C 4F 33 28 FD
CF38:50 33 29 2C 45 32 28 50 48
CF40:32 29 2C 45 33 28 50 33 2B
CF48:29 2C 57 31 28 50 32 2C 98
CF50:50 31 29 2C 57 32 28 50 70
CF58:33 2C 50 32 29 2C 4D 31 8F
CF60:28 50 32 2C 50 31 29 2C F6
CF68:4D 32 28 50 33 2C 50 32 62
CF70:29 2C 54 28 50 33 2C 4E B2
CF78:50 29 2C 49 4E 28 50 31 89
```

```
CF80:2C 4E 50 29 2C 45 28 4E 7B
CF88:50 29 00 52 41 00 4D 4F B3
CF90:00 45 50 00 50 31 00 50 23
CF98:32 00 50 33 00 4E 50 00 68
CFA0:4F 31 28 30 29 00 4F 32 56
CFA8:28 30 29 00 4F 33 28 30 55
CFB0:29 00 49 4E 28 30 2C 30 7D
CFB8:29 00 57 31 28 30 2C 30 75
CFC0:29 00 57 32 28 30 2C 30 8D
CFC8:29 00 45 32 28 30 29 00 1D
CFD0:45 33 28 30 29 00 54 28 02
CFD8:30 2C 30 29 00 4D 31 28 F3
CFE0:30 2C 30 29 00 4D 32 28 FD
CFE8:30 2C 30 29 00 45 28 30 D9
CFF0:29 00 00 00 00 00 00 81 A6
CFF8:00 00 00 00 54 45 00 00 50
```

Program 2. XOR

```
HR 10 REM COPYRIGHT 1990 COMPU
TE! PUBLICATIONS INC. -
{SPACE}ALL RIGHTS RESERV
ED
GP 20 PRINT"{CLR}{5}{N}":POKE5
3280,0:POKE53281,11
QQ 30 IF PEEK(49153)<>24 OR PE
EK(49157)<>196 THEN LOAD
"BP.ML",8,1
PC 40 X=RND(-33333)
SD 50 SYS 49152,2,2,1,4,0.25,0
.9,0.02
CJ 60 SYS 49167,1,"00","0"
QQ 70 SYS 49167,2,"10","1"
ER 80 SYS 49167,3,"01","1"
FC 90 SYS 49167,4,"11","0"
DQ 100 PRINT"LEARNING PATTERNS
"
KS 110 PRINT
KD 120 PRINT"THE TOTAL ERROR I
S:"
```

```
BX 130 TI$="000000"
GK 140 SYS 49164,1
CS 150 PRINT"TIME SPENT LEARNI
NG :";TI$
KG 160 PRINT"{DOWN}RESULTS:
{DOWN}"
XG 170 SYS49155,"00"
HE 180 PRINT "0 XOR 0 =";INT(O
3(1)+0.5);
KH 190 PRINT " (";O3(1);)"
JJ 200 SYS49155,"10"
MF 210 PRINT "1 XOR 0 =";INT(O
3(1)+0.5);
JG 220 PRINT " (";O3(1);)"
DM 230 SYS49155,"01"
BJ 240 PRINT "0 XOR 1 =";INT(O
3(1)+0.5);
QE 250 PRINT " (";O3(1);)"
BX 260 SYS49155,"11"
DP 270 PRINT "1 XOR 1 =";INT(O
3(1)+0.5);
AK 280 PRINT " (";O3(1);)"
```

Program 3. ENCODE

```
HR 10 REM COPYRIGHT 1990 COMPU
TE! PUBLICATIONS INC. -
{SPACE}ALL RIGHTS RESERV
ED
GP 20 PRINT"{CLR}{5}{N}":POKE5
3280,0:POKE53281,11
QQ 30 IF PEEK(49153)<>24 OR PE
EK(49157)<>196 THEN LOAD
"BP.ML",8,1
CM 40 X=RND(-11111)
GQ 50 SYS 49152,4,2,4,4,0.25,0
.9,0.02
DX 60 SYS 49167,1,"1000","0010"
MR 70 SYS 49167,2,"0100","0001"
FQ 80 SYS 49167,3,"0010","1000"
DF 90 SYS 49167,4,"0001","0100"
DQ 100 PRINT"LEARNING PATTERNS
"
KS 110 PRINT
KD 120 PRINT"THE TOTAL ERROR I
S:"
BX 130 TI$="000000"
GK 140 SYS 49164,1
JJ 150 PRINT"TIME SPENT LEARNI
NG :";TI$:PRINT"PRINT"
RESULTS:"
RF 160 PRINT"{3 SPACES}LAYER
{6 SPACES}LAYER
{7 SPACES}LAYER"
SK 170 PRINT"{4 SPACES}ONE
{8 SPACES}TWO{8 SPACES}
THREE"
AC 180 SYS49155,"1000"
CC 190 PRINT "1{2 SPACES}0
```

```
{2 SPACES}0{2 SPACES}0
{SPACE}-->";INT(O2(1)+0
.5);INT(O2(2)+0.5);"-->
";
DC 200 FOR I= 1 TO 4
HB 210 PRINT INT(O3(I)+0.5);
QD 220 NEXT I
PG 230 PRINT
MB 240 SYS49155,"0100"
MS 250 PRINT "0{2 SPACES}1
{2 SPACES}0{2 SPACES}0
{SPACE}-->";INT(O2(1)+0
.5);INT(O2(2)+0.5);"-->
";
PG 260 FOR I= 1 TO 4
XE 270 PRINT INT(O3(I)+0.5);
EH 280 NEXT I
DM 290 PRINT
QE 300 SYS49155,"0010"
CP 310 PRINT "0{2 SPACES}0
{2 SPACES}1{2 SPACES}0
{SPACE}-->";INT(O2(1)+0
.5);INT(O2(2)+0.5);"-->
";
GM 320 FOR I= 1 TO 4
JK 330 PRINT INT(O3(I)+0.5);
XP 340 NEXT I
GR 350 PRINT
FK 360 SYS49155,"0001"
JG 370 PRINT "0{2 SPACES}0
{2 SPACES}0{2 SPACES}1
{SPACE}-->";INT(O2(1)+0
.5);INT(O2(2)+0.5);"-->
";
SS 380 FOR I= 1 TO 4
AR 390 PRINT INT(O3(I)+0.5);
CS 400 NEXT I
SB 410 PRINT
```

EDITOR'S
CHOICE

QEWB

Robert Bixby

Here's an electronic jigsaw puzzle with a twist, a slide, and a spin. This mind bender for the 64 will keep you coming back again and again.

Jigsaw puzzles have entertained people for decades, but there's one problem with them: Once you've completed a puzzle, you must either undo your work and start over or get a new puzzle.

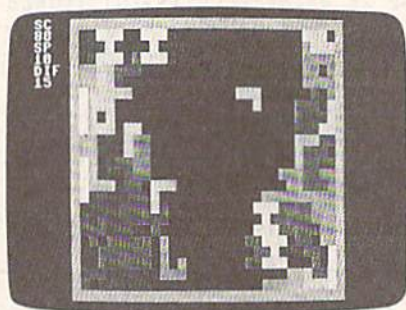
Qewb is an animated electronic jigsaw puzzle that solves this problem once and for all. With its revolving game board, rotating pieces, and multiple difficulty levels, *Qewb* provides an unlimited number of puzzles in a single package.

Typing It In

Qewb is written entirely in machine language, so you must use *MLX*, the machine language entry program found elsewhere in this issue, to enter it. The *MLX* prompts, and the values you should enter, are as follows:

Starting address: 0801

Ending address: 19A0



In Qewb, the double-sided-board option makes for an especially challenging game.

Follow the *MLX* instructions carefully, and be sure to save a copy of the program to disk or tape before you exit *MLX*. To start *Qewb*, simply load and run it as you would any BASIC program.

The object of *Qewb* is to position as many pieces on the board as possible. In order to do this, you must place the pieces next to one another without leaving gaps. On the lower levels, the pieces are simple and fit together easily. Later, they become more complex and are more difficult to position.

Game Options

When you run *Qewb*, you'll see the first option screen. From here, you can adjust the difficulty of the game in two ways. First, you can make the game harder or easier by pressing H or E, respectively. Second, you can change the game's speed setting: Press S to slow the game; press F to make it faster. After you've set the difficulty level, press RETURN to continue.

The next option screen describes the game controls and also allows you to pick the type of game that you'll play. You can choose between a revolving or a stationary game board, rotating or nonrotating pieces, and a single- or a double-sided board.

The revolving-board option causes the board to scroll from bottom to top each time a new piece appears. As pieces move off the top of the screen, they reappear at the bottom. Choosing this option generally makes the game easier to play.

The rotating-pieces option causes a piece to rotate as it moves across the board. Each piece rotates a quarter turn as it moves one space. This option

makes placing pieces especially challenging at greater speeds.

The single-/double-sided board option lets you place pieces on one or both sides of the board, respectively. Gameplay is easier with a single-sided board because you only need to concentrate on one side of the board at once. When you've set all the options, press RETURN to begin play.

Playing the Game

The game board itself occupies most of the playing screen. Your score, the speed, and the difficulty setting are also displayed. As the game begins, the game board is empty and pieces begin to appear one at a time. Each piece moves directly to the side of the board unless you change its path. If you're playing a double-sided game, a piece appears in the center of the board and moves to one side or the other. If you're playing a single-sided game, the piece appears on the right side and moves to the left.

You can move a piece toward the top of the board by pressing J. Pressing L moves it toward the bottom of the board. If you haven't selected the automatic-rotation option from the second option screen, you can rotate a piece by pressing K.

Pieces can be seated manually or automatically. If the current piece comes into contact with another piece as it moves toward the side of the board, the piece seats itself automatically. Because seating doesn't occur immediately upon contact, you'll have a brief moment to slide the piece before it's permanently positioned. If you want to seat a piece manually, press the space bar; the piece will move directly to the side of the board.

To pause a game at any time, press the RUN/STOP key. To continue play, press any other key. To abort the current game, press the back-arrow key (+).

When a game is over, *Qewb* prompts you for your name and then displays the high scores for the session. To play another game, press Y; to exit to BASIC, press N.

Qewb

```
0801:0B 08 FF FF 9E 32 32 38 F2
0809:38 0D EE 08 FF FF 8F 22 D4
0811:0D 0D 0D 0D 0D 0D 0D 21
0819:0D 0D 0D 0D 0D 0D 0D 29
0821:0D 0D 0D 0D 0D 0D 0D 31
0829:20 20 20 20 20 20 20 39
0831:20 20 20 20 B0 C0 C0 C0 2A
0839:C0 C0 C0 C0 C0 C0 C0 49
0841:C0 C0 C0 AE 0D 20 20 2E
0849:20 20 20 20 B0 C0 C0 7D
0851:C0 BD 43 4F 50 59 52 49 64
0859:47 48 54 20 31 39 38 39 C3
0861:AD C0 C0 C0 AE 0D 20 20 A6
0869:20 20 20 20 20 20 DD 43 18
0871:4F 4D 50 55 54 45 21 20 F5
0879:20 50 55 42 4C 49 43 41 CB
```

```
0881:54 49 4F 4E 53 DD 0D 20 29
0889:20 20 20 20 20 20 AD 27
0891:C0 C0 AE 33 32 34 20 20 FD
0899:57 2E 20 57 45 4E 44 4F 95
08A1:56 45 52 B0 C0 C0 BD 0D 15
08A9:20 20 20 20 20 20 B9
08B1:20 20 20 AD AE 47 52 45 35
08B9:45 4E 53 42 4F 52 4F 2C 1D
08C1:20 4E 43 B0 BD 0D 20 20 6B
08C9:20 20 20 20 20 20 20 D9
08D1:20 20 AD C0 C0 C0 C0 07
08D9:C0 C0 C0 C0 C0 C0 C0 E9
08E1:C0 BD 0D 0D 0D 0D 0D F7
08E9:0D 0D 0D 0D 00 00 A9 DF
08F1:00 8D 20 D0 8D 21 D0 A9 B2
08F9:90 20 D2 FF EA EA EA 20 AD
0901:B5 18 4C 50 09 51 45 57 F1
0909:42 72 2E 20 62 49 58 42 CB
0911:59 43 2F 4F 20 63 6F 6D 56
0919:70 75 74 65 21 20 62 4F 43
0921:4F 4B 53 33 32 34 20 77 65
0929:2E 20 77 45 4E 44 4F 56 16
0931:45 52 73 55 49 54 45 20 84
0939:32 30 30 67 52 45 45 4E 6D
0941:53 42 4F 52 4F 2C 20 6E 76
0949:63 20 32 37 34 30 35 20 BB
0951:21 0A 20 5F 0D 4C 60 0F D9
0959:A0 00 A5 C5 C9 02 08 06 CA
0961:A9 00 8D E4 18 60 C9 07 25
0969:D0 04 A9 01 D0 F4 88 D0 66
0971:E9 AD 1B D4 29 01 4C 63 DD
0979:09 20 20 44 09 06 06 09 D5
0981:03 15 0C 14 19 20 4C 05 04
0989:16 05 0C 20 20 20 20 4D
0991:20 20 47 01 0D 05 20 53 C4
0999:10 05 05 04 20 20 20 B7
09A1:20 05 20 12 68 92 20 4D 45
09A9:41 4B 45 53 20 47 41 4D FA
09B1:45 20 48 41 52 44 45 52 0C
09B9:2C 20 12 65 92 20 4D 41 73
09C1:4B 45 53 20 49 5D 20 45 58
09C9:41 53 49 45 52 0D 20 12 E7
09D1:66 92 20 4D 41 4B 45 53 A9
09D9:20 47 41 4D 45 20 46 41 43
09E1:53 54 45 52 2C 20 12 73 F9
09E9:92 20 4D 41 4B 45 53 20 41
09F1:49 54 20 53 4C 4F 57 45 8A
09F9:52 0D 20 20 20 20 70 B0
0A01:52 45 53 53 20 12 72 45 A2
0A09:54 55 52 4E 92 20 54 4F D8
0A11:20 4D 41 4B 45 20 53 45 FB
0A19:4C 45 43 54 49 4F 4E 00 76
0A21:A9 93 20 D2 FF A2 0A A0 5F
0A29:00 18 20 F0 FF A0 00 B9 92
0A31:A2 09 F0 07 20 D2 FF C8 7C
0A39:4C 30 0A A0 00 B9 7A 09 AF
0A41:99 32 04 A9 A0 99 5A 04 ED
0A49:B9 8E 09 99 AA 04 A9 A0 F1
0A51:99 D2 04 C8 C0 14 90 E5 51
0A59:A9 C8 8D 6F 04 A9 C5 8D FC
0A61:58 04 A9 C6 8D E7 04 A9 02
0A69:D3 8D D0 04 A0 00 02 00 6F
0A71:A9 01 99 5A D8 C8 CC E2 D9
0A79:18 90 F5 9D D2 D8 E8 EC 0F
0A81:E5 18 90 F7 A9 02 99 5A 03
0A89:D8 C8 C0 14 90 F6 9D D2 04
0A91:D8 E8 E0 14 90 F8 A5 C5 23
0A99:C9 40 F0 FA C9 0E D0 10 A8
0AA1:CE E2 18 AD E2 18 D0 4F 1C
0AA9:A9 01 8D E2 18 4C F8 0A A0
0AB1:C9 1D 0D 12 EE E2 18 AD 0E
0AB9:E2 18 C9 14 90 39 A9 13 8F
0AC1:8D E2 18 4C F8 0A C9 0D AD
0AC9:D0 10 CE E5 18 AD E5 18 DD
0AD1:D0 25 A9 01 8D E5 18 4C 5D
0AD9:F8 0A C9 15 D0 12 EE E5 0A
0AE1:18 AD E5 18 C9 14 90 0F 7A
0AE9:A9 13 8D E5 18 4C F8 0A 95
0AF1:C9 01 D0 03 4C A0 0C 20 92
0AF9:FE 0A 4C 6D 0A A2 00 A0 EB
0B01:80 CA D0 FD 88 D0 FA 60 E1
0B09:93 0D 0D 0D 20 20 20 80
0B11:73 45 54 20 53 50 45 43 68
0B19:49 41 4C 20 50 52 4F 50 6A
0B21:45 52 54 49 45 53 20 20 65
```

Qewb

Table with 30 columns and 1000 rows of alphanumeric data. Columns are labeled with hex values from 0DD1 to 1071. Each row contains a sequence of characters representing a specific data point.

15C9:05 99 00 06 99 00 07 A9 C1
 15D1:0F 99 00 D8 99 00 D9 99 91
 15D9:00 DA 99 00 DB C8 D0 E1 73
 15E1:60 00 08 10 18 20 28 30 FF
 15E9:38 40 48 A0 00 8C F7 18 8D
 15F1:A2 01 B9 09 19 DD 09 19 E0
 15F9:90 08 F0 12 20 1F 16 4C A3
 1601:F3 15 C8 E8 E0 09 90 EA 4B
 1609:AD F7 18 D0 DE 60 B9 F9 FF
 1611:18 DD F9 18 90 EC F0 EA 86
 1619:20 1F 16 4C 03 16 B9 09 91
 1621:19 48 BD 09 19 99 09 19 8E
 1629:68 9D 09 19 B9 F9 18 48 D1
 1631:BD F9 18 99 F9 18 68 9D F5
 1639:F9 18 8C F5 18 8E F4 18 56
 1641:B9 E2 15 A8 BD E2 15 AA 7E
 1649:A9 00 8D F7 18 B9 29 19 8E
 1651:48 BD 29 19 99 29 19 68 D3
 1659:9D 29 19 E8 C8 EE F7 18 5A
 1661:AD F7 18 C9 08 90 E6 AE 01
 1669:F4 18 AC F5 18 A9 01 8D 02
 1671:F7 18 60 53 30 3A 51 45 33
 1679:57 42 2E 41 52 43 93 0D 8F
 1681:20 20 20 20 20 20 20 AD
 1689:20 73 41 56 45 20 54 48 CB
 1691:49 53 20 50 45 52 46 4F 8F
 1699:52 4D 41 4E 43 45 3F 0D 0A
 16A1:20 28 73 43 52 41 54 43 0E
 16A9:48 45 53 20 4F 4C 44 20 0C
 16B1:20 71 45 57 42 20 41 4E CB
 16B9:44 20 52 45 50 4C 41 43 28
 16C1:45 53 20 49 54 2E 29 0D B8
 16C9:20 20 20 20 20 20 20 F5
 16D1:20 20 20 20 20 20 3C 1A
 16D9:79 2F 6E 3E 00 A0 00 A5 68
 16E1:C5 C9 40 D0 F8 B9 7F 16 3C
 16E9:F0 06 20 D2 F0 C8 D0 F5 FB
 16F1:A5 C5 C9 40 FF FA C9 19 BF
 16F9:F0 0B 68 68 A9 00 85 C6 14
 1701:A9 93 4C D2 FF A9 0D 20 80
 1709:D2 FF A9 0F A2 08 A0 0F 4C

1711:20 BA FF A9 0B A2 74 A0 05
 1719:16 20 BD FF 20 C0 FF A2 B8
 1721:0F 20 C6 FF 20 E4 FF 20 6C
 1729:D2 FF C9 0D D0 F6 20 D2 40
 1731:FF A9 08 AA A8 20 BA FF B0
 1739:A9 0A A2 75 A0 16 20 BD C5
 1741:FF A9 E1 85 FB A9 18 85 AA
 1749:FC A9 FB A2 99 A0 19 20 AB
 1751:D8 FF A2 0F 20 C6 FF 20 6D
 1759:E4 FF 20 D2 FF C9 0D D0 3D
 1761:F6 A9 0D 20 D2 FF A9 08 0B
 1769:20 C3 FF A9 0F 20 C3 FF B3
 1771:20 CC FF A2 00 85 C6 00 11
 1779:A9 0F A2 08 A0 FF 20 BA 51
 1781:FF A9 00 A2 00 A0 00 20 E6
 1789:BD FF 20 C0 FF A2 0F 20 6F
 1791:C6 FF 20 E4 FF 20 D2 FF 9B
 1799:C9 0D D0 F6 20 D2 FF A9 6F
 17A1:08 AA A8 20 BA FF A9 0A C8
 17A9:A2 75 A0 16 20 BD FF A9 9D
 17B1:00 A2 E1 A0 18 20 D5 FF BB
 17B9:A2 0F 20 C6 FF 20 E4 FF B7
 17C1:20 D2 FF C9 0D D0 F6 A9 94
 17C9:0D 20 D2 FF A9 08 20 C3 52
 17D1:FF A9 0F 20 C3 FF 20 CC 79
 17D9:FF A2 00 85 C6 60 93 0D F4
 17E1:0D 0D 08 0E 1C 20 20 7D
 17E9:20 20 20 20 20 71 71 20 FF
 17F1:20 20 20 65 65 65 20 20 B3
 17F9:77 20 77 20 77 20 62 62 BB
 1801:62 62 0D 05 20 20 20 20 CE
 1809:20 20 20 71 20 20 71 20 F0
 1811:20 20 65 20 20 20 20 77 41
 1819:20 77 20 77 20 20 62 20 19
 1821:20 62 0D 1F 20 20 20 20 6F
 1829:20 20 20 71 20 20 71 20 11
 1831:20 20 65 65 20 20 20 77 B5
 1839:20 77 20 77 20 20 62 62 7B
 1841:62 0D 05 20 20 20 20 20 6A
 1849:20 20 71 20 71 71 20 20 73
 1851:20 65 20 20 20 20 77 20 81

1859:77 20 77 20 20 62 20 20 29
 1861:62 0D 1C 20 20 20 20 20 6D
 1869:20 20 20 71 71 20 71 20 DB
 1871:20 65 65 65 20 20 20 77 47
 1879:20 77 20 20 20 62 62 62 4F
 1881:0D 0D 0D 0D 0D 0D 0D B1
 1889:0D 1E 6D 3F 50 59 52 49 FE
 1891:47 48 54 20 28 63 29 20 45
 1899:31 39 38 39 20 63 6F 6D 26
 18A1:70 75 74 65 21 20 70 55 0C
 18A9:42 4C 49 43 41 54 49 4F A8
 18B1:4E 53 00 00 A0 00 8C 20 1C
 18B9:0D 8C 21 D0 B9 DF 17 F0 13
 18C1:07 20 D2 FF C8 4C BD 18 E2
 18C9:A2 00 A0 00 A9 08 8D B4 9C
 18D1:18 CA D0 FD 88 D0 FA CE 07
 18D9:B4 18 AD B4 18 D0 F2 60 B5
 18E1:00 0A 00 01 0A 05 0F 0A 31
 18E9:01 01 00 07 02 08 0B 01 92
 18F1:00 01 00 07 06 00 00 FF 03
 18F9:00 00 00 00 12 14 87 22
 1901:8D 00 00 00 00 00 00 00 F9
 1909:00 00 00 00 00 00 00 00 3B
 1911:00 00 00 00 00 00 00 00 43
 1919:20 20 20 20 20 20 20 20 4B
 1921:00 00 00 00 00 00 00 00 53
 1929:20 20 20 20 20 20 20 20 5B
 1931:20 20 20 20 20 20 20 20 63
 1939:20 20 20 20 20 20 20 20 6B
 1941:20 20 20 20 20 20 20 20 73
 1949:20 20 20 20 20 20 20 20 7B
 1951:48 4F 42 42 53 20 20 20 63
 1959:43 41 4C 56 49 4E 20 20 50
 1961:42 49 4C 4C 20 20 43 41 54 3A
 1969:4F 50 55 53 20 20 20 20 19
 1971:20 20 20 20 20 20 20 20 A3
 1979:20 20 20 20 20 20 20 20 AB
 1981:20 20 20 20 20 20 20 20 B3
 1989:20 20 20 20 20 20 20 20 BB
 1991:20 20 20 20 20 20 20 20 C3
 1999:00 00 00 00 00 00 00 00 CB **G**



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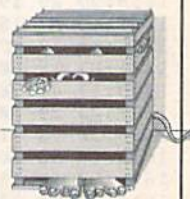
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PINHEAD

James Merlo

Quick reflexes are what you'll need to master this fast-paced, arcade-style game for the 64. Game paddles or joystick required.

The circus is in town. The show's about to begin. But wait, where did all those balloons come from? They're floating around the top of the tent and you—a lowly clown—have been elected to get them down.

Suddenly, you have an idea. You insert a straight pin through your cap and climb onto a trampoline. You begin to bounce. There's a balloon directly overhead. Just maybe. . . . Now, one big jump. Wham! You just scored in *Pinhead*.

Pinhead is an addictive, fast-action game written entirely in machine language. The object of this game is to pop as many balloons as you can using a clown that you bounce from a trampoline. As the game proceeds, the balloons and the clown move ever faster, ultimately reaching a frenetic pace.

Getting Started

Since *Pinhead* is written in machine language, you'll need to type it in using *MLX*, the machine language entry program found elsewhere in this issue. When *MLX* prompts you, respond with the values given below.

Starting address 0801
Ending address 17C0

When you've finished typing in the program, be sure to save a copy of it before exiting *MLX*.

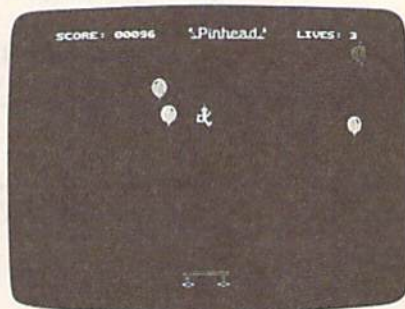
Pinhead loads and runs like a BASIC program. When you're ready to play, plug a set of game paddles into port 1 or a joystick into port 2. Then load the program and type RUN. For a paddle-controlled game (the default), press f1; for joystick control, press f3.

Point of Attack

When the game begins, your clown stands poised on a trampoline at the bottom of the screen. Your score and the number of clowns remaining (four) are indicated at the top. After a moment,

balloons begin to drift across the screen. Pick out a balloon to pop and use the game paddles or the joystick to maneuver the trampoline under it. Then, when you're ready, press the fire button to launch the clown from the trampoline.

If you strike the target balloon at an angle, the clown will change direction. Position the trampoline beneath the descending clown. The closer the clown is to the center of the trampoline when it lands, the higher it bounces. To give the trampoline extra spring, hold down the fire button. If the bouncing clown misses the trampoline and hits the ground, you lose a life.



Acrophobics beware! You'll soar to dizzying heights to pop these balloons.

Scoring is based on the size and speed of the balloons you pop. The smaller and faster a balloon is, the more points you receive for popping it. Also, you're awarded an extra life every 2000 points.

As the game progresses, the clown and balloons move faster. Once you've scored 300 points, the clown speeds up. At 500 points, the balloons start moving faster. At the 1500-point mark, the clown speeds up again. The last increase occurs at the 2000-point barrier, when the balloons reach maximum speed.

The game ends when you no long-

er have any clowns. To start a new game, press the fire button.

Pinhead

0801:0E	08	25	00	9E	32	30	36	13	0A81:3C	7E	28	1E	1A	22	01	42	D7	0D29:00	00	00	00	00	00	00	00	00	00	43
0809:34	20	20	20	00	00	00	AD	EE	0A89:F8	00	5E	08	03	FF	80	01	80	0D31:00	00	00	00	00	00	00	00	33	09	BA
0811:11	D0	29	EF	8D	11	D0	78	CC	0A91:FF	00	00	FE	18	FE	D3	F8	F2	0D39:F0	FF	96	7E	1F	B4	8A	7C	E3	80	
0819:A9	34	85	01	A0	C4	B9	3C	93	0AA1:76	07	FC	24	CC	FC	55	78	02	0D41:CE	D6	E6	E7	0B	F0	30	30	E0	83	
0821:08	99	F8	00	E0	83	B0	06	37	0AA9:6C	82	B0	C4	E3	67	E1	71	E8	0D49:30	F3	81	71	00	1D	FE	72	A4		
0829:B9	E7	08	99	33	03	88	D0	32	0AB1:22	3A	C4	85	CF	71	9F	10	E9	0D51:20	22	3C	E4	A1	CC	CC	FE	B2		
0831:ED	A9	64	85	2D	A9	41	85	9F	0AB9:38	BF	11	10	36	42	48	64	AC	0D59:0C	0C	FB	C0	38	06	FC	A0	7C		
0839:2E	4C	00	01	10	F0	07	63	39	0AC1:7E	00	00	3C	00	00	18	00	09	0D61:07	C0	FC	D6	43	FE	C6	0C	EB		
0841:59	4A	16	B9	58	09	99	E8	F1	0AC9:00	18	F4	F8	4F	C5	43	45	6F	0D69:18	30	F7	A0	51	00	07	7C	B9		
0849:F7	C8	D0	F7	EE	02	01	EE	19	0AD1:80	08	0D	F9	13	FC	21	51	89	0D71:C6	7E	06	7C	5C	03	46	18	AA		
0851:05	01	C6	F9	ED	A2	03	23		0AD9:A2	80	21	20	16	19	02	E2	81	0D79:80	F8	FF	00	00	00	00	00	00	12	
0859:20	34	03	F0	33	C9	07	D0	95	0AE1:07	0A	31	1E	28	42	A6	7C	18	0D81:00	00	00	00	00	00	00	00	00	9B	
0861:16	A2	01	20	34	03	D0	0A	A0	0AE9:00	D5	03	3F	80	06	7F	C0	A3	0D89:00	00	00	00	00	00	00	00	00	A3	
0869:A2	04	20	34	03	18	69	07	65	0AF1:06	21	F8	2C	43	E0	C0	20	72	0D91:00	00	00	00	00	00	00	00	00	AB	
0871:10	05	A2	0E	20	34	03	85	5D	0AF9:E0	8A	80	B0	81	16	FF	80	21	0D99:00	00	00	00	00	00	00	00	00	B3	
0879:A8	A5	A7	85	A9	A5	FE	85	FB	0B01:01	FF	00	00	FE	00	00	38	C7	0DA1:00	00	00	00	00	00	00	00	00	BB	
0881:F7	A5	FF	85	F8	A5	F7	85	FE	0B09:00	00	10	00	00	10	E9	42	77	0DA9:00	00	00	00	00	00	00	00	00	C3	
0889:A5	F8	85	FF	A5	F7	85	FE	72	0B11:12	00	00	00	00	00	00	5F	10	0DB1:00	00	00	00	00	00	00	00	00	CB	
0891:E8	20	34	03	D0	19	A0	02	03	0B19:A1	03	FC	A1	22	FE	60	48	90	0DB9:00	00	00	00	00	00	00	00	00	D3	
0899:D0	1D	85	A6	18	A5	FC	65	2B	0B21:70	40	04	84	80	68	11	02	12	0DC9:00	00	00	00	00	00	00	00	00	E3	
08A1:A6	85	F7	A5	FD	65	A7	85	1A	0B29:03	FF	0E	4E	E8	E2	91	B3	6B	0DD1:00	00	00	00	00	00	00	00	00	EB	
08A9:F8	20	6C	03	4C	13	01	E8	95	0B31:3E	47	C0	DB	68	0E	7F	F8	81	0DD9:00	00	00	00	00	00	00	00	00	F3	
08B1:20	34	03	D0	0B	A0	03	84	B1	0B41:7F	1C	FC	07	C6	03	6C	E1	2D	0DE1:00	00	00	00	00	00	00	00	00	FB	
08B9:A8	A2	08	20	34	03	D0	DA	F3	0B49:07	F2	27	1E	3C	3A	34	38	D1	0DE9:00	00	00	00	00	00	00	00	00	04	
08C1:E8	20	34	03	D0	0A	E8	20	A5	0B51:44	9C	40	1C	CC	A4	00	47	BA	0DF1:00	00	00	00	00	00	00	00	00	2A	
08C9:34	03	18	69	04	A8	D0	E7	9A	0B59:D1	0E	A1	8E	7E	CF	95	C0	18	0DF9:F0	FF	B0	30	70	70	08	04	FE		
08D1:E8	20	34	03	D0	0A	A2	02	0B	0B61:31	1C	31	20	39	A2	73	21	9B	0E01:02	01	1F	1F	3E	18	1F	A0	65		
08D9:20	34	03	18	69	06	D0	ED	DB	0B69:02	77	E2	00	05	38	04	04	CF	0E11:07	0C	7F	7E	90	00	63	E1	B8		
08E1:A2	08	20	34	03	D0	E6	A9	5F	0B71:2D	CC	FE	9A	56	80	FC	33	BC	0E19:30	30	3F	B0	00	31	31	F1	65		
08E9:00	85	A7	A4	FB	F0	CA	06	5C	0B79:76	F8	62	F0	27	2A	C0	22	E9	0E21:3B	0F	98	9F	98	B8	EF	E0	14		
08F1:FA	2A	26	A7	C6	FB	0C	D0	D5	0B81:09	02	3C	22	20	04	18	24	AB	0E29:03	8F	C0	C7	0C	1C	F7	BE	BE		
08F9:F2	A8	60	48	B1	FE	85	FA	CD	0B89:47	E2	01	8B	F3	C7	F9	41	C8	0E31:C1	63	E3	63	77	DD	60	01	AE		
0901:A9	08	85	FB	68	A4	FE	D0	FE	0B91:F2	15	1E	C8	0A	7C	9F	E2	1B	0E39:F8	09	18	18	F7	0C	0E	0E	B2		
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0911:DE	A4	FF	C0	07	D0	D8	A9	9E	0BA1:3F	F8	18	A4	03	14	E0	10	1D	0E49:FF	20	2E	7E	A8	17	70	F7	1D		
0919:37	85	01	58	4C	00	50	A4	75	0BA9:10	42	38	EC	F8	E5	E0	00	4F	0E51:1E	89	E4	81	58	88	88	57	E0		
0921:A8	F0	22	A5	F7	38	E5	A8	77	0BB1:7F	CC	84	24	1E	F7	0A	8F	02	0E59:3E	2F	0F	F8	80	F0	09	89	35		
0929:B0	03	C6	F8	38	85	F7	A5	2A	0BB9:25	F0	73	1C	21	11	C6	52	FB	0E61:72	02	40	4E	91	8E	11	11	1E		
0931:FC	E5	A8	B0	02	C6	FD	85	08	0BC1:80	43	40	08	7F	FF	FF	3F	AC	0E69:0E	CE	0F	38	44	44	3C	04	55		
0939:FC	B1	F7	88	91	FC	98	D0	40	0BC9:FF	FE	1F	FF	0C	28	DE	F0	BA	0E71:38	D8	5F	FB	3E	08	08	48	F5		
0941:F8	C4	A9	F0	0A	B1	F7	C6	13	0BD1:22	F0	0C	6F	D1	2E	9E	71	A3	0E79:30	7B	72	8B	FA	8A	8A	60	0B		
0949:FD	C6	F8	C6	A9	10	EC	E6	E5	0BD9:00	E6	A8	11	2F	01	9F	64	F0	0E81:0F	20	62	A7	22	20	EC	81	E0		
0951:01	EA	EA	EA	C6	01	60	00	A5	0BE1:3F	22	48	7F	72	91	A3	00	42	0E89:3B	42	43	42	3A	3D	91	5B	A5		
0959:C2	78	A0	30	0A	FF	FF	FF	52	0BE9:87	80	10	10	82	38	6C	18	CC	0E91:95	11	11	B0	FE	3F	FF	FF	FF	05	
0961:AA	AA	AA	74	01	0E	01	F1	44	0BF1:1E	76	11	8F	34	F6	33	F2	A6	0E99:FF	87	FF	FF	C3	FF	FF	E1	97		
0969:73	F1	68	95	78	64	00	02	6F	0BF9:22	02	FB	72	91	A3	00	87	EA	0EA1:FF	FF	F0	FF	7F	F8	FF	3F	FA		
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0981:28	0C	4A	AF	0C	93	07	81	4D	0C21:E0	07	FF	C0	03	20	F8	8C	8E	0EB9:00	00	00	DA	CE	C3	B9	B0	2D		
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09C9:E4	01	47	7E	00	A4	05	80	7C	0C69:80	30	1C	06	9F	0F	61	79	36	0F01:D0	C8	C0	B9	D2	D9	23	9F	53		
09D1:1E	1E	3F	12	8F	25	51	24	5B	0C71:08	2D	03	49	60	01	BE	C0	13	0F09:99	94	8F	8A	85	81	7D	79	5A		
09D9:7E	44	0E	63	86	21	D8	33	D1	0C79:30	FF	86	FC	8F	8F	CE	06	EF	0F11:75	71									

Pinhead

0FD1:80	81	83	85	87	8A	8D	90	6B	1279:80	1E	4C	EB	53	20	53	52	C1	1521:EE	60	2E	08	04	C9	09	D0	4B
0FD9:93	97	9B	9F	A3	A8	AD	B2	E2	1281:20	C3	54	C2	B8	8D	CB	58	49	1529:10	D4	D0	30	0D	E0	29	07	F2
0FEL:B8	BE	CA	CB	D2	E8	02	3C	DB	1289:CE	33	AD	D0	D0	18	ED	50	CA	1531:42	96	82	8D	F9	07	EE	2A	3F
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0FF9:98	96	95	94	93	92	92	93	A5	12A1:69	CC	F1	20	B1	B8	03	0C	70	1549:35	F3	4C	9C	DF	24	0C	2D	33
1001:94	95	96	98	9A	9C	9F	A2	56	12A9:B0	75	A2	52	18	C9	28	90	C5	1551:D3	B5	E0	F5	9D	68	0D	AA	A1
1009:A5	A8	AC	B0	B4	B8	BD	C2	8D	12B1:08	A0	00	46	DC	8C	2D	52	27	1559:80	F0	19	A9	01	B8	18	38	11
1011:C7	CD	D3	2A	C0	8B	D4	CF	53	12B9:88	8C	CD	58	4C	A7	52	AA	D4	1561:58	71	60	50	70	30	4C	6D	6F
1019:CA	C5	C1	BD	B9	B5	B2	AF	DD	12C1:AD	C9	15	D0	09	AD	1B	D4	E8	1569:56	5C	B8	F8	03	DA	1D	3F	79
1021:AC	AA	A8	A7	A6	A5	A5	A6	8F	12C9:2D	CE	58	8D	0C	58	8A	60	59	1571:A9	0A	AA	4F	48	E4	7F	18	2A
1029:A7	AA	AA	AC	AF	B2	B5	B9	D4	12D1:C9	0C	A0	9F	0B	99	0A	0A	C8	1579:C9	3A	90	F3	9D	E0	2D	00	33
1031:BD	C1	C5	CA	CF	D4	08	02	E9	12D9:53	0D	61	2A	0E	4C	85	DC	43	1581:C3	B8	8D	97	04	0F	F0	F6	1C
1039:3C	DA	D5	D1	CB	CA	C7	C4	F3	12E1:A9	90	90	0A	09	A9	08	F0	A1	1589:99	29	D0	AD	D1	C3	99	F0	81
1041:C2	C0	B6	BC	BA	B9	B8	8B		12E9:21	C9	0F	B0	15	10	F0	19	E1	1591:25	4A	4A	18	69	8A	9A	FA	4F
1049:B7	B7	B8	B9	BA	BB	BC	BE	E2	12F1:4C	F2	52	4C	9B	86	57	07	B4	1599:07	40	B8	39	88	C3	0C	18	85
1051:C0	C2	C4	C7	CA	CD	D1	D5	9E	12F9:48	85	06	A9	11	30	15	12	84	15A1:27	BD	D7	51	F1	05	D0	90	B4
1059:DA	FF	88	10	E0	FD	FF	1F	17	1301:A6	08	C2	54	A6	48	05	85	FF	15A9:0F	A3	00	7C	18	05	4C	C6	40
1061:FE	FF	FF	FF	FF	7F	FF	FF	01	1309:94	04	98	12	13	53	14	62	1F	15B1:56	AD	58	00	53	15	D0	20	2E
1069:C3	FF	FF	E1	FF	FF	F0	FF	6B	1311:4A	1E	4C	B1	89	94	03	48	75	15B9:D4	56	DC	E1	CF	4C	E2	7C	8F
1071:7F	F8	FF	3F	FC	FF	1F	FE	A8	1319:89	02	29	01	31	25	00	A6	7E	15C1:C3	F0	4D	BD	D6	4C	37	1E	04
1079:FF	0F	FF	FF	FF	FF	FF	FF	A8	1321:15	C4	94	16	98	12	17	53	85	15C9:20	27	EB	60	90	03	48	90	03
1081:FF	FF	41	5B	FB	D0	DA	7A	D2	1329:18	62	4A	44	4C	BC	89	94	7E	15D1:36	0B	04	19	8F	0D	80	88	26
1089:B0	B4	3C	2C	2E	1E	0A	0B	82	1331:FF	48	89	FE	29	FD	31	25	53	15D9:11	20	45	57	27	DE	63	06	34
1091:8F	02	1C	02	00	00	00	0E	8C	1339:FC	A6	19	C4	94	1A	98	12	47	15E1:18	FD	68	99	42	50	B0	04	F6
1099:20	C2	D8	21	D0	78	A9	7F	E2	1341:1B	53	1C	62	4A	6A	4C	C7	CF	15E9:04	28	A0	82	ED	63	06	0F	74
10A1:8D	0D	DC	08	E7	1A	32	04	F7	1349:53	C9	F8	F0	1F	C9	FA	F0	21	15F1:50	4C	26	57	FE	20	35	98	0D
10A9:1B	8D	11	A6	C4	12	29	39	41	1351:1B	C9	F9	F0	1C	F9	F8	F0	88	15F9:4A	A8	43	F0	12	57	47	50	B7
10B1:8D	14	32	4D	50	D9	03	91	3A	1359:13	C9	1D	F0	0F	C9	1E	F0	FA	1601:90	0B	BE	B6	06	86	58	60	D6
10B9:5E	1D	09	D0	4C	2D	50	68	9E	1361:0B	C9	1F	F0	89	0E	E0	FD	B6	1609:AD	10	D0	90	3F	F4	98	0A	3C
10C1:A8	68	AA	68	40	4C	E7	50	3F	1369:20	A4	DD	53	4C	D2	53	D7	E5	1611:A8	B9	04	D0	C9	0A	90	E2	08
10C9:64	DE	08	2B	19	52	CF	AD	27	1371:AE	34	14	43	F2	28	28	8A	C5	1619:4C	44	6C	2E	06	2A	29	03	1B
10D1:40	04	70	EE	C4	58	20	44	1C	1379:7C	14	14	CB	3E	0A	40	46	03	1621:C9	02	D0	65	20	E7	54	AD	1A
10D9:E5	C1	C2	02	59	8A	04	40	13	1381:01	00	8F	82	C2	31	47	41	EC	1629:C6	0D	F0	E4	14	30	E1	4C	D9
10E1:2C	9D	00	D8	0C	0D	4C	F0	2B	1389:EE	5E	A3	B0	A9	81	85	3C	52	1631:78	57	0C	CE	8D	CD	88	1B	44
10E9:A9	03	8D	15	F4	00	96	80	F7	1391:A9	41	85	3D	87	0B	4C	4B	AD	1639:D4	2D	C7	00	8D	CC	58	A0	05
10F1:8D	17	99	26	1C	38	04	AC	AA	1399:55	A9	E5	8D	03	08	8E	00	BF	1641:00	A2	00	AD	F3	58	39	E7	4C
10F9:E2	A9	E1	AD	FE	80	06	8D	A0	13A1:02	AD	82	C9	02	D0	EE	80	D2	1649:58	D0	0B	C8	E8	58	E8	C0	41
1101:27	C0	0E	20	28	50	96	1D	77	13A9:1B	C2	EE	50	04	AD	C4	C9	1B	1651:06	D0	F0	4C	C8	57	BD	6D	24
1109:84	DA	8D	03	C0	08	02	A4	D4	13B1:A3	D0	DF	CE	F9	07	EE	40	D0	1659:00	0F	8D	21	19	B9	FA	07	B9
1111:D0	A9	0C	8D	25	D0	8F	41	2D	13B9:B8	AD	80	20	C9	C8	D2	88	59	1661:26	89	23	10D	82	9D	D5	58	C6
1119:8E	F8	07	E8	E8	8E	F9	07	AC	13C1:00	88	36	E8	CE	31	02	AD	B4	1669:AE	0B	0B	BD	52	59	8D	50	50
1121:A9	80	8D	12	94	13	FF	8D	89	13C9:92	C9	2F	D0	C0	86	8D	BD	97	1671:AD	FC	81	0E	03	E4	AD	FD	C9
1129:0E	18	01	D8	18	D4	50	91	4C	13D1:2A	59	46	05	20	5D	9D	E0	0F	1679:58	A2	04	20	C0	57	20	E5	CE
1131:04	A9	05	D4	A2	80	8A	50	2A	13D9:D9	E8	E0	28	D0	F0	AD	01	6C	1681:57	60	18	70	C9	07	01	48	6A
1139:02	03	A9	0D	9D	91	D7	A6	AC	13E1:C6	0D	04	F0	0A	AD	00	DC	22	1689:C9	3A	90	0D	18	E9	09	9D	24
1141:8A	D0	F2	AD	19	D4	8D	02	4F	13E9:29	10	F0	03	4C	3A	54	98	83	1691:30	BC	CA	A9	01	E0	FF	D0	55
1149:BE	AD	1E	4C	80	F3	A2	00	D7	13F1:0F	C4	1A	01	C5	11	C6	10	34	1699:8E	60	4C	8C	C1	78	F7	82	07
1151:DC	40	0C	29	10	8D	2E	0D	26	13F9:01	C7	11	00	7A	8D	C1	8D	CF	16A1:24	03	70	F8	C9	30	F0	16	45
1159:84	0F	38	08	A9	10	CA	12	3E	1401:17	7D	8D	CF	12	D0	10	01	B7	16A9:70	62	F0	4F	90	99	D0	A9	EF
1161:04	8D	84	A5	CB	C9	C6	64	4B	1409:D1	11	D2	10	01	D5	11	D8	14	16B1:19	A1	0F	00	8D	D2	9E	6C	16
1169:08	A9	05	6C	4C	06	51	C9	A7	1411:10	01	DB	11	DE	10	01	E1	29	16B9:83	F0	31	74	78	5A	0C	4F	E5
1171:41	6A	05	A9	D0	15	60	20	C5	1419:11	E4	10	01	F3	11	F4	90	73	16C1:33	1E	08	50	03	81	CE	67	38
1179:5A	57	AD	F6	58	8D	26	04	0D	1421:0D	F5	21	34	8D	F6	30	11	6E	16C9:65	46	CF	0A	03	8D	D3	4F	1A
1181:A2	00	BD	F7	58	9D	08	04	79	1429:D3	0E	64	80	D4	81	11	FF	F2	16D1:A3	39	D0	C8	A9	3C	EB	80	5B
1189:E8	E0	05	D0	F5	78	B7	59	60	1431:8D	CB	D8	30	8D	F7	84	09	8F	16D9:AD	F9	6B	32	D0	81	A2	32	EF
1191:F0	72	36	03	04	D0	39	AD	43	1439:F8	88	F9	80	08	FA	88	FB	80	16E1:64	4C	C1	40	C9	35	D0	0D	61
1199:C8	58	29	08	D0	16	87	60	2A	1441:80	DC	FE	CA	24	BC	CE	58	77	16E9:A9	23	8D	D4	58	A9	07	8D	B7
11A1:64	E2	0A	71	22	90	61	F9	17	1449:A2	00	A0	00	88	D0	FD	CA	25	16F1:CE	30	17	04	10	2B	09	A1	95
11A9:42	07	AC	EC	8A	18	6D	8B	2E	1451:D0	FA	4C	31	EA	40	1F	C1	95	16F9:F8	58	CD	30	02	F0	17	8D	05
11B1:90	61	69	29	2D	3C	D4	D0	09	1459:42	33	82	83	8B	F1	C2	06	A7	1701:FE	58	29	36	01	37	2C	55	DF
11B9:07	5A	10	C9	1E	90	48	A2	FA	1461:01	21	E1	80	30	6A	A0	AD	B0	1709:EE	13	AD	10	03	C9	3A	D0	AE
11C1:03	1A	D0	02	A2	06	CA	D1	BA	146																	



DISK EDITOR

Stacy J. Prowell

You probably use your disk drive mainly for loading and saving BASIC programs or for loading commercial software. You may even dabble with sequential and relative files. BASIC provides commands—LOAD, SAVE, OPEN, PRINT#, and so on—for performing these and other simple tasks. In addition, the Disk Operating System (DOS) provides high-level commands that handle other essential disk functions, such as formatting disks and scratching files. The advantage of these commands is that you don't need to know how the drive actually performs each task. For example, when you execute a SAVE command, you don't have to tell the drive how and where to store the file; BASIC and DOS take care of the details for you.

High-level commands are great for casual users and beginners, but some tasks can't be performed with a single command. For example, DOS has a scratch command, but no unscratch command. If you accidentally scratch a file, there's no command to bring it back, even though all the information is still on the disk. DOS also has the ability to lock a file so that it can't be scratched, but there's no command to let you use this feature.

To perform tasks for which there are no commands, you have to program the disk drive directly. DOS provides several low-level commands for this purpose. The Block-Read and Block-Write commands let you change the contents of an individual block or sector. They give you access to every byte on a disk, but using them from BASIC or machine language can be difficult. *Disk Editor* takes the work out of using low-level disk commands without taking away their power and flexibility.

Examine and alter any byte on a disk with this flexible utility for the Commodore 64 and a 1541 or 1571 disk drive.

Typing It In

Disk Editor is written in machine language, so to enter it, you'll need to use *MLX*, the machine language entry program found elsewhere in this issue. The *MLX* prompts, and the values you should enter, are as follows:

Starting address: 8000
Ending address: 8F87

When you've finished typing, be sure to save a copy of the program to disk.

To run *Disk Editor*, type LOAD"filename",8,1 and then type NEW. Next, insert the disk you want to edit and type SYS 32768. Be very careful with *Disk Editor* until you're sure it works correctly. If you made a typing error when entering the program, it could ruin your disk. The first time you use it, work on a scratch disk. That way, if there's a problem, you won't lose valuable data.

Tracks and Sectors

To use *Disk Editor* effectively, it's important to understand how Commodore disks are organized. Disks formatted on the 1541 and single-sided disks formatted on the 1571 are divided into 35 tracks, and each track is divided into a number of sectors. Double-sided 1571 disks also have 35 tracks on the back side of the disk, for a total of 70 tracks. The longer tracks near the outer edge of a disk contain 21 sectors, while

the shorter tracks near the center hub contain only 16. The tracks in between contain from 16 to 21 sectors, depending on the length of the track.

Each disk sector contains 256 bytes. Of these, 254 are available for storing data. The remaining 2 bytes contain a pointer to the next sector in a file. This pointer allows DOS to keep track of all the sectors in a file without having to keep lists of sectors in the directory.

The disk directory is used by DOS to keep track of which files are on the disk and where they're located. Each directory entry contains information about a file's type, location, name, and size. If DOS needs more information about a specific file—the record size for relative files, for example, it stores this information in the directory also.

The first sector of the disk directory, track 18, sector 0, contains the name of the disk and the Block Availability Map (BAM). The BAM lets DOS know which sectors are currently being used and which ones are free. Track 18, sector 1 is the first sector of the directory itself. It contains a pointer to the second directory sector and information about the first eight files on the disk.

You can learn more about your disks and disk drive by reading the manual that came with the drive. The appendices in the back of the manual are especially helpful for understanding how information is stored on disk. If you're interested in programming the drive yourself, the manual also has chapters on DOS commands and low-level programming.

Editing Disks

Disk Editor begins by reading track 18, sector 0 and displaying its contents in a 16 × 16 grid. The data is represented

Disk Editor

by characters, so you should be able to read the name of the disk in the tenth line of the grid. If you can't, press SHIFT-Commodore to switch to upper/lowercase characters. The previous, current, and next sectors are indicated to the right of the grid along with the number of sectors stored on the stack. *Disk Editor* displays the disk status below the grid.

The following paragraphs describe the commands available in *Disk Editor*. The commands are divided into two groups: those that affect the current sector, and those that are more general commands. The first group of commands, those that affect the current sector, are described below.

L Load a disk sector. When you press L, a cursor appears beside the label *This*:. To load a sector, enter the track number and press RETURN; then type the sector number. *Disk Editor* pushes the current track and sector numbers—hereafter referred to as the *sector pointer*—onto the stack and loads the sector indicated. If the sector you request doesn't exist, the disk status line displays *ILLEGAL TRACK OR SECTOR* and the grid's contents remain unchanged. If you press L accidentally, you can abort the command by entering spaces for the track number.

S Save a disk sector. This command works much the same way as the Load command except the contents of the grid are saved to the sector you indicate. To save to the current sector (the sector indicated by *This*:.), simply press RETURN twice.

+, **-** Load an adjacent disk sector. Pressing **+** loads the next higher sector, while pressing **-** loads the next lower sector. For example, if the current sector is track 14, sector 3, pressing **+** loads sector 4 of track 14. Using the same example, pressing **-** loads sector 2 of track 14. If the current sector is the first in a track and you press **-**, *Disk Editor* loads the last sector from the previous track. Similarly, if the current sector is the last in a track and you press **+**, *Disk Editor* loads the first sector from the next track. Both commands push the current sector pointer onto the stack before loading the new sector. *If you own a 1571, note that the + and - commands won't work correctly with your disk drive. Neither command loads sectors from the back side of the disk (tracks 36-70).*

N Load next disk sector. Commodore disk sectors are chained together by the sector pointer in the first two bytes of the sector. For example, the first two bytes of track 18, sector 0 are 18 and 1. Thus, track 18, sector 1 follows track 18, sector 0 in the disk directory. *Disk Editor*

displays the pointer to the next sector beside the label *NEXT*:. Pressing N saves the current sector pointer on the stack and loads the sector indicated by *NEXT*:. This command is handy for tracing through the sectors of a file or the disk directory.

P Load previous disk sector. Commodore disk sectors are linked by pointers in only one direction. You can follow the pointers from front to back, but you can't follow them from back to front. *Disk Editor* circumvents this problem with its stack. Each time you load a new disk sector, the program pushes the old sector pointer onto the stack. When you press P, it pops the top pointer from the stack and loads that sector from the disk. The number next to the label *Stack*: indicates how many sector pointers are on the stack. Once this value reaches 0, pressing P has no effect. The stack can hold up to 127 sector pointers.

SHIFT-1, SHIFT-2, SHIFT-3 Save grid. *Disk Editor* has three buffers into which you can store the contents of the grid. Hold down the SHIFT key and press 1, 2, or 3 to store the grid contents in a buffer. The track and sector numbers aren't stored with sector data, so you can use this command to copy sectors from one location to another or even from one disk to another.

Disk Editor Commands

Command	Action
L	Load a sector
S	Save a sector
+	Load adjacent sector (current plus 1)
-	Load adjacent sector (current minus 1)
N	Load next sector
P	Load previous sector
SHIFT-1, 2, 3	Save buffer
1, 2, 3	Recall buffer
H	Help
SPACE	Read disk error channel
@	Send disk command
F	Toggle format
D	Display directory
CTRL-K	Clear stack
CTRL-L	Change text color
CTRL-B	Change border color
CTRL-S	Change screen color
Q	Quit
E	Enter edit mode
CTRL-P	Position cursor
CTRL-C	Change value
CTRL-N	Load sector
RETURN	Exit edit mode
B	Enter BAM mode
CTRL-C	Toggle sector
CTRL-P	Plot file map
CTRL-W	Write BAM
RETURN	Exit BAM mode

1, 2, 3 Recall grid. Press 1, 2, or 3 to place the contents of one of the buffers back into the grid. These commands don't change the sector pointer, so it may be invalid after the command is executed.

General Commands

The following commands are more general and affect the disk as a whole or the program itself.

H Help. Pressing H displays a summary of the commands and their respective keystrokes. Press any key to return to the main screen.

SPACE Read the disk drive error channel. Pressing the space bar updates the disk-status display at the bottom of the screen.

@ Send a disk command. By pressing @, you can send any disk command to the disk drive. For example, press @ and then type V0: to validate the disk.

F Change grid format. Pressing F allows you to toggle the format of the grid between the 16 × 16 standard format, the default, and the 32 × 8 directory format. Directory format makes finding filenames in the disk directory much easier, because each directory entry is listed on a line by itself.

D Display disk directory. Pressing D displays the disk's directory in a format similar to that available from BASIC. *Disk Editor* displays the file length, filename, and file type (including files of type DEL) and the location of each file's first sector. For relative files, *Disk Editor* shows the record length and location of the first side sector, too. Press SHIFT-LOCK to pause the directory. Release it to continue. Press RUN/STOP to abort the directory.

CTRL-K Clear the stack. Pressing CTRL-K resets the stack pointer to 0, effectively removing all sector pointers from the stack.

CTRL-L Change the text color.

CTRL-B Change the border color.

CTRL-S Change the screen color.

Q Quit. Pressing Q allows you to exit *Disk Editor* and return to BASIC.

The remaining two commands change *Disk Editor*'s mode of operation and are described in detail below.

Edit Mode

Pressing E puts *Disk Editor* into edit mode. The edit screen looks exactly like the main screen except that a box ap-

pears in the upper left corner of the grid and four numbers appear at the bottom of the screen. The first three numbers are the value of the byte under the cursor in decimal, hexadecimal, and binary, respectively. The fourth number is the cursor position within the grid.

Move the cursor over the grid with the cursor keys. To change the value under the cursor, press CTRL-C and then enter the new value. To enter values as hexadecimal, type a \$ before the value. To enter binary values, type a % before the number. If neither of these characters precedes the number, the value is assumed to be decimal. If you want to enter values as text, simply position the cursor and begin typing. Pressing CTRL-9 turns reverse text on, and CTRL-0 turns reverse text off, just as in the BASIC editor. The line at the bottom of the screen indicates whether reverse mode is on or off.

You can move the cursor to a specific position within the grid by pressing CTRL-P and entering the location. As with the CTRL-C command above, you can enter this value as decimal, hexadecimal, or binary.

Sector pointers are usually stored in the first two bytes of a disk sector, but not always. Directory sectors contain up to eight sector pointers other than the one in the first two bytes. To load a sector pointed to by these pointers, you could enter edit mode, write down the track and sector numbers, and then use the Load command. But there's an easier way. Simply place the edit cursor over the first byte of the sector pointer and press CTRL-N. *Disk Editor* stores the current sector pointer on the stack and loads the new sector from disk.

Press RETURN to exit edit mode and return to the main screen.

BAM Mode

The Block Availability Map, stored on track 18, sector 0, is a binary map of all the sectors on the disk. Every sector on the disk has a corresponding bit in the BAM which tells DOS whether or not that sector is allocated. Unfortunately, the BAM is difficult to read from a disk sector editor (unless you can convert Commodore screen codes to binary in your head). *Disk Editor's* BAM mode simplifies viewing and editing a disk's BAM.

Pressing B from the main screen loads and displays the BAM from the disk. *Disk Editor* displays the BAM in table form. The tracks are listed along the top of the table; the sectors are listed down the left side. Each sector is represented on the table by a dot. If the dot is displayed in reverse video, the corresponding sector is free. If the dot is displayed normally, the corresponding sector is allocated. The number of free blocks is shown in the lower right cor-

ner of the screen.

When you first enter BAM mode, the cursor is in the upper left corner of the screen. You can use the cursor keys to move it over the screen. Press CTRL-C to toggle the status of the sector under the cursor. As you free and allocate sectors, the number of free blocks, displayed in the lower right corner, changes.

Occasionally, you need to know which sectors are occupied by a specific file. For example, you may suspect that a file on your disk is corrupted and occupies the same sectors as another file. You can plot the sectors that a file occupies by moving the edit cursor to the first sector of the file and pressing CTRL-P. All of the sectors occupied by the file are marked with an asterisk. So if you plot the sectors for a file you think is corrupted and then plot the sectors for a good file, you can actually see whether the two occupy the same sectors.

After you've finished editing the BAM, you can press CTRL-W to save it back to disk. Pressing RETURN takes you back to the main screen.

Using Disk Editor with BASIC

Disk Editor occupies the area of memory beginning at \$8000 (32768). If you need to use it and BASIC at the same time, you must protect *Disk Editor* from BASIC. To do this, enter the following commands after you load *Disk Editor* and before you type SYS 32768.

POKE 56,128:POKE 55,0:NEW

This command sequence moves BASIC's top-of-string pointer below *Disk Editor* so that the program won't be overwritten by string data.

Disk Editor

```

8000:4C 4A 8F 00 00 00 00 00 AB
8008:55 31 3A 32 2C 30 2C 00 E4
8010:55 32 3A 32 2C 30 2C 00 2D
8018:42 2D 50 3A 32 2C 30 0D E2
8020:00 23 0D 24 4C 45 44 51 1F
8028:45 53 47 52 50 52 53 55 76
8030:4C 45 52 3F 3F 31 3F 3F 63
8038:32 3F 3F 33 00 00 00 3D
8040:00 10 0D FF F0 00 C0 30 20
8048:00 C0 30 00 C0 30 00 C0 07
8050:30 00 C0 30 00 C0 30 00 E7
8058:C0 30 00 C0 30 00 FF F0 44
8060:00 00 00 00 00 00 00 61
8068:00 00 00 00 00 00 00 69
8070:00 00 00 00 00 00 00 71
8078:00 00 00 00 00 00 00 79
8080:00 00 00 30 31 32 33 34 71
8088:35 36 37 38 39 41 42 43 B2
8090:44 45 46 40 00 00 00 00 D1
8098:15 15 15 15 15 15 15 99
80A0:15 15 15 15 15 15 15 A1
80A8:15 13 13 13 13 13 13 AA
80B0:12 12 12 12 12 12 11 11 AE
80B8:11 11 11 00 52 52 45 53 52
80C0:53 20 48 20 46 4F 52 20 B2
80C8:48 45 4C 50 00 00 00 50 1E
80D0:52 45 56 3A 00 54 48 49 E5
80D8:53 3A 00 4E 45 58 54 3A 65
80E0:00 00 53 54 41 43 4B 3A 79
80E8:00 93 44 49 53 4B 20 45 39
80F0:44 49 54 4F 52 20 56 45 BA
80F8:52 20 30 37 38 38 20 42 C9

```

```

8100:59 20 53 54 41 43 59 20 51
8108:50 52 4F 57 45 4C 4C 0D 28
8110:0D 3C 4C 3E 20 4C 4F 41 28
8118:44 20 20 20 20 20 20 20 2D
8120:20 20 20 20 20 3C 53 3E 18
8128:20 53 41 56 45 0D 3C 2B 9F
8130:3E 20 3C 2D 3E 20 41 44 ED
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8148:3E 20 43 48 41 49 4E 0D 38
8150:3C 40 3E 20 43 4F 4D 4D 8A
8158:41 4E 44 20 20 20 20 20 FB
8160:3C 53 50 41 43 45 3E 20 40
8168:52 45 41 44 20 45 52 52 5F
8170:4F 52 0D 3C 45 3E 20 45 BD
8178:44 49 54 20 42 4C 4F 43 A1
8180:4B 20 20 20 20 20 20 3C 35
8188:42 3E 20 45 44 49 54 20 A4
8190:42 41 4D 0D 3C 51 3E 20 43
8198:51 55 49 54 20 20 20 20 E9
81A0:20 20 20 20 20 20 20 20 A3
81A8:3C 44 3E 20 44 49 52 45 D5
81B0:43 54 4F 52 59 0D 0D 43 D5
81B8:54 52 4C 2D 4B 20 52 45 9B
81C0:53 45 54 20 53 54 41 43 FC
81C8:4B 20 20 43 54 52 4C 2D 63
81D0:4C 20 54 45 58 54 20 43 78
81D8:4F 4C 4F 52 0D 43 54 52 16
81E0:4C 2D 42 20 42 41 43 4B 88
81E8:47 52 4F 55 4E 44 20 20 47
81F0:20 43 54 52 4C 2D 53 20 62
81F8:53 43 52 45 45 4E 20 43 FB
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8208:3E 20 3C 32 3E 20 3C 33 FC
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8220:4D 20 4D 45 4D 4F 52 59 77
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8230:48 20 53 48 49 46 54 20 7C
8238:2D 20 50 55 54 20 42 4C 2F
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8250:4E 20 42 41 4D 3A 20 43 B7
8258:54 52 4C 2D 43 20 54 4F 0B
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8270:20 20 20 20 43 54 52 4C EF
8278:2D 57 20 57 52 49 54 45 09
8280:53 20 42 41 4D 0D 20 20 92
8288:20 20 20 20 20 20 43 54 08
8290:52 4C 2D 50 20 50 4C 4F A6
8298:54 53 20 43 55 52 52 45 B2
82A0:4E 54 20 43 48 41 49 4E 42
82A8:0D 0D 49 4E 20 45 44 49 6D
82B0:54 3A 20 43 54 52 4C 2D 58
82B8:50 20 50 4F 53 49 54 49 9E
82C0:4F 4E 53 20 43 55 52 53 D4
82C8:4F 52 0D 20 20 20 20 8F
82D0:20 20 20 20 43 54 52 4C 50
82D8:2D 43 20 43 48 41 4E 47 A8
82E0:45 53 20 44 41 54 41 0D 90
82E8:20 20 20 20 20 20 20 20 ED
82F0:20 43 54 52 4C 2D 4E 20 5A
82F8:4C 4F 41 44 53 20 42 4C 50
8300:4F 43 4B 20 46 52 4F 4D 52
8308:20 50 4F 49 4E 54 45 52 52
8310:57 49 54 48 20 43 55 52 2F
8318:53 4F 52 3A 20 43 54 52 93
8320:4C 2D 4C 20 43 48 41 4E 30
8328:47 45 53 20 43 55 52 53 F7
8330:4F 52 20 43 4F 4C 4F 52 48
8338:0D 3C 52 45 54 55 52 4E 5E
8340:3E 20 45 58 49 54 53 20 FE
8348:45 44 49 54 20 41 4E 44 58
8350:20 42 41 4D 20 4D 4F 44 0E
8358:45 53 00 20 5C 8C A9 E9 2B
8360:85 FC A9 80 85 FD A0 00 0C
8368:B1 FC F0 0B 20 D2 FF E6 89
8370:FC D0 F5 E6 FD D0 F1 20 8E
8378:AF 83 4C 0B 8D 48 A4 D3 1D
8380:B1 D1 49 80 91 D1 68 0B 3A
8388:29 7F 8D 03 80 29 60 D0 20
8390:06 AD 03 80 09 40 60 C9 42
8398:20 D0 04 AD 03 80 60 C9 E3
83A0:40 D0 06 AD 03 80 09 20 E3

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Disk Editor

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83A8:60 AD 03 80 49 C0 60 20 E1      8650:C9 A0 B0 03 4C 43 85 8D B8
83B0:E4 FF C9 00 F0 F9 60 8D 21      8658:3E 80 20 14 85 E8 C8 E8 34
83B8:05 80 8D 06 80 A5 D3 8D 44      8660:C8 20 F3 8D AD 3E 80 20 B8
83C0:04 80 20 7D 83 20 AF 83 45      8668:D2 FF EE 94 80 20 5C 8C CF
83C8:20 7D 83 C9 0D F0 45 C9 CC      8670:4C 43 85 A9 20 20 D2 FF E6
83D0:9D F0 24 C9 14 F0 20 C9 72      8678:4C D2 FF 20 0B 8D A9 14 58
83D8:1D F0 2C 8D 03 80 29 E0 56      8680:20 B7 83 20 03 8B A2 0F 98
83E0:F0 E0 29 80 D0 DC AD 03 1E      8688:20 C9 FF AD 00 02 F0 0D E9
83E8:80 AE 06 80 F0 D4 20 D2 92      8690:A2 00 BD 00 02 F0 06 20 A6
83F0:FF CE 06 80 4C C2 83 AE 97      8698:D2 FF E8 D0 F5 20 CC FF 03
83F8:06 80 EC 05 80 F0 C3 EE 4F      86A0:20 52 8D A9 0F 20 C3 FF 1F
8400:06 80 C6 D3 4C C2 83 AE 65      86A8:60 AD 3F 80 8D 94 80 AD AE
8408:06 80 F0 B6 CE 06 80 E6 34      86B0:40 80 8D 95 80 A9 12 8D 65
8410:D3 4C C2 83 AD 05 80 18 41      86B8:3F 80 A9 00 8D 40 80 20 49
8418:6D 04 C0 A8 88 B1 D1 C9 EB      86C0:5C 8C A9 04 20 A9 8B 20 73
8420:20 D0 0C 88 CC 04 D0 B0 9F      86C8:2B 8B AD 94 80 8D 3F 80 86
8428:F4 A9 00 8D 00 02 60 C8 80      86D0:AD 95 80 8D 40 80 A9 93 ED
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8438:B1 D1 20 88 83 9D 00 02 AF      86E0:04 85 FD A2 05 A0 00 8C 72
8440:E8 C8 CC 06 80 90 F1 A9 BD      86E8:3E 80 BD 00 98 8D 03 80 6E
8448:00 9D 00 02 60 29 7F 2C AB      86F0:A0 88 8A 29 03 C9 03 D0 4A
8450:93 80 F0 03 18 69 09 29 33      86F8:0A AC 3E 80 B9 98 80 38 6F
8458:0F 60 A2 00 86 FC A9 0A DA      8700:E9 10 A8 8C 95 80 A9 5C 44
8460:85 FE AD 00 02 D0 01 60 57      8708:6E 03 80 6A AC 3E 80 91 B6
8468:C9 24 D0 07 A9 10 85 FE 81      8710:FC 20 4E 8C CE 95 80 D0 D6
8470:E8 D0 09 C9 25 D0 05 A9 FF      8718:ED E8 8A 29 03 D0 CB E8 18
8478:02 85 FE E8 BD 00 02 D0 15      8720:EE 3E 80 A9 52 85 FC A9 2D
8480:03 A5 FC 60 48 A5 FE 85 76      8728:04 85 FD AD 3E 80 C9 23 DF
8488:FD 20 9B 84 68 20 4D 84 37      8730:90 B8 A2 30 8E 02 04 E8 7A
8490:18 65 FC 85 FC E8 D0 E4 09      8738:8E 2A 04 A2 00 BD 02 04 C2
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84A8:88 10 F5 85 FD 60 85 FC 8A      8750:3A 90 08 FE 03 04 A9 30 3D
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84B8:FC 2A 29 01 09 30 20 D2 1C      8760:A9 14 8D 96 80 AE 96 80 D0
84C0:FF CA D0 F3 60 85 FC A9 92      8768:E8 E8 A0 00 20 F3 8D AD D3
84C8:24 20 D2 FF A2 02 86 FD 6E      8770:96 80 20 05 85 CE 96 80 54
84D0:A0 04 26 FC 2A 88 D0 FA CF      8778:10 EB 20 D4 88 60 20 A9 8B
84D8:29 0F AA BD 83 80 D0 D2 9C      8780:86 20 8D 87 20 0B 8D A9 F6
84E0:FF C6 FD D0 EB 60 85 FC 51      8788:04 20 BD 8B 60 A9 00 8D 49
84E8:C9 64 B0 12 A9 30 20 D2 48      8790:95 80 8D 96 80 20 90 8E D9
84F0:FF A5 FC C9 0A 80 07 A9 6A      8798:AE 96 80 AC 95 80 20 C3 32
84F8:30 20 D2 FF A5 FC AA A9 9C      87A0:8E 20 AF 83 C9 0C D0 06 53
8500:00 20 CD BD 60 85 FC C9 85      87A8:20 86 8E 4C 98 87 C9 03 79
8508:64 90 E6 A9 2D 20 D2 FF 70      87B0:D0 32 AE 96 80 E8 E8 AC 1A
8510:20 D2 FF 60 AD 94 80 8D 34      87B8:95 80 C8 C8 20 F3 8D A4 E8
8518:03 80 AE 41 80 CA 8A 2D 20      87C0:D3 B1 D1 49 80 91 D1 AD 90
8520:03 80 A8 AD 03 80 4A 4A B5      87C8:95 80 0A 18 69 04 AA BD
8528:4A 4A 8D 03 80 AD 41 80 8A      87D0:B1 D1 2A 90 06 FE 00 98 40
8530:C9 20 D0 03 4E 03 80 AE A0      87D8:4C DE 87 DE 00 98 20 D4 1C
8538:03 80 60 A9 00 8D 94 80 6B      87E0:88 4C 98 87 C9 13 F0 A5 F4
8540:20 90 E8 20 F8 85 20 2E 9F      87E8:C9 91 D0 0A CE 96 80 10 DD
8548:86 20 AF 83 C9 03 D0 1B E3      87F0:F0 EE 96 80 10 EB C9 17 E9
8550:20 0B 8D A9 09 20 B7 83 36      87F8:D0 19 AD 95 80 48 AD 96 DC
8558:E0 00 F0 E7 20 5A 8A AE 92      8800:80 48 20 62 88 20 DB 86 90
8560:94 80 9D 00 98 20 F4 8B 44      8808:68 8D 96 80 68 8D 95 80 B0
8568:4C 43 85 C9 0C D0 06 20 87      8810:4C 98 87 C9 11 D0 13 EE DB
8570:86 8E 4C 43 85 C9 10 D0 64      8818:96 80 AD 96 80 AE 95 80 1E
8578:15 20 0B 8D A9 09 20 B7 B9      8820:DD 98 80 90 BC CE 96 80 2E
8580:83 E0 00 F0 BE 20 5A 84 44      8828:D0 B7 C9 9D D0 0A CE 95 84
8588:8D 94 80 4C 43 85 C9 13 2B      8830:80 1D AE EE 95 80 10 A9 C2
8590:D0 08 A9 00 8D 94 80 4C 47      8838:C9 10 D0 14 EE 95 80 AE 4E
8598:43 85 C9 91 D0 0D AD 94 A3      8840:95 80 AD 96 80 DD 98 80 88
85A0:80 38 ED 41 80 8D 94 80 AF      8848:90 97 CE 95 80 4C E1 87 3B
85A8:4C 43 85 C9 11 D0 0D AD 8B      8850:C9 0D D0 04 20 BA 8E 60 4D
85B0:41 80 18 6D 94 80 8D 94 AC      8858:C9 10 D0 85 20 8B 8A 4C 55
85B8:80 4C 43 85 C9 9D D0 06 44      8860:E1 87 A9 52 85 FC A9 04 16
85C0:CE 94 80 4C 43 85 C9 1D 0E      8868:85 FD A2 05 A0 00 8C 3E BC
85C8:D0 06 EE 94 80 4C 43 85 26      8870:80 A0 08 8C 95 80 AC 3E F9
85D0:C9 0E D0 1C 20 70 8D AE AC      8878:80 B1 FC 2A 6E 03 80 20 19
85D8:94 80 BD 00 98 8D 3F 80 FF      8880:4E 8C CE 95 80 D0 EF AD E3
85E0:E8 BD 00 98 8D 40 80 20 E7      8888:03 80 9D 00 98 E8 8A 29 95
85E8:2B 8B 20 7D 8C 4C 3B 85 D9      8890:03 D0 FE BD FF 97 29 3F FE
85F0:C9 0D D0 40 20 BA 8E 60 AB      8898:9D FF 97 E8 EE 3E 80 A9 15
85F8:A0 00 A2 15 20 F3 8D AE 94      88A0:52 85 FC A9 04 85 FD AD 56
8600:94 80 BD 00 98 8D 95 80 D5      88A8:3E 80 C9 23 90 C3 AD 3F 92
8608:20 E6 84 20 73 86 AD 95 18      88B0:80 8D 94 80 AD 40 80 8D FC
8610:80 20 C5 84 A9 20 20 73 E7      88B8:95 80 A9 12 8D 3F 80 A9 1F
8618:86 AD 95 80 20 AE 84 20 73      88C0:00 8D 40 80 20 6A 8B AD B4
8620:73 86 A9 3A 20 D2 FF AD 5B      88C8:94 80 8D 3F 80 AD 95 80 50
8628:94 80 20 E6 84 80 20 14 0C      88D0:8D 40 80 60 A2 04 A9 00 47
8630:85 4C C3 8E C9 12 D0 06 B2      88D8:85 FC 85 FD BD 00 98 E8 84
8638:20 D2 FF 4C 43 85 C9 92 25      88E0:E8 E8 E8 E0 94 B0 6A 65 AC
8640:C0 06 20 D2 FF 4C 43 85 A5      88E8:FC 85 FC 90 EF E6 FD D0 6A
8648:C9 20 90 08 C9 80 90 07 4D

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8BA0:20 C3 FF A9 01 20 C3 FF 63
 8BA8:60 18 69 98 85 FD A9 00 24
 8BB0:85 FC A0 00 B9 00 98 91 6E
 8BB8:FC C8 D0 F8 60 18 69 98 F8
 8BC0:85 FD A9 00 85 FC A0 00 B0
 8BC8:B1 FC 99 00 98 C8 D0 F8 AD
 8BD0:60 A9 00 AE 3F 80 20 CD 77
 8BD8:BD A9 20 20 D2 FF A9 00 29
 8BE0:AE 40 80 20 CD BD A9 0D 37
 8BE8:20 D2 FF 20 CC FF 20 52 BF
 8BF0:8D 4C ED 8A A9 29 85 FC 42
 8BF8:A9 04 85 FD A0 00 AE 41 1A
 8C00:80 A9 70 91 FC C8 A9 40 89
 8C08:91 FC C8 CA D0 FA A9 6E 23
 8C10:91 FC A2 00 20 4E 8C A9 82
 8C18:5D 91 FC AD 41 80 85 FE D4
 8C20:C8 BD 00 98 91 FC E8 F0 D9
 8C28:04 C6 FE D0 F3 A9 5D C8 AB
 8C30:91 FC E0 00 D0 DE 20 4E FD
 8C38:8C A9 6D 91 FC AE 41 80 6E
 8C40:A9 40 C8 91 FC CA D0 FA 20
 8C48:A9 7D C8 91 FC 60 A9 28 AC
 8C50:18 65 FC 85 FC 90 02 E6 DB
 8C58:FD A0 00 60 A9 52 85 FC 3D
 8C60:A9 04 85 FD A2 00 A0 00 36
 8C68:B1 FC 9D 00 98 E8 F0 0C A3
 8C70:C8 CC 41 80 90 F2 20 4E 30
 8C78:8C 4C 68 8C 60 20 2F 8D 30
 8C80:20 F4 8B A9 CB 85 FC A9 0B
 8C88:05 85 FD A2 08 86 FE A0 68
 8C90:00 A2 00 E8 BD CB 80 F0 AF
 8C98:07 29 3F 91 FC C8 D0 F3 21
 8CA0:20 4E 8C C6 FE D0 EC AE 1F
 8CA8:97 80 CA BD 00 97 8D 96 F2
 8CB0:80 CA BD 00 97 8D 95 80 13
 8CB8:A0 19 A2 0E 20 F3 8D 20 A9
 8CC0:1D 8D AE 3F 80 8E 95 80 7F
 8CC8:AE 40 80 8E 96 80 A0 19 53
 8CD0:A2 0F 20 F3 8D 20 1D 8D F6
 8CD8:AD 00 98 8D 95 80 AD 01 BF
 8CE0:98 8D 96 80 A0 19 A2 10 43
 8CE8:20 F3 8D 20 1D 8D A0 19 3C

8CF0:A2 12 20 F3 8D AD 97 80 F5
 8CF8:4A 20 E6 84 60 20 03 8B 79
 8D00:A2 0F 20 52 8D A9 0F 20 AA
 8D08:C3 FF 60 A2 28 A9 20 9D 01
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 8D20:20 05 85 A9 2C 20 D2 FF 5F
 8D28:AD 96 80 20 05 85 60 A9 7A
 8D30:20 A2 00 9D 00 04 9D 00 29
 8D38:05 9D 00 06 E8 D0 F4 A2 B4
 8D40:1F 9D 00 07 CA 10 FA A2 F1
 8D48:00 9D 48 07 E8 E0 A0 D0 21
 8D50:F8 60 AD 07 80 D0 15 A2 3A
 8D58:0F 20 C6 FF 20 0B 8D 20 44
 8D60:CF FF C9 0D F0 06 20 D2 20
 8D68:FF 4C 5F 8D 20 CC FF 60 EF
 8D70:AD 3F 80 AE 97 80 9D 00 27
 8D78:97 AD 40 80 E8 9D 00 97 30
 8D80:E8 8E 97 80 60 AE 97 80 1C
 8D88:CA BD 00 97 8D 40 80 CA 2B
 8D90:BD 00 97 8D 3F 80 8E 97 07
 8D98:80 60 20 70 8D AD 00 98 D2
 8DA0:8D 3F 80 AD 01 98 8D 40 03
 8DA8:80 20 2B 8B 60 20 85 8D 46
 8DB0:20 2B 8B 60 AE 3F 80 EE 80
 8DB8:40 80 AD 40 80 DD 97 80 F8
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 8DC8:3F 80 E8 E0 24 90 05 A2 DE
 8DD0:01 8E 3F 80 4C 2B 8B AE D4
 8DD8:3F 80 CE 40 80 10 11 CA C2
 8DE0:D0 02 A2 23 BD 97 80 8D 46
 8DE8:40 80 CE 40 80 8E 3F 80 5F
 8DF0:4C 2B 8B 18 20 F0 FF 60 15
 8DF8:A2 0F A0 19 20 F3 8D A9 64
 8E00:02 20 B7 83 20 5A 84 E0 A9
 8E08:00 D0 01 60 8D 3F 80 A2 8C
 8E10:0F A0 1C 20 F3 8D A9 02 8D
 8E18:20 B7 83 20 5A 84 E0 00 4C
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 8E30:2B 8B 60 20 F8 8D E0 00 93
 8E38:D0 01 60 20 5C 8C 20 6A CB

8E40:8B 60 AD 41 80 49 30 29 B7
 8E48:30 8D 41 80 60 68 68 00 86
 8E50:A9 00 8D 97 80 60 AD 3C 8A
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 8E60:80 29 03 4C A9 8B EE 20 A6
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 8E70:02 AD 86 02 A2 00 9D 00 3B
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 8E88:80 AD 42 80 8D 2E D0 60 C8
 8E90:A2 3F BD 43 80 9D 40 03 B8
 8E98:CA 10 F7 A9 0D 8D FF 07 5E
 8EA0:AD 42 80 8D 2E D0 A9 00 16
 8EA8:8D 1C D0 8D 1D D0 8D 17 E4
 8EB0:D0 8D 1B D0 A9 80 8D 15 89
 8EB8:D0 60 AD 15 D0 29 7F 8D 15
 8EC0:15 D0 60 84 FC 8E 3E 80 10
 8EC8:A9 08 85 FD 20 9B 84 A9 6F
 8ED0:26 18 65 FC 85 FC 80 02 C6
 8ED8:E6 FD A5 FC 8D 0E D0 AD 61
 8EE0:10 D0 29 7F 66 FD 90 02 A5
 8EE8:09 80 8D 10 D0 AC 3E 80 93
 8EF0:84 FC A9 08 85 FD 20 9B 45
 8EF8:84 A9 41 18 65 FC 8D 0F B5
 8F00:D0 60 4C 53 46 2B 2D 4E E5
 8F08:50 51 20 31 32 33 21 22 7D
 8F10:23 0B 0C 02 13 45 40 42 95
 8F18:48 44 27 8E 33 8E 42 8E 21
 8F20:B4 8D D7 8D 9A 8D AD 8D C4
 8F28:4D 8E FD 8C 56 8E 56 8E 42
 8F30:56 8E 5E 8E 5E 8E 5E 8E 4B
 8F38:50 8E 6E 8E 66 8E 6A 8E AA
 8F40:3B 85 7B 8E 7E 87 5B 83 82
 8F48:0B 89 A9 12 8D 3F 80 A9 B9
 8F50:00 8D 40 80 20 2B 8B 20 C7
 8F58:FD 8C 20 7D 8C 20 AF 83 3D
 8F60:8D 3C 80 A2 17 DD 02 8F 53
 8F68:F0 05 CA 10 F8 30 EB 8A 86
 8F70:0A AA BD 1A 8F 8D 7E 8F D9
 8F78:BD 1B 8F 8D 80 8F 20 4A D4
 8F80:8F 4C 5A 8F 00 00 00 00 BE

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SOUND SAMPLER 64

Let's face it: Creating sound effects on the 64 will never be as easy as plucking a string. The 64's Sound Interface Device, or SID, chip contains some 25 separate registers that control sound. Attempting to produce a particular effect by POKEing these registers is both tedious and time-consuming, especially for the novice programmer.

Now, *Sound Sampler 64* offers an alternative. This program allows you to access every programmable SID-chip register without prior computations or bothersome POKES. Furthermore, it utilizes the full potential of the chip, including filtering and waveform control, and it even lets you print out the register values that you've chosen so that you can later enter them into your own programs.

Getting Started

Sound Sampler 64 is written entirely in BASIC. To ensure accurate entry, use *The Automatic Proofreader*, found elsewhere in this issue, as you type it in. When you've finished, be sure to save a copy of the program to tape or disk.

To begin creating sounds, simply plug a joystick into port 2; then load and run the program. A screen with four columns will appear. The first three columns contain parameters that control the SID chip's three voices. These include frequency values; attack, decay, sustain, and release rates; waveform types; and so on. The last column contains general parameters that apply to all three voices and include volume, high- and low-filter values, resonance, and filter type. The joystick is used to change the parameters.

Sound Sampler 64 has two modes: move mode, indicated by a blue screen border, and change mode, indicated by

Guy Johnson

Have you ever wanted to add sound effects to a program or to just experiment with the sound capabilities of your 64? This program handles all the tedious details for you, leaving you free to create. Joystick required. Printer recommended.



Sound Sampler 64's powerful control panel.

a yellow border. In move mode, use the joystick to move the cursor to the parameter you wish to set. In change mode, push the joystick up or down to increase or decrease the parameter the cursor is on. To switch between modes, press the fire button.

Voice Parameters

Let's take a closer look at the voice parameters in the first three screen columns. The first two—FRHI and FRLO—determine a sound's frequency or pitch; FRHI is the frequency's high byte, while FRLO is its low byte. Each

parameter has a value in the range 0-255, for an overall frequency value of 0-65535. Adjust FRHI to make major changes in pitch, and use FRLO to fine-tune the sound. A table of frequency values for different musical notes is located in Appendix M of the *Commodore 64 User's Guide*.

The next two parameters, PULO and PUHI, are used to change the timbre of the sound for the pulse waveform. These parameters are only active for an individual voice when the pulse waveform is selected (see below). As with frequency, pulse is broken into a low byte (0-255) and a high byte (0-15). Change the first parameter to fine-tune the pulse, and the second to make major changes in it.

The waveform parameter (WVFM) determines the type of wave used to generate the sound. Possible values are 16, for a triangular waveform; 32, for a sawtooth waveform; 64, for a pulse waveform; and 128, for a random-noise waveform. Experiment with different waveforms to find the sound you like. (The pulse waveform requires that at least one of the pulse parameters above be set to something other than 0.)

The next four parameters are used to set a voice's sound envelope; each has a range of 0-15. The first, attack (ATAK), determines how quickly the sound reaches full volume—in as little as two milliseconds to as long as 8 seconds. Decay (DCAV) determines how fast the sound falls to sustain level; it varies from six milliseconds to 24 seconds. Sustain (SUST) is the volume at which the sound is held after the decay; it varies from 0-15, allowing you to set the voice's sustain volume in increments of 6⅔ percent of the overall volume. Release (RELS) is the rate at

which the sound falls from the sustain volume to 0; its values are similar to those of the decay cycle.

The final parameter is the PLAY parameter. When PLAY is set to 1, the corresponding voice is played. When it's set to 0, that voice is turned off (this doesn't always mean that no sound is heard). Before a voice can be heard, the following conditions must be met:

- The volume (see below) must be nonzero.
- A waveform must be selected.
- A frequency must be set.
- There must be an attack or a decay.

General Parameters

The parameters in the column on the right side of the screen affect all three voices. The clear parameter (CLR) sets all parameters on the screen to 0, so be careful when you use it. The volume parameter (VOL) controls how loud each voice is and ranges from 0 to 15.

There are four different filter parameters: FILO, FIHI, FIVO, and FITY (each one starts with FI). FILO (0-7) and FIHI (0-255) combine to determine the cutoff frequency. Depending on which filter type is used, these values cause the filter to attenuate all frequencies that are above, below, or near the cutoff point.

FIVO (0-7) determines which voices are affected by the filter. It is figured by adding up the values of the voices you want the filter to affect. Following is a table of the voice values for use with this parameter:

Voice Number	Value
Voice #1:	1
Voice #2:	2
Voice #3:	4

For example, let's say you want the filter to affect voices 1 and 3. To do this, set the FIVO parameter to 5 (1 + 4 = 5).

The last filter parameter is FITY (0-7). The 64 has three filter types: high pass, low pass, and band-pass. The high-pass filter removes lower frequencies, letting the higher frequencies pass. The low-pass filter has the opposite effect: It removes high frequencies while allowing low frequencies to pass. The band-pass filter allows a band or group of frequencies to pass through while frequencies above and below the band are removed. Set FITY to 4 for a high-pass filter, to 2 for a band-pass filter, or to 1 for a low-pass filter.

You can combine the filters to create some interesting effects. For example, suppose you want to combine the low- and high-pass filters to filter out midrange frequencies. To do this, set the FITY parameter to 5 (1 + 4 = 5).

The final parameter is RESO (0-15). Adjusting this increases or decreases the filter resonance.

The Finished Product

When you have developed the sound you like, turn on your printer and press f1. Label the project and each individual voice at the prompts. When you've finished, the program prints a table of values in "S+" notation. This means that the numbers in the first column are offsets from memory location 54272 (the starting SID chip address). So, to incorporate the sounds you create into your own program, for each register, add 54272 to the number in the first column; then POKE the value in the second column into this memory location.

Sound Sampler 64

```
HQ 10 REM COPYRIGHT 1990 COMPU
TE! PUBLICATIONS, INC. -
ALL RIGHTS RESERVED
SE 20 PRINT "{CLR}"TAB(12)"COPY
RIGHT 1990":PRINTAB(6)"
COMPUTE! PUBLICATIONS, I
NC."
RD 30 PRINTTAB(10)"ALL RIGHTS
{SPACE}RESERVED"
GM 40 FORJF=1TO2500:NEXT
JQ 50 DATA 4,14,24,34
MS 60 DATA 3,5,7,9,11,13,15,17
,19,21
AS 70 FOR Q=1TO4:READX:CR(Q)=X
:NEXT
RC 80 FOR Q=1TO10:READX:LR(Q)=
X:NEXT
MP 90 DIMZ(4,10)
QJ 100 POKE53281,0:POKE53280,1
4
PH 110 PRINT "{CLR}"{10 SPACES}
{WHT} SOUND SAMPLER 64"
GG 120 PRINT:PRINT "{GRN}VOICE
{SPACE}#1{2 SPACES}{3}V
OICE #2{2 SPACES}{1}VOI
CE #3{2 SPACES}{CYN}ALL
3"
QR 130 PRINT "{YEL}"
QR 140 DATAFRHI,FRLO,PULO,PUHI
,WVFM,ATAK,DCAY,SUST,PE
LS,PLAY
PP 150 FORQ=1TO10:READXS:FORQ2
=1TO3:PRINTXS;"
{6 SPACES}";:NEXTQ2:PRI
NT:PRINT:NEXTQ
PR 160 DATACLR,VOL,FILO,FIHI
,RESO,FIVO,FITY,PLAY
MB 170 FORQ=1TO8:POKE214,LR(Q)
:PRINT:POKE211,CR(4):RE
ADX$:PRINT "{4 LEFT}"XS:
NEXTQ
SX 180 PRINT "{8}"
CX 190 S=54272:FORQ=0TO24:POKE
S+Q,0:NEXTQ:FORQ=1TO4:F
ORQ2=1TO10:Z(Q,Q2)=0
JR 200 NEXT:NEXT
KJ 210 FORC=1TO3:FORL=1TO10:PO
KE214,LR(L):PRINT:POKE2
11,CR(C):PRINTZ(C,L);"
{LEFT}{3 SPACES}"
AX 220 NEXT:NEXT
SE 230 FORQ=1TO8:POKE214,LR(Q)
:PRINT:POKE211,CR(4):PR
INT0;"{LEFT}{3 SPACES}"
:NEXT
EQ 240 PRINT:PRINT "{DOWN}
{11 RIGHT}{3 DOWN}PRESS
F1 TO PRINT";
DJ 250 C=1:L=1
DF 260 REM{3 SPACES}** MOVEMEN
T LOOP **
XK 270 POKE214,LR(L):PRINT:POK
```

```
E211,CR(C):PRINT "{RVS}"
Z(C,L)"{LEFT}{OFF}";:P
OKE211,CR(C)
HP 280 JS=PEEK(56320)
MP 290 GETA$:IFAS$=CHRS(133)THE
N1030:REM PRINT
GQ 300 IFJS=127THEN280
JR 310 IFJS=111THENPOKE53280,7
:FORS=0TO199:NEXT:GOTO
450
KC 320 PRINT "{OFF}"Z(C,L);"
{LEFT}{2 SPACES}"
QK 330 IFJS=126THENL=L-1:REM U
P
XX 340 IFJS=125THENL=L+1:REM D
OWN
GH 350 IFJS=123THENC=C-1:REM L
EFT
AX 360 IFJS=119THENC=C+1:REM R
IGHT
DE 370 IFL>10THENL=10
KP 380 IFL<1THENL=1
JQ 390 IF(C=4)AND(L>8)THENL=8
QS 400 IFC<1THENC=1
CH 410 IFC>4THENC=4
SP 420 IF(L>8)AND(C>3)THENC=3
BX 430 GOTO270
GE 440 REM{3 SPACES}**
{4 SPACES}CHANGE LOOP
{4 SPACES}**
DE 450 IFC=4THEN870
RR 460 IFL=1THENM=S+1:F=0:T=25
5:GOTO560
BB 470 IFL=2THENM=S:F=0:T=255:
GOTO560
ES 480 IFL=3THENM=S+2:F=0:T=25
5:GOTO560
FH 490 IFL=4THENM=S+3:F=0:T=15
:GOTO560
JM 500 IFL=5THEN680
KQ 510 IFL=6THENM=S+5:F=2:P=Z(
C,7):T=15:GOTO560
PS 520 IFL=7THENM=S+5:F=1:P=Z(
C,6):T=15:GOTO560
MH 530 IFL=8THENM=S+6:F=2:P=Z(
C,9):T=15:GOTO560
QK 540 IFL=9THENM=S+6:F=1:P=Z(
C,8):T=15:GOTO560
BD 550 IFL=10THEN820
XJ 560 JS=PEEK(56320)
ED 570 IFJS=127THEN560
FH 580 IFJS=125THENZ(C,L)=Z(C,
L)-1:GOTO620
MC 590 IFJS=126THENZ(C,L)=Z(C,
L)+1:GOTO620
GX 600 IFJS=111THENPOKE53280,1
4:FORS=0TO199:NEXT:GOT
O260
XQ 610 GOTO560
AD 620 IFZ(C,L)>TTHENZ(C,L)=0:
POKE211,CR(C):PRINT"
{5 SPACES}";:GOTO640
SB 630 IFZ(C,L)<0THENZ(C,L)=T:
GOTO640
GD 640 IFF=0THENPOKEM+(C-1)*7,
Z(C,L):GOTO670
RQ 650 IFF=1THENPOKEM+(C-1)*7,
P+Z(C,L):GOTO670
KD 660 IFF=2THENPOKEM+(C-1)*7,
P+Z(C,L)*16
HM 670 POKE211,CR(C):PRINT"
{RVS}";Z(C,L);"{LEFT}
{OFF}";:GOTO560
RX 680 REM ** WAVEFORM CHANGE
{SPACE}**
BB 690 JS=PEEK(56320)
RX 700 IFJS=127THEN690
XP 710 IFJS=125THEN750
BX 720 IFJS=126THEN780
GD 730 IFJS=111THENPOKE53280,1
4:FORS=0TO199:NEXT:GOT
O270
QH 740 GOTO690
```

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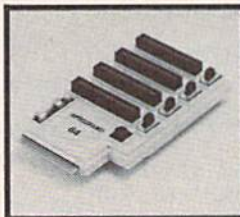
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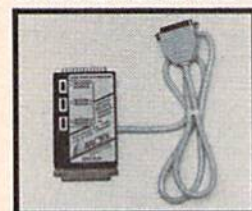
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Sound Sampler

- AR 750 IFZ (C,L)=0THENZ (C,L)=128:GOTO770
- HA 760 Z (C,L)=Z (C,L)/2:IFZ (C,L)<16THENZ (C,L)=0
- RB 770 POKES+4+(C-1)*7,Z (C,L):POKE211,CR (C):PRINT"RVS";Z (C,L);"{LEFT} {OFF} ";:GOTO680
- RM 780 IFZ (C,L)=0THENZ (C,L)=16:GOTO810
- XH 790 Z (C,L)=Z (C,L)*2
- CC 800 IFZ (C,L)>128THENZ (C,L)=0:POKE211,CR (C):PRINT"RVS";Z (C,L);"{LEFT} {OFF} {2 SPACES}";
- SX 810 POKES+4+(C-1)*7,Z (C,L):POKE211,CR (C):PRINT"RVS";Z (C,L);"{LEFT} {OFF} ";:GOTO680
- CK 820 POKES3280,14:REM PLAY A VOICE
- CP 830 IFZ (C,L)=0THENPOKES+4+(C-1)*7,Z (C,5)+1:GOTO860
- XB 840 POKES+4+(C-1)*7,Z (C,5):Z (C,L)=0:POKE211,CR (C):PRINT"RVS";Z (C,L);"{LEFT} {OFF}";
- CP 850 GOTO260
- ME 860 Z (C,L)=1:POKE211,CR (C):PRINT"RVS";Z (C,L);"{LEFT} {OFF}";:GOTO260
- XM 870 REM{3 SPACES}** ALL VOICES COLUMN **
- XE 880 IFL=1THENPOKES3280,14:GOTO190
- CP 890 IFL=2THENM=S+3:F=1:P=Z (C,7):T=15:GOTO560
- QX 900 IFL=3THENM=S:F=0:T=7:GOTO560
- MJ 910 IFL=4THENM=S+1:F=0:T=255:GOTO560
- CJ 920 IFL=5THENM=S+2:F=2:P=Z (C,6):T=15:GOTO560
- JC 930 IFL=6THENM=S+2:F=1:P=Z (C,5):T=7:GOTO560
- KM 940 IFL=7THEN1190:REM ELSE PLAY ALL VOICES
- GM 950 POKE214,LR (10):PRINT:FORG=0TO2:POKES+4+G*7,Z (G+1,5):POKE211,CR (G+1)
- MJ 960 PRINT0"LEFT ";:Z (G+1,10)=0:NEXT
- RB 970 IFZ (C,L)=1THENZ (C,L)=0:POKE214,LR (8):PRINT:GOTO990
- XS 980 GOTO1000
- AK 990 POKE211,CR (C):PRINT"RVS";Z (C,L);"{LEFT} {OFF} ";:POKES3280,14:GOTO260
- EQ 1000 POKE214,LR (10):PRINT:FORG=0TO2:POKES+4+G*7,Z (G+1,5)+1:POKE211,CR (G+1)
- HC 1010 PRINT1"LEFT ";:Z (G+1,10)=1:NEXT
- GH 1020 POKE214,LR (8):PRINT:Z (C,L)=1:GOTO990
- FD 1030 REM PRINT IT
- FG 1040 PRINT"CLR}{3 DOWN}":INPUT"ENTER TITLE";YS (0):PRINT
- QR 1050 INPUT"ENTER NAME OF VOICE 1:";YS (1)
- SE 1060 PRINT:INPUT"ENTER NAME OF VOICE 2:";YS (2)
- XS 1070 PRINT:INPUT"ENTER NAME OF VOICE 3:";YS (3)
- EM 1080 PRINT:PRINT"PRINTING..."
- RA 1090 OPEN4,4:PRINT#4,"SOUND SAMPLE: ";YS (0):PRINT#4,""
- QR 1100 PRINT#4,"S=54272. REG'S GIVEN IN 'S+' NOTATION:"
- RA 1110 FORN=1TO3:PRINT#4,YS (N):FORN2=0TO4:PRINT#4,(N-1)*7+N2;" ";Z (N,N2+1)
- JR 1120 NEXTN2:PRINT#4,5+(N-1)*7;" ";Z (N,6)*256+Z (N,7)
- MR 1130 PRINT#4,6+(N-1)*7;" ";Z (N,8)*256+Z (N,9):NEXTN
- DC 1140 PRINT#4,"":PRINT#4,21;" ";Z (4,3)
- HM 1150 PRINT#4,22;" ";Z (4,4)
- JA 1160 PRINT#4,23;" ";Z (4,5)+Z (4,6)
- HQ 1170 PRINT#4,24;" ";Z (4,2)+Z (4,7)*16
- KJ 1180 CLOSE4:PRINT"DONE!":END
- CD 1190 REM ADJUST FILTER TYPE
- QB 1200 JS=PEEK (56320):IFJS=127THEN1200
- DE 1210 IFJS=111THENPOKES3280,14:FORJS=0TO199:NEXT:GOTO270
- PS 1220 IFJS=125THENZ (C,L)=Z (C,L)-1:GOTO1250
- JQ 1230 IFJS=126THENZ (C,L)=Z (C,L)+1:GOTO1250
- BR 1240 GOTO1200
- CE 1250 IFZ (C,L)>7THENZ (C,L)=0
- PD 1260 IFZ (C,L)<0THENZ (C,L)=7
- GA 1270 POKES+24,Z (C,2)+Z (C,L)*16:POKE211,CR (C):PRINT"RVS";Z (C,L);"{LEFT} {OFF} {SPACE}";
- RS 1280 GOTO1200



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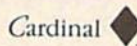
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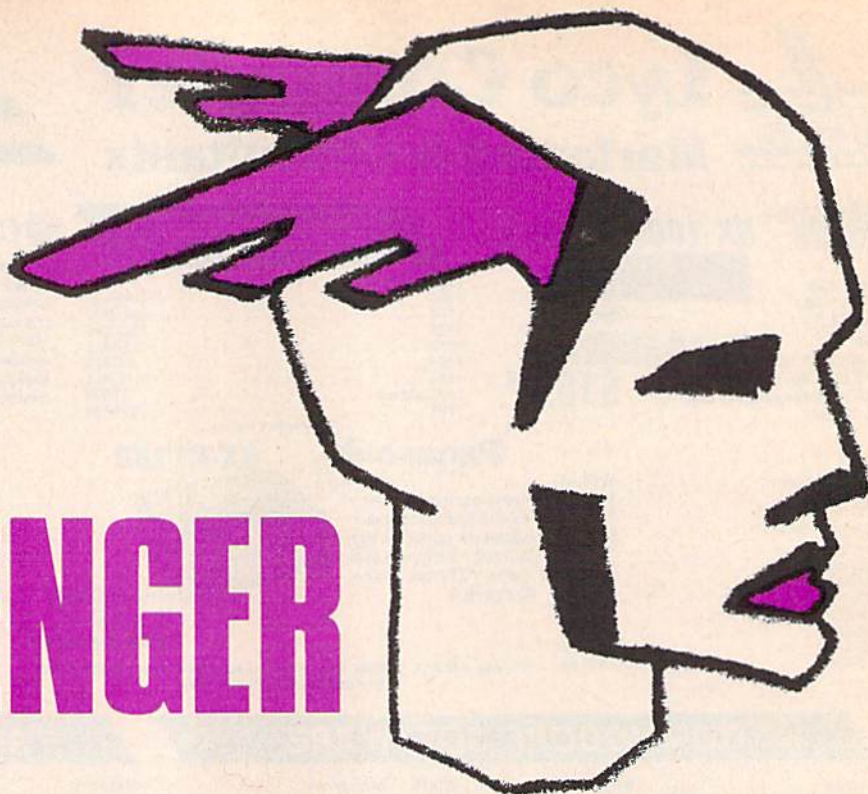
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MESSENGER

Stephane Edwardson

Here's a fun way to send a message to a friend: Generate a stand-alone text file that recreates your actual type-in sequence. For the 64.

Need to add a personal touch to your notes, online messages, or program instruction files? *Messenger* just may be your answer. It lets you enter a message using the built-in screen editor and then save it to disk in the form of a BASIC program. When you run this program, your message is displayed on the screen one keystroke at a time, exactly as you typed it in.

Because *Messenger* uses the screen editor, you can produce some interesting and entertaining effects with it. In addition to letting you enter ordinary text and graphics characters, you can cursor around the screen, change screen colors, change text colors, and so forth. With a 31K buffer and a built-in message compactor, *Messenger* is capable of handling lengthy dispatches. It can also "grab" text from sequential files on disk and incorporate it into your message.

Getting Started

Messenger is written in BASIC with machine language routines in DATA statements. Enter the program using *The Automatic Proofreader*, found elsewhere in this issue. When you've finished typing, be sure to save a copy of the program to disk.

When you're ready to begin, load and run *Messenger*. After the program initializes, you're presented with a menu of eight options. At the bottom of the screen is a handy memory gauge

which tells you the length of the current message and the amount of memory still available.

Using the Program

The first menu option is View Message. This option lets you preview the message that's currently in the text buffer. During the playback sequence, you can press the Commodore key to speed up the process or the SHIFT/LOCK key to pause the display.

The second menu option is Enter Message. Select this option when you wish to edit an existing message or create a new one. If there's currently a message in the text buffer, it will be played back (using Option 1) before you're placed in edit mode. Once in this mode, you can move the cursor around, type in text, change screen colors, or do whatever you like.

The built-in screen editor is active, so practically any keystroke is allowed. As you type in your message, the program takes each keypress and stores its corresponding CHR\$ value in the text buffer. The only keys that behave differently are the function keys, which have the following assignments:

- f1 Cycles the border colors
- f2 Inserts a one-second pause in the message
- f3 Cycles the screen colors
- f4 Resets the screen, border, and text colors

f5 Enables uppercase/graphics character set

f7 Enables lower-/uppercase character set

f8 Exits edit mode and returns you to the main menu

When you've finished typing in your message, press f8 to return to the main menu. Also, if you're typing in a large message, it's a good idea to periodically check the amount of free memory available. To do this, press f8, note the memory gauge, and then return to edit mode by selecting Option 2.

The third option is Make Message Program. This option lets you convert the buffer contents into a stand-alone message file. Use this option only after you've edited your message and are completely satisfied with it. When you select this option, you'll be prompted for a password (eight characters or less). This password will be encoded into your text file and only those who can supply it will be able to read your message. If you don't want a password-encoded text file, just press RETURN at the prompt.

Next, enter a filename (16 or fewer characters) for your message file or press RETURN to abort this option and return to the main menu. If you enter a filename, your message is compressed (see Option 4) and then saved to disk in a ready-to-run format.

The fourth option is Compact Memory. This option is used to crunch the data within the text buffer to conserve memory and disk space. Whenever a character occurs more than two

times consecutively within the message, the compactor routine inserts a special code or token in the message and compresses the repeating characters into a two-byte sequence. Using this approach, up to 255 repeating characters can be stored in two bytes. Note that this option executes automatically before a message is saved to disk in the stand-alone format (Option 3).

Option 5 is Save Message Text. Use this option to save incomplete messages or to store files for future reference. When you select this option, you'll be prompted for a filename. If you wish to abort the option, just press RETURN at the prompt. If you choose to continue, enter a filename and the contents of the text buffer will be saved to disk as a sequential file. Note that the message isn't compacted before the save, so if you want to conserve disk space, execute Option 4 before this one.

The sixth option, Load Message Text, performs the opposite of Option 5. It loads previously saved text files (both compacted and uncompact) or any sequential text file containing Commodore ASCII text. Text that's loaded with this option will be appended to the text buffer.

When you choose Option 6, a directory of sequential files on the disk in the drive is displayed. Next, you're prompted for the name of the file you wish to load. Enter a filename or press RETURN to abort the option.

If you wish to include a BASIC program listing in your message, you must first convert the program file to a sequential file and then later append it to the message. To perform this conversion, load the program into memory and then type the following command sequence:

```
OPEN 1,8,8,"0:filename.seq,S,W":CMD1:
LIST
PRINT#1:CLOSE1
```

where *filename.seq* is the name of the sequential file that you're creating.

Option 7, the Clear Memory option, is used to clear the contents of the text buffer. Be careful with this option; once you've cleared the buffer, there's no way to recover the data.

The last option, Option 8, is Quit. This option exits *Messenger* and resets the computer. Be sure that you save all data before selecting this option.

Special Effects

Using the standard Commodore screen editor, you can create some rather impressive and interesting effects. By using the INST/DEL key to push and pull words around, you can make text appear to dance across the screen. To give different portions of your message emphasis, you can cycle the text, screen, and border colors. By pressing

f5 or f7, you can alternate between the two character sets.

Scrolling effects can be achieved in a number of ways. One way is to type in your message at the bottom of screen and then press the RETURN key several times. The text will move up one screen line each time you press RETURN. Downward scrolling can be performed by typing your message at the top of the screen, erasing it, typing it again on the next line, and so on. This method may seem a little tedious, but the results are worth it.

These examples represent only a small sample of what you can do with *Messenger*. With a little creativity and some experimentation, you'll be creating dazzling messages in no time.

Messenger

```
HQ 10 REM COPYRIGHT 1990 COMPU
TE! PUBLICATIONS, INC. -
ALL RIGHTS RESERVED
MH 20 POKE55,0:POKE56,PEEK(46)
+4:CLR:PRINT"{CLR}{DOWN}
{CYN}"TAB(9)"ONE MOMENT,
PLEASE..."
DS 30 POKE53280,0:POKE53281,0:
POKE650,128:DIMA(70)
RS 40 FORZ=0TO9:A(Z+48)=Z:A(Z+
61)=Z+6:NEXT:FORZ=1TO7:R
EADB:NEXT
XM 50 FORZ=49152TO49879:READA$
:Q=16*A(ASC(A$))+A(ASC(R
IGHT$(A$,1)):G=G+Q
AB 60 POKEZ,Q:NEXT:IFG<>95982T
HENPRINT"{DOWN}ERROR IN
{SPACE}DATA STATEMENT.":
STOP
JC 70 CLR:SYS49195:DEFFNA(X)=P
EEK(X)+256*PEEK(X+1)
JS 80 AD=FNA(55):U$=CHR$(8)+CH
R$(142):N=AD:POKEZ,0:W=4
0959
XQ 90 IFN>WTHENN=W:POKEW,0
RF 100 POKE53280,0:POKE53281,0
:PRINT"{CLR}";U$;MB=N-
AD:FB=W-N
PM 110 A$="":FORZ=1TO29:A$=A$+
"*":NEXT:B$="{DOWN}
{6 RIGHT}{RVS}{7}":C$=
"{OFF}{YEL}"
PA 120 PRINTTAB(15){7}MESSENG
ER{4}:PRINTTAB(12)"COP
YRIGHT{2 SPACES}1990"
PQ 130 PRINTTAB(6)"COMPUTE! PU
BLICATIONS, INC."
BS 140 PRINTTAB(11)"ALL RIGHTS
RESERVED"
AE 150 PRINT"{BLU}{DOWN}
{5 RIGHT}{A}"A$"{S}":FO
RZ=1TO8:PRINT"{5 RIGHT}
-TAB(35)"_":PRINT"
{5 RIGHT}{Q}"A$"{W}"
CP 160 NEXT
QR 170 PRINT"{UP}{5 RIGHT}{Z}"
A$"{X}{HOME}{4 DOWN}"
QJ 180 PRINTB$"1"CS"VIEW MESSA
GE"
RK 190 PRINTB$"2"CS"ENTER MESS
AGE"
GD 200 PRINTB$"3"CS"MAKE MESSA
GE PROGRAM"
QD 210 PRINTB$"4"CS"COMPACT ME
MORY"
BQ 220 PRINTB$"5"CS"SAVE MESSA
GE TEXT (SEQ)"
QQ 230 PRINTB$"6"CS"LOAD MESSA
```

```
GE TEXT (SEQ)"
XB 240 PRINTB$"7"CS"CLEAR MEMO
RY"
XD 250 PRINTB$"8"CS"QUIT"
RH 260 PRINT,, "{8}{2 DOWN}";RI
GHT$(STR$(FB+1E6),5);"
{CYN} BYTES FREE"
JA 270 PRINT,, "{8}";RIGHT$(STR
$(MB+1E6),5);" {CYN} BYT
ES USED":POKE198,0
MP 280 GETA$:IFAS<"1"ORAS>"8"
T HEN280
CC 290 ONVAL(A$)GOTO300,360,35
0,470,480,550,310,330
GF 300 SYS49192,AD:FORZ=1TO500
:NEXT:GOTO90
QQ 310 GOSUB740:IFAS="N"THEN90
HS 320 N=AD:POKEZ,0:GOTO90
ES 330 GOSUB740:IFAS="N"THEN90
KX 340 SYS64738
SF 350 GOSUB890:GOTO90
AH 360 SYS49192,AD:FORZ=54272T
O54300:POKEZ,0:POKE5429
6,15
BG 370 RESTORE:FORZ=6TO0STEP-1
:READY:POKE54272+Z,Y:NE
XT:POKE198,0
SD 380 B=54276:C=53280:D=C+1:A
=USR(0):POKEB,33:POKEB,
255:POKEN,A:N=N+1
JK 390 IFA<133ORA>140THEN460
RK 400 IFA=133THENPOKEC,(PEEK(
C)AND15)+1
KR 410 IFA=134THENPOKED,(PEEK(
D)AND15)+1
XF 420 IFA=138THENPOKEC,0:POKE
D,0:PRINT"{CLR}{CYN}";U
$;
KX 430 IFA=135THENPRINTU$;
KE 440 IFA=136THENPRINTCHR$(14
);
SD 450 IFA=140THENN=N-1:POKEN,
0:GOTO90
ME 460 PRINTCHR$(A);:GOTO380
PK 470 GOSUB1050:GOTO90
PE 480 PRINT"{CLR}"TAB(15)"
{DOWN}{6}TEXT SAVE"
JD 490 F$="":INPUT"{4 DOWN}
{CYN}FILENAME ";F$:IFF$
=" "THEN90
EF 500 GOSUB860:PRINT"{CLR}
{5 DOWN}"TAB(10){6}SAV
ING...PLEASE WAIT"
JC 510 OPEN2,8,2,F$+"",S,W":GOS
UB800:IFER<>0THENS40
RA 520 IFPEEK(AD)<138THENPRIN
T#2,CHR$(138);
EC 530 SYS49201,AD
RX 540 CLOSE2:CLOSE15:SYS65511
:GOTO90
DJ 550 GOSUB860:S$="":FORZ=1TO
40:S$=S$+" ":NEXTZ
QK 560 PRINT"{CLR}{6}"TAB(10)"
FILES ON THIS DISK:
{DOWN}{6}{GRN}"
XX 570 OPEN2,8,0,"$0:*=$":C$=C
HR$(34):GOSUB800:IFER<>
0THEN730
FH 580 GET#2,A$,A$
MK 590 GET#2,A$,A$:IFAS=" "THEN
680
CM 600 GET#2,A$,A$:N$=" "
EG 610 GET#2,A$:IFAS=" "THEN590
KS 620 IFAS<>C$THEN610
EX 630 GET#2,A$:IFAS<>C$THENS$
=N$+A$:GOTO630
AX 640 IFZ=41THENZ=0:PRINT"
{RVS}"LEFT$(N$+S$,40)"
{6}{OFF}";:GOTO660
HK 650 PRINTN$;SPC(20-LEN(N$))
;
BQ 660 GET#2,A$:IF A$<>" " THEN
660
```

Messenger

```
DD 670 GOTO590
QH 680 CLOSE2:CLOSE15:PRINT:PR
INT"{RVS}{GRN}";SS
SR 690 F$="":INPUT"{CYN}{DOWN}
FILE TO LOAD ";F$:IFF$=
"THEN730
JH 700 PRINT"{CLR}{5 DOWN}"TAB
(10)"{6}LOADING...PLEAS
E WAIT"
EM 710 OPEN2,8,2,F$+"",S,R":GOS
UB800:IFER<>0THEN730
AC 720 SYS49198,N:N=FNA(781)+1
:POKEN,0
JP 730 CLOSE2:CLOSE15:SYS65511
:GOTO90
QC 740 PRINT"{CLR}"TAB(15)"
{YEL}{2 DOWN}WARNING!!!
"
FX 750 PRINT"{2 DOWN}{CYN}
{3 SPACES}THIS OPTION W
ILL ERASE THE CURRENT"
PC 760 PRINTTAB(11)"{DOWN}MESS
AGE IN MEMORY."
ME 770 PRINTTAB(10)"{3 DOWN}
{6}ARE YOU SURE? [Y/N]"
:POKE198,0
JM 780 GETAS:IFAS<>"Y"ANDAS<>"
N"THEN780
KK 790 RETURN
XQ 800 OPEN15,8,15:INPUT#15,ER
,ER$,ET,ES:IFER=0THENRE
TURN
RP 810 PRINT"{CLR}"TAB(11)"
{2 DOWN}{6}OPERATION AB
ORTED."
QA 820 PRINT"{7 DOWN}{RED}DISK
ERROR:{YEL}";ER;ER$;ET
;"{LEFT}";ES
FE 830 PRINTTAB(14)"{6}
{7 DOWN}PRESS A KEY":PO
KE198,0
CA 840 GETAS:IFAS$=""THEN840
SM 850 RETURN
CA 860 PRINT"{CLR}{6}{5 DOWN}"
TAB(5)"INSERT A DISK AN
D PRESS A KEY":POKE198,
0
ES 870 GETAS:IFAS$=""THEN870
CX 880 RETURN
JS 890 A=AD:PRINT"{CLR}{CYN}
{5 DOWN}"
SD 900 FORZ=1TO8:KY(Z)=0:NEXT:
Q=1
CK 910 PRINT"INPUT PASSWORD TO
CODE THE MESSAGE.
{5 SPACES}{6}{RETURN}
{CYN} ONLY TO NOT CODE"
MB 920 K$="":INPUT"{DOWN}PASSW
ORD (8 CHARACTERS MAX.)
";K$
MK 930 P=1:IFK$=""THENK$=CHR$(
0):P=0
JE 940 FORZ=1TO3:K$=K$+K$:NEXT
:F$="":INPUT"{DOWN}FILE
NAME";F$:IFF$=""THENRET
URN
XX 950 GOSUB860:PRINT"{CLR}{6}
{5 DOWN}{3 SPACES}COMPA
CTING AND SAVING THE ME
SSAGE."
SB 960 PRINTTAB(14)"{CYN}
{2 DOWN}PLEASE WAIT.
{3 DOWN}"
ME 970 GOSUB1060:OPEN2,8,2,F$+
"P,W":GOSUB800:IFER<>0
THEN1040
HG 980 PRINT#2,CHR$(1)CHR$(8);
:X=2049
PF 990 X=FNA(X):IFFNA(X+2)<>20
00THEN990
CQ 1000 FORZ=XTOFNA(45)-1:PRIN
T#2,CHR$(PEEK(Z));:NEX
T
JJ 1010 PRINT#2,CHR$(P);:FORZ=
1TO8:POKE49183+Z,0:NEX
T
GB 1020 FORZ=49152TO49615:PRIN
T#2,CHR$(PEEK(Z));:NEX
T
PB 1030 FORZ=1TO8:POKE49183+Z,
ASC(MID$(K$,Z,1)):NEXT
:SYS49207,AD:POKE49184
,0
SF 1040 CLOSE2:CLOSE15:SYS6551
1:RETURN
BG 1050 PRINT"{CLR}{6}"TAB(8)"
{5 DOWN}COMPACTING...
{SPACE}PLEASE WAIT
{3 DOWN}"
XX 1060 IFN=ADTHENRETURN
XA 1070 SYS49204,AD:N=FNA(781)
:RETURN
HX 1080 DATA255,31,255,1,0,50,
0
JK 1090 DATA AD,28,C0,A9,4C,A0
,00,84,FB,91,14,A9,C0,
85,FC,A2,04,B1,14,91
HQ 1100 DATA FB,88,D0,F9,E6,FC
,E6,15,CA,D0,F2,60,00,
00,00,00,00,00,00,00
MR 1110 DATA 4C,3A,C0,4C,D0,C1
,4C,0A,C2,4C,2E,C2,4C,
49,C2,4C,A5,C2,20,95
XG 1120 DATA C1,A5,14,8D,51,C1
,A5,15,8D,52,C1,20,A8,
C0,20,BD,C0,20,72,C1
AQ 1130 DATA A9,00,8D,CE,C1,AD
,20,C0,F0,03,20,9F,C1,
A9,00,85,A2,20,4B,C1
PH 1140 DATA C9,00,D0,07,20,A8
,C0,20,88,C1,60,8D,C9,
C1,20,04,C1,20,88,C1
CE 1150 DATA AD,C9,C1,20,D2,FF
,20,72,C1,AD,C9,C1,29,
7F,C9,21,30,03,20,D5
ME 1160 DATA C0,AD,8D,02,29,02
,F0,04,A9,05,85,A2,A9,
03,C5,A2,10,FC,AD,8D
ME 1170 DATA 02,29,01,D0,F9,4C
,5D,C0,A0,19,A9,00,99,
FF,D3,88,D0,FA,A9,0F
RQ 1180 DATA 8D,18,D4,A2,05,20
,42,C1,60,A9,00,8D,20,
D0,8D,21,D0,A9,9F,20
QH 1190 DATA D2,FF,A9,93,20,D2
,FF,A9,8E,20,D2,FF,60,
8D,C9,C1,A0,06,B9,C2
PA 1200 DATA C1,99,00,D4,88,10
,F7,A9,21,8D,04,D4,A2,
00,A0,05,AD,8D,02,29
GH 1210 DATA 02,F0,02,A0,01,CA
,D0,FD,88,D0,FA,A9,FF,
8D,04,D4,AD,C9,C1,60
GP 1220 DATA C9,85,D0,04,EE,20
,D0,60,C9,89,D0,0C,20,
88,C1,A2,3C,20,42,C1
AF 1230 DATA 20,72,C1,60,C9,86
,D0,04,EE,21,D0,60,C9,
8A,D0,04,20,BD,C0,60
FS 1240 DATA C9,87,D0,06,A9,8E
,20,D2,FF,60,C9,88,D0,
05,A9,0E,20,D2,FF,60
HS 1250 DATA A2,01,A9,00,85,A2
,E4,A2,D0,FC,60,AD,CE,
C1,D0,1B,AD,FF,FF,EE
HS 1260 DATA 51,C1,D0,03,EE,52
,C1,C9,01,D0,12,20,50,
C1,8D,CE,C1,20,50,C1
SP 1270 DATA 8D,CF,C1,CE,CE,C1
,AD,CF,C1,60,A4,D3,B1,
D1,8D,CC,C1,B1,F3,8D
GK 1280 DATA CD,C1,A9,A0,91,D1
,AD,86,02,91,F3,60,A4,
D3,AD,CC,C1,91,D1,AD
CP 1290 DATA CD,C1,91,F3,60,20
,FD,AE,20,8A,AD,20,F7,
B7,60,A0,00,A2,00,A1
DP 1300 DATA 14,59,20,C0,81,14
,A1,14,F0,0E,E6,14,D0,
02,E6,15,C8,98,29,07
QM 1310 DATA A8,4C,A3,C1,A9,00
,8D,20,C0,60,00,32,00,
01,FF,1F,FF,00,00,00
PA 1320 DATA 00,00,00,00,A9,DB
,8D,11,03,A9,C1,8D,12,
03,60,A4,D3,B1,F3,48
QM 1330 DATA B1,D1,48,AD,86,02
,91,F3,A4,D3,68,48,49,
80,91,D1,20,E4,FF,AA
CK 1340 DATA A4,D3,68,48,91,D1
,8A,F0,EB,A4,D3,68,68,
91,F3,8A,A8,A9,00,4C
PA 1350 DATA 91,B3,20,95,C1,A2
,02,20,C6,FF,20,CF,FF,
A0,00,91,14,20,B7,FF
MH 1360 DATA 29,40,D0,09,E6,14
,D0,EE,E6,15,4C,12,C2,
A6,14,A4,15,60,20,95
QG 1370 DATA C1,A2,02,20,C9,FF
,A0,00,B1,14,F0,0C,20,
D2,FF,E6,14,D0,F3,E6
MR 1380 DATA 15,4C,36,C2,60,20
,95,C1,A5,14,85,FB,A5,
15,85,FC,A0,00,B1,FB
CA 1390 DATA D0,07,91,14,A6,14
,A4,15,60,C8,C0,FF,F0,
04,D1,FB,F0,F7,C0,01
GB 1400 DATA F0,20,C0,02,F0,1C
,48,A9,01,20,9A,C2,98,
20,9A,C2,18,65,FB,85
RH 1410 DATA FB,A9,00,65,FC,85
,FC,68,20,9A,C2,4C,54,
C2,20,9A,C2,E6,FB,D0
MC 1420 DATA 02,E6,FC,4C,54,C2
,A2,00,81,14,E6,14,D0,
02,E6,15,60,20,95,C1
GK 1430 DATA A2,02,20,C9,FF,A2
,00,A0,00,A1,14,59,20,
C0,8E,CA,C1,8C,CB,C1
AK 1440 DATA 20,D2,FF,AE,CA,C1
,AC,CB,C1,A1,14,F0,0E,
E6,14,D0,02,E6,15,C8
JK 1450 DATA 98,29,07,A8,4C,B1
,C2,60
XJ 2000 POKE53280,0:POKE53281,
0:PRINT"{CLR}"CHR$(142
)CHR$(8):X=2049
FP 2010 DEFNA(X)=PEEK(X)+256*
PEEK(X+1)
PX 2020 X=FNA(X):IFX<>0THENY=X
+2:GOTO2020
GR 2030 IFPEEK(Y+1)=173THENSYS
(Y+1)
HC 2040 IFPEEK(Y)=0THEN2080
DR 2050 PRINT"{4 DOWN}{GRN}THI
S MESSAGE IS PROTECTED
"
CE 2060 INPUT"{DOWN}PLEASE ENT
ER PASSWORD ";K$
GQ 2070 FORZ=1TO8:N$=N$+K$:POK
E49183+Z,ASC(MID$(N$,Z
,1)):NEXT:POKEY,0
QS 2080 PRINT"{CLR}{CYN}
{9 SPACES}MESSENGER FI
LE-PLAYER"
FH 2090 PRINT"{7}{9 DOWN}HOLD
{SPACE}{RVS}{6} CMDR
{OFF}{7} TO SPEED UP"
HD 2100 PRINT"{DOWN}HOLD {RVS}
{6} SHET {OFF}{7} TO F
REEZE DISPLAY"
PS 2110 PRINTTAB(9)"{YEL}
{9 DOWN}PRESS ANY KEY
{SPACE}TO START":POKE1
98,0
AJ 2120 GET AS:IF AS$="" THEN
{SPACE}2120
FK 2130 SYS 49152,(Y+465):RUN
```

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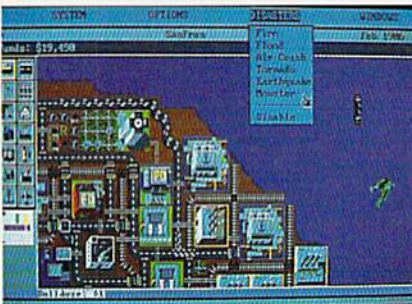
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BattleTech Successful departure for Infocom p. 65



Kings of the Beach Fun-filled 3-D volleyball simulation p. 66

Fire King

This new game comes from the Strategic Studies Group and Micro Forte, a software company "dedicated to creating the most visual and entertaining software" designed to keep you on the edge of your seat. *Fire King* comes within inches of this goal.

Fire King combines action and role play, and its pace never slows. Its fantasy-filled plot is extremely well conceived, and, unlike many games of this genre, it keeps the player's interest. *Fire King* is for one or two players, but playing with a friend makes the going much easier.

Your quest begins when the Fire King is killed and a supernatural Death Beast takes control of your town. It's up to you to assume the role of one of six characters to begin the first miniadventure and reclaim your town.

Each character is uniquely defined, and each one's attributes are different. Should you choose a magic user? A warrior? Your decision drastically affects gameplay, as certain attributes are more important than others.

Control and move your character in eight directions with a joystick. Bumping into an object adds that item to one of your nine pockets. When all pockets are filled, you're informed that you can carry no more.

Unlike many other action/role-playing games, Fire King holds your interest all the way through.

Bumping into a book displays its contents or prompts you to answer a riddle. Be sure to note every clue along the way because a correct answer to the riddle rewards you with gold or another clue. Also, watch for scrolls. They contain magic spells you'll need throughout the game. Some spells permit you to walk on water, while others make you invisible.

You start off in your lodgings, the beginning and ending point of each quest. Leave your room and enter the town square. In the town, you may choose to steal gold from the Treasury, visit the Holy Temple of Dragara, or match your fighting or magic skills with monsters kept in the Thieves Guild. Exploring the town thoroughly is important: Many of the objects here can make your quest easier.

But the catacombs below the town is where the first adventure takes place. Here you must seek and destroy the

Death Beast, releasing its evil hold on the town and permitting you to uncover the Fire King's mysterious tomb. Completing this miniquest is just one small part of the game.

After solving this first mystery, more difficult challenges test your mind and magic in the wilderness surrounding the world of the Fire King. The outskirts and landscapes are well detailed and designed, and they enhance the game's feeling of fantasy and adventure. The wilderness contains many species and races: Some are friendly, some are not. The terrain includes many rivers that erode your strength and dexterity. Boots for Water Walking are a must because the strong currents can carry your character away in no time.

Magic is an important part of *Fire King*. You'll need many enchanted objects to complete the game. Even though every character possesses magical abilities, spells are more powerful when cast by wizards and enchantresses.

Fire King comes on two disks and contains a decoder wheel that's needed to advance through each adventure. Also included on the inside cover of the package is a map of the mythical world, including a plan of the town. The landscape is painstakingly rendered. Every detail on the screen is shown on the map.

Fire King's only drawback is the player's manual. It isn't organized well, and it lacks information about the game's main objective. It contains hints for the first quest but doesn't provide a clue for subsequent ones.

Despite the manual's problems, *Fire King* does have flicker-free scrolling, grade-A graphics, and a captivating plot. It's a topnotch game all the way around.

—Romney Laanstra

Fire King
Strategic Studies Group
Distributed by Electronic Arts
1820 Gateway Dr.
San Mateo, CA 94404
\$29.95

Omni-Play Basketball

I have an avid interest and involvement in sports. When I'm not shooting baskets at the playground on the corner, I usually can be found consulting the record books to settle a sports bet between my friends. But all that has changed now. Thanks to *Omni-Play Basketball*, I've gone pro.

I've become an owner. Next to basketball team owners, medieval potentates knew nothing of power, manipulation, or internecine warfare. We team owners must know when to trade and when to cut our players loose. For the fan, basketball consists of thrilling shots between the beer commercials;

for the players, basketball is lived game to game. But for us owners, managers, and coaches in the upper echelons of Olympus, basketball isn't a matter of a single shot, game, or season. It's season after season, year after year. It's our life.

Omni-Play Basketball brings the entire snarling beast of basketball into your home, including the unsightly, seamy side of the business: back-room dealing. It's all here, cheerleaders, a side-view module (available at extra cost), and inane sports commentary for the brain-damaged—in short, professional sports in all its glory, but without the commercials.

But be warned, this isn't a game you can simply sit down with and start playing. It requires careful study. Get out your reading glasses; the manual is encyclopedic. Begin by looking over the history of the league and the teams, which provides a wealth of stats. Actual teams can be inspected as well, on a player-by-player basis. Then you can begin to build your team.

It's all here: cheerleaders, inane sports commentary, and pro basketball in all its glory, but without the commercials.

Omni-Play Basketball provides you with a quantity of cash (trading points) which you use to purchase the best players you can afford from other teams. Recruit rookies or try to trade for better players (plus a healthy amount of cash). Another way to improve your team is to send a failing player to training camp. Players, as in real life, suffer injuries from which they must recover.

You can play against the computer or a friend, or (the ultimate in flexibility) *Omni-Play Basketball* can play itself until you get the hang of the game. Sit back and watch games played out in realistic animation or skip the actual game and go right to the score.

Ever since the invention of the videotape machine (a device developed to watch television for people who don't have time for it themselves, according to Douglas Adams), I've been looking forward to the self-playing videogame. You can set it up to play against itself and then go do something useful—like watching basketball on television.

As a coach, you can make decisions such as electing to charge in after free throws, work inside, work the clock, or go for the quick shot. You can elect to foul out the opposing team, anticipate inside passes, steal the ball, or change coverage. >

Reviews

The major problem is that the game is slow in loading. The modules are high in quality, and it's obvious some very sophisticated work has gone into this package. A fast loader would have made a big difference. After a few minutes of loading, I have a tendency to wander away, watch the Lakers on the tube, and forget there's a game loading until my wife reminds me that I left the computer running.

The theory behind *Omni-Play* is that improvements and updates can be added periodically. This is a game designed to grow with you. Already, new modules—at about \$20 each—have been introduced for side-view games and college play. *Fantasy League* is an update that allows you to assemble a dream team of greats throughout basketball history. What's next? Italian league? Who knows? But SportTime wants your suggestions. It looks like a creative team that's headed for the forefront in sports software.

—Robert Bixby

Omni-Play Basketball
SportTime
Dept #632
3187-G Airway Ave.
Costa Mesa, CA 92626
\$34.95

Might and Magic II

It's rare when a film sequel surpasses or even lives up to the quality of the original, but computer games tend to get better as the Roman numerals following their names grow larger. Just consider the evolution of the Ultima and Wizardry series. *Might and Magic II* is no exception to this rule.

Might and Magic II builds upon the solid scheme of its predecessor, adding a number of enhancements to the program while leaving the basic system intact. The graphics have benefited from a complete facelift and rival the best of anything seen in other adventure games. Color and detail in the 3-D views of the landscape approach genuine artistry. The various creatures and characters encountered are rendered in equally vivid style and even display a small degree of animation. No matter how many hours you spend exploring the game's imaginary environs, your journey will never visually grow wearisome.

Some other changes, such as the inclusion of automapping and the addition of hirelings, help bring it in line with recent advances in adventure-game design. The game also introduces a few wrinkles of its own in the form of time travel and secondary skills that can be purchased by characters.

A big part of any sequel's appeal is that it lets you resurrect your seasoned

warriors from the previous adventure and thrust them into a new set of deadly situations. This continuity is nice because veterans of the first *Might and Magic* will be able to plunge right into the thick of things without having to nurse new adventurers up to strength.

On the other hand, newcomers to the series will have to spend a fair amount of time tiptoeing around the first town and dungeon before their characters are powerful enough to venture into the world at large. The rule book claims that encounters are tailored to the experience level of the party, but in practice beginners can expect to meet some nasty creatures in large quantities.

No matter how long you
explore, your journey
will never visually grow
wearisome.

Might and Magic II is set in the land of Cron, a once-peaceful empire now beset by the usual bevy of fantasy-game baddies—goblins, giants, dragons, and the like—plus a staggering assortment of uncommon creatures as well. (The back-of-the-box blurb promises more than 250 varieties of monsters.) The game's premise revolves around the evil-entity-threatens-world-with-destruction theme.

The introductory material in the manual remains deliberately vague, allowing you the pleasure of piecing together information yourself. In the absence of any initial context for your adventures, however, play appears rather aimless at the outset. While the various quests you undertake lend your wanderings some sense of direction, even these tasks often seem like plot devices to kill time (and monsters) until your characters acquire sufficient experience to begin their true mission.

But *Might and Magic II* is not coy when it comes to revealing something of the philosophy underlying its design. "Combat is the heart of *Might and Magic II*," the rule book reads. And in the course of play, you can expect to fight almost all of the 250 creatures that inhabit the realm. Even first-level characters may have to contend with 50 or more monsters in a single battle.

Fortunately, the combat system is fast-paced and smartly constructed. It dispenses with the maneuvering of individual characters and monsters in favor of a more abstract routine that still retains a tactical flavor. But it also lacks the ability to resolve combat automatically, a surprising omission considering the simplicity of the system. You will sorely miss this feature on those many

occasions when you must fight your way through a horde of lesser creatures.

In a sense, the title sums up the focus of play because your progress hinges on repeated tests of your might and magic (or might alone, since magic primarily functions as a form of might in battle). However, *Might and Magic II* carries its preoccupation with combat to a dangerous extreme. The excessive swordplay risks turning the adventure into an exercise in battle tactics, with the land of Cron serving as nothing more than a cardboard stage for recurring mass melees.

In terms of design, *Might and Magic II* represents a significant improvement over its predecessor in every respect. Its primary problem is that its hack-'n'-slash mentality reveals a surprising lack of imagination for a fantasy game.

—Jeff Seiken

Might and Magic II
New World Computing
Distributed by Electronic Arts
1820 Gateway Dr.
San Mateo, CA 94404
\$39.95

SimCity

Do you want to be a city father? Think you could do a better job of planning and running a city than the distinguished gentlemen down at City Hall? Well, Maxis Software and a city simulator called *SimCity* are ready to give you absolute control.

My fellow citizens, I would be less than candid if I did not tell you my first reaction to a city simulator was one of skepticism. Just how interesting could a computer program about city planning be? It sounds too much like work. But let me make this perfectly clear: *SimCity* is a blast!

Start with undeveloped terrain, clear a section of land, and then use your zoning authority to attract development. As Master Planner, it's your job to make sure each area has all the requirements to support the designated zoning. This means supplying electrical power, building roads, and offering public services. Only then will the Sims, microscopic people who populate the city, find it advantageous to move in and develop the properties.

As every city official knows, running a city costs money. Taxes must be collected from the Sims to expand the city and attract more growth. If you've done a good job in your planning and have included the right mix of residential, industrial, and commercial property, property values will skyrocket and Sims will flock to your city. When this happens, even more taxes may be collected due to the increased property

values and growing population. High-cost community projects, such as a major seaport or airport, can now be funded, putting you on your way to creating a booming metropolis.

Keeping up with the growth in your city isn't always easy. Traffic congestion can hamper expansion if road systems are inadequate. Residential areas can fill to capacity, effecting a labor shortage and a slowdown of industrial and commercial growth. A wise city manager is always one step ahead of demand.

SimCity's simulation activity marches on even when you're away from the keyboard. I left a rather complex city unattended for a half-hour, and when I returned I was aghast to find rampant unemployment, high levels of pollution, and traffic reminiscent of Los Angeles during rush hour. Luckily, I had saved the city in its earlier splendor to a data disk and could return to my utopia. An onscreen graph in the program helps you track problems of this type and stay ahead of uncontrolled growth.

I often race my 9- and 11-year-old sons to the computer for first dibs on SimCity.

If you enjoy challenging tasks or wish to test your management skills against massive problems that can plague a city, *SimCity* offers eight ready-made, out-of-control city scenarios to tackle. Each scenario defies you to reverse the devastating effects that have the city on the brink of decay.

There's also a great disaster menu. Release a Godzilla-like monster and let it have its way with your city, and then try your best to restore power and repair the destruction in its wake. Fire storms can be selectively set or randomly generated as a byproduct of a destructive earthquake. Tornadoes can be made to wreak havoc at your command. Your best option after such disasters is to bulldoze a stricken area and rezone for future development.

Included with the program is a 43-page booklet, a hardware system card, and a user-reference card, all written exclusively for the 64 version. It's refreshing to see a software company that values Commodore users enough to write machine-specific documentation.

SimCity is a terrific simulation that offers hours, days, and months of enjoyment for the entire family. I often race my 9- and 11-year-old sons to the computer for first dibs on *SimCity*. It's a program that wears a variety of hats. I

am reluctant to call it a game, but it operates and plays as easily as most games. It's a serious city simulation that can also provide casual entertainment. *SimCity* does not require a lot of study, but it manages to be highly educational—and a lot of fun.

—Steve Hedrick

SimCity
Maxis
Distributed by Broderbund
17 Paul Dr.
San Rafael, CA 94903
\$29.95

BattleTech

Infocom's *BattleTech: The Crescent Hawk's Inception* is a cross between a land-craft driving simulation, an *Empire Strikes Back*-style arcade challenge, and an *Ultima*-like role-playing game.

As Jason Youngblood, a thirty-first-century Lyran officer, your first chore is to learn the intricacies of piloting one of several BattleMech war machines. At the Pacifica Training School, you'll encounter simulated hostile craft that must be destroyed before you can advance to the next phase of your education. Completing this segment can be quite a chore, particularly in later stages when you are facing three enemy Mechs to your one.

Between practice missions, you'll spend your time visiting a variety of locations within the training area. You may chat with friends in the lounge, enroll in specialized combat classes at the citadel, buy and sell stocks at the ComStar station with the hope of making money to purchase items at the various shops, or go to your barracks to catch up on your sleep.

Before you get too comfortable, you are catapulted into the real world as the result of an enemy raid on your base. If you are skillful and lucky, you'll escape in the Chameleon, the sturdiest and deadliest Mech available. Although not as maneuverable as its lighter cousins and prone to overheating, the Chameleon is equipped with heavy armor and a multitude of weapons, including lasers, missiles, and machine guns. Additional conventional and high-tech armaments may be purchased in towns along your route, providing you have the funds. Parking and repair facilities are also at your disposal.

Traveling cross-country, you visit numerous locations (even video stores), enlist allies, discover hidden valuables, battle foes, and hopefully save the planet from the scourge of the loathsome Kurita warriors. At times, you'll engage enemy infantry. Without benefit of a Mech, these infantry groups can be dispatched quickly. Similarly,

should your Mech be destroyed and you are ejected from it, you'll be a sitting duck until you can commandeer another vehicle.

Easing your chore somewhat is a user-friendly control system that consists of a series of menus, all accessible via a joystick or the keyboard. From the main menu, you may adjust a variety of game settings: You can set combat speed, inspect or heal your character, load or save a game, or view an overhead map. Later menus allow you to select types of movement and weapons, scan friendly and hostile units, decide whether to let the computer hold up your end of the battle or to do the fighting yourself, engage in combat, and choose among a host of other options.

The game screen consists of three areas. Depending on the situation, the upper left window features movement directions, battle reports, or animated sequences. Characters' attributes, represented by bar graphs, are presented in the lower left corner of the screen. During battle, this box contains combat commands. The right window, the largest of the three, displays attractive, 3-D overhead views of the figures and the scrolling countryside.

BattleTech is a unique cross between a simulation, an arcade challenge, and a role-playing game.

Occasionally, this scenery is replaced by text, recounting meetings and other events in Jason's life. As good as the descriptions of Jason's nightmare or the break-in at the mayor's house are, there is no way for the player to enter into the story.

The absence of this interaction makes *BattleTech* a far cry from Infocom's classic text adventures or even the company's newer graphics-oriented line of narrative/puzzle-solving entertainment.

The program comes without copy protection. However, to enter the training mode, all candidates must pass a test, which consists of correctly labeling the parts of a WSP-1A WSP reconnaissance Mech. A correctly labeled diagram appears only in the 20-page instruction booklet.

Six games may be saved on a backup copy of the flip side of the program disk. Duplicating the original is a time-consuming process, as are the many disk loads required during play. Drawbacks aside, *BattleTech's* designers have blended a number of genres and, by do-

Reviews

ing so, have created something unique. Players searching for new worlds to explore, futuristic vehicles to pilot, and battles to fight need look no further.

—Len Poggiali

BattleTech:

The Crescent Hawk's Inception
Infocom
Distributed by Mediagenic
3885 Bohannon Dr.
Menlo Park, CA 94025
\$39.95

Kings of the Beach

Pull out the sunscreen and your neon jams—you're going to take the beach by storm. You have the speed, the agility, and the height to play stellar doubles volleyball in Electronic Arts' *Kings of the Beach*.

Boot up the game and head for the practice courts. *Kings of the Beach* has three courts where you can learn the basics and then hone your skills. Even if you've played in a gym, on a real beach, or in a park, you'll need some time with the coach in this game.

I've never played another sports simulation that so accurately recreates the feeling of the game.

The hardest part of the game is finding the ball on the court. *Kings of the Beach* deserves a round of applause for creating a 3-D playing field onscreen, but that third dimension is the source of much confusion when the ball heads for your court. Just watch the ball's shadow instead of the ball, and soon you'll be moving to the right spot.

For those of us who head in the opposite direction, the game seems to nudge us to the right place. So don't be too aggressive as you control your player; he has an innate sense of where the ball is headed.

Setting is the easiest volleyball skill in *Kings of the Beach*. For one thing, your doubles partner nearly always bumps the ball right to you. For another thing, the timing is intuitive. After a few tries, you can easily figure out when to hit the joystick button for a beautiful set.

Bumping is a little harder. First, you must figure out where the ball will land. That's not as easy as it is in setting because your opponents are not as cooperative about getting the ball to you as your doubles partner is. Once you get to the right spot, you must hit the joystick button at just the right moment. Timing is much more critical in

bumping than it is in setting.

Setting and bumping are the bread and butter of volleyball—not too spectacular, but essential to strategy. Spiking, on the other hand, is the crème-de-la-crème of beach volleyball. In *Kings of the Beach*, it's no different.

While bumping is a combination of placement and timing, spiking is all timing. Your setter is supposed to put the ball where you want it, so you're already in the right place. The trick is to double-click the joystick button at just the right instant to meet the ball properly. If you jump at the wrong time, you'll be flying while the ball rolls away. Sometimes a poorly executed spike results in a hit that goes out of bounds or a dink that drops gently into the opponent's court.

When you're on defense and the opponents spike into your court, the complementary move is a block, which is executed much like a spike. Double-click your joystick button just before your opponent connects with the ball. A good block sends the ball back to the other court faster than you can say *sand flea*.

After practicing each of these skills individually, you can play a few matches or enter the tournament. Each new pair of opponents is more skillful than the last, and each victory moves you closer to a new beach with new opponents. Tournaments are set in such exotic places as Rio, Hawaii, and Chicago.

Of all the sports simulations I've ever played, this is the best. To be fair, though, volleyball is my favorite sport in the real world. However, I've never played another sports simulation that so accurately recreates the feeling of the game. Even before I scored my first point against the easiest opponents, I loved *Kings of the Beach*.

Besides the simulation's accuracy, its graphics are excellent. Each player, although not sharply represented, is identifiable by a colorful pair of shorts, a sun visor, or some other characteristic. The screen is colorful, the 3-D field is a real challenge, and there is a two-player option.

Crowd noise and the sound of the sand flying under your feet create an atmosphere of sunny weather and competition. The game designers packed a lot of detail into this package.

If you love volleyball, sports simulations, or well-designed games, you're a sure convert to *Kings of the Beach*. It combines all the best features into a fun and challenging game.

—Heidi E. H. Aycock

Kings of the Beach
Electronic Arts
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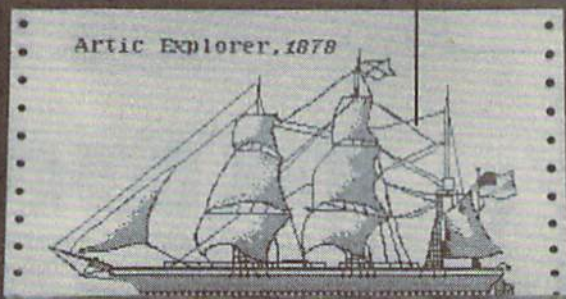
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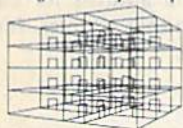
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machine language programming

A Word Counter

Jim Butterfield

Last month, we began a discussion of 256-tables. These are tables of 256 bytes, arranged so that a program can reference any position in the table by way of the X or Y index registers.

This month, we'll use a *fixed* table—a table whose values have been preset by BASIC to help us perform a word count on a text document. Each item in the table will represent a particular ASCII character. If a character is used within a word, the corresponding table entry will be 1; otherwise, the table entry will be 0. Certain characters are vague, and we must make arbitrary decisions about them. For example, the hyphen: Is *half-hour* one word or two?

Here's the idea: We grab a character from the text file. By referring to the 256-table, we get a classification: 1 or 0, word character or not. If we find that a new character is classified as 1, and the previous character was classified as 0, we know that a new word is starting. In such a case, we increment the word counter.

Keep in mind that many word processors do not store text files as conventional PET-ASCII characters. They might use screen codes or true ASCII characters. If so, you must change the 256-table to correspond to this character type.

A Word-Counting Program

Word Count works on both the 64 and the 128. The BASIC portion of the program POKES the machine language routine into memory at \$2500 (9472) and then builds the 256-table that identifies the characters at \$2600 (9728). It sets all values in the table to 0 and then reclassifies the alphabetic characters—both upper- and lowercase—and numeric characters as 1.

Next, it opens the file to be checked as logical file 1 and then activates the machine language routine with a SYS call. We begin by zeroing certain counters.

```
2500 LDA #000 ;set ...
2502 STA $25F0 ;... low-order word
      count,
2505 STA $25F1 ;high-order word
      count,
2508 STA $25FF ;and word flag to 0
```

Then we connect our input to logical

file 1, previously opened by BASIC.

```
250B LDX #001 ;logical file 1
250D JSR $FFC6 ;switch input stream
```

The next instruction begins our main loop. Each time around the loop, we take a character from the file.

```
2510 JSR $FFE4 ;get character from file
```

We transfer the character to the Y register, and then we use it to get the character type, 1 or 0.

```
2513 TAY ;move character to Y
2514 LDA $2600,Y ;and get character
      type
```

The previous character type has been stored at address \$25FF. If the new character is the same type, we skip ahead, as there's no work to be done.

```
2517 CMP $25FF ;same type as before?
251A BEQ $252A ;yes, so continue
```

Otherwise, we know the character type has changed—from 1 to 0 at the end of a word, or from 0 to 1 at the beginning of a word. In either case, we log the new previous-character status.

```
251C STA $25FF ;log changed type
```

Then we test the new character type for 0. The easiest way to do this is to transfer it to another register, say Y. If the character type is 0, we're at the end of a word and can skip any extra accounting.

```
251F TAY ;test character type
2520 BEQ $252A ;if 0, continue
```

If it isn't 0, we've found the start of a word. So, we increment our word counter.

```
2522 INC $25F0 ;add to counter
2525 BNE $252A ;if overflow ...
2527 INC $25F1 ;add to high byte.
```

Everything joins together here. We test the status (ST) byte to see if there are any more bytes to be read from the file.

```
252A LDA $90 ;test ST byte
252C BEQ $2510 ;if more, go back
252E JMP $FFCC ;CLRCHN and quit
```

The BASIC program takes over at this point and prints the number of words.

Remember: If you find yourself doing a lot of comparisons—especially with characters or bytes—take a look to

see if a 256-table can do the job. In the extreme case, a double table could let you dig out a 16-bit address for each type, and branch to that address. It's a powerful technique.

Word Count

```
AR 100 DATA 169,0,141,240,37,1
      41,241,37
MH 110 DATA 141,255,37,162,1,3
      2,198,255
HE 120 DATA 32,228,255,168,185
      ,0,38
DE 130 DATA 205,255,37,240,14,
      141,255
HQ 140 DATA 37,168,240,8,238,2
      40,37,208,3
RH 150 DATA 238,241,37,165,144
      ,240,226
QE 160 DATA 76,204,255
RD 200 FOR J=9472 TO 9520
EJ 210 READ X:T=T+X
BP 220 POKE J,X
AE 230 NEXT J
PF 240 IF T<>7145 THEN STOP
CK 500 C=9728:C0=C+128
GF 510 FOR J=0 TO 255:POKE J+C
      ,0:NEXT J
EH 520 FOR J=48 TO 57:POKE J+C
      ,1:NEXT J
PK 530 FOR J=65 TO 90
BB 540 POKE J+C,1:POKE J+C0,1
SK 550 NEXT J
PB 600 OPEN 15,8,15
FE 610 INPUT "FILE NAME";F$
FR 620 OPEN 1,8,2,F$
BX 630 INPUT#15,A,A$,A1,A2:IF
      {SPACE}A<>0 THEN PRINT
      {SPACE}A$:STOP
EP 640 SYS 9472
QE 650 CLOSE 1
AH 660 CLOSE 15
GH 670 W=PEEK(9712)+PEEK(9713)
      *256
JK 680 PRINT "FILE HAS";W;"WOR
      DS." G
```

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The Automatic Proofreader

Philip I. Nelson

The Automatic Proofreader helps you type in program listings for the 128 and 64 and prevents nearly every kind of typing mistake.

Type in the Proofreader exactly as listed. Because the program can't check itself, type carefully to avoid mistakes. Don't omit any lines, even if they contain unusual commands. After you've finished, save a copy before running it.

Next, type RUN and press RETURN. After the program displays the message "Proofreader Active," you're ready to type in a BASIC program.

Every time you finish typing a line and press RETURN, the Proofreader displays a two-letter checksum in the upper left corner of the screen. Compare this result with the two-letter checksum printed to the left of the line in the program listing. If the letters match, it's almost certain the line was typed correctly. If not, check for your mistake and correct the line.

The Proofreader ignores spaces not enclosed in quotation marks, so you can omit or add spaces between keywords and still see a matching checksum. However, spaces inside quotes are almost always significant, so the program pays attention to them.

The Proofreader does not accept keyword abbreviations (for example, ? instead of PRINT). If you prefer to use abbreviations, you can still check the line by LISTing it, moving the cursor back to the line, and pressing RETURN.

If you're using the Proofreader on the 128, do not perform any GRAPHIC commands while the Proofreader is active. When you perform a command like GRAPHIC 1, the computer moves everything at the start of BASIC program space—including the Proofreader—to another memory area, causing the Proofreader to crash. The same thing happens if you run any program with a GRAPHIC command while the Proofreader is in memory.

Though the Proofreader doesn't interfere with other BASIC operations, it's a good idea to disable it before running another program. The simplest way to disable it is to turn the computer off then on. A gentler method is to SYS to the computer's built-in reset routine (65341 for the 128, 64738 for the 64).

These reset routines erase any program in memory, so be sure to save the program you're typing in before entering the SYS command.

When using the Proofreader with another utility, disable both programs before running a BASIC program. While the Proofreader seems unaffected by most utilities, there's no way to promise it will work with any and every combination of utilities you might want to use. The more utilities activated, the more fragile the system becomes.

The Automatic Proofreader

```

10 VE=PEEK(772)+256*PEEK(773):LO
=43:HI=44:PRINT "{CLR}{WHT}AU
TOMATIC PROOFREADER FOR ";
20 IF VE=42364 THEN PRINT"C-64"
30 IF VE=17165 THEN LO=45:HI=46:
WAIT CLR:PRINT "128"
40 SA=(PEEK(LO)+256*PEEK(HI))+6:
FOR J=SA TO SA+166:READ B:POKE
E J,B:CH=CH+B:NEXT
50 IF CH<>20570 THEN PRINT "**ERR
OR* CHECK TYPING IN DATA STAT
EMENTS":END
60 FOR J=1 TO 5:READ RF,LF,HF:RS
=SA+RF:HB=INT(RS/256):LB=RS-(
256*HB)
70 CH=CH+RF+LF+HF:POKE SA+LF,LB:
POKE SA+HF,HB:NEXT
80 IF CH<>22054 THEN PRINT "**ERR
OR* RELOAD PROGRAM AND CHECK
{SPACE}FINAL LINE":END
90 IF VE=17165 THEN POKE SA+14,2
2:POKE SA+18,23:POKE SA+29,224
:POKESA+139,224
100 POKE SA+149,PEEK(772):POKE S
A+150,PEEK(773):PRINT "{CLR}P
ROOFREADER ACTIVE"
110 SYS SA:POKE HI,PEEK(HI)+1:PO
KE (PEEK(LO)+256*PEEK(HI))-1,
0:NEW
120 DATA120,169,73,141,4,3,169,3
,141,5,3,88,96,165,20,133,167
130 DATA165,21,133,168,169,0,141
,0,255,162,31,181,199,157,227
140 DATA3,202,16,248,169,19,32,2
10,255,169,18,32,210,255,160
150 DATA0,132,180,132,176,136,23
0,180,200,185,0,2,240,46,201
160 DATA34,208,8,72,165,176,73,2
55,133,176,104,72,201,32,208
170 DATA7,165,176,208,3,104,208,
226,104,166,180,24,165,167
180 DATA121,0,2,133,167,165,168,
105,0,133,168,202,208,239,240
190 DATA202,165,167,69,168,72,41
,15,168,185,211,3,32,210,255
200 DATA104,74,74,74,74,168,185,
211,3,32,210,255,162,31,189
210 DATA227,3,149,199,202,16,248
,169,146,32,210,255,76,86,137
220 DATA65,66,67,68,69,70,71,72,
74,75,77,80,81,82,83,88
230 DATA13,2,7,167,31,32,151,116
,117,151,128,129,167,136,137

```

How to Type In COMPUTE!'s Gazette Programs

Each month, *COMPUTE!'s Gazette* publishes programs for the Commodore 128 and 64. Each program is clearly marked by title and version. Be sure to type in the correct version for your machine. All 64 programs run on the 128 in 64 mode. Be sure to read the instructions in the corresponding article. This can save time and eliminate any questions which might arise after you begin typing.

We regularly publish two programs designed to make typing easier: *The Automatic Proofreader*, for BASIC programs, and *MLX*, for entering machine language programs.

When entering a BASIC program, be especially careful with DATA statements as they are extremely sensitive to errors. A mistyped number in a DATA statement can cause your machine to "lock up" (you'll have no control over the computer). If this happens, the only recourse is to turn your computer off and then on, erasing what was in memory. This could cause you to lose valuable data, so be sure to *save a program before you run it*. If your computer crashes, you can always reload the program and look for the error.

Special Characters

Most of the programs listed in each issue contain special control characters. To facilitate typing in any programs from *Gazette*, use the following listing conventions.

The most common type of control characters in our listings appear as words within braces: {DOWN} means to press the cursor-down key; {5 SPACES} means to press the space bar five times.

To indicate that a key should be shifted (hold down the SHIFT key while pressing another key), the character is underlined. For example, A means hold down the SHIFT key and press A. You may see strange characters on your screen, but that's to be expected. If you find a number followed by an underlined key enclosed in braces (for example, {8 A}), type the key as many times as indicated (in our example, enter eight shifted A's).

If a key is enclosed in special brackets, [], hold down the Commodore key (at the lower left corner of the keyboard) and press the indicated character.

Rarely, you'll see a single letter of the alphabet enclosed in braces. This can be entered on the Commodore 64 by pressing the CTRL key while typing the letter in braces. For example, {A} means to press CTRL-A.

The Quote Mode

Although you can move the cursor around the screen with the CRSR keys, often a programmer will want to move the cursor under program control. This is seen in examples such as {LEFT} and {HOME} in the program listings. The only way the computer can tell the difference between direct and programmed cursor control is the *quote mode*.

Once you press the quote key, you're in quote mode. This mode can be confusing if you mistype a character and cursor left to change it. You'll see a graphics symbol for cursor left. In this case, you can use the DEL key to back up and edit the line. Type another quotation mark and you're out of quote mode. If things really get confusing, you can exit quote mode simply by pressing RETURN. Then just cursor up to the mistyped line and fix it.

When You Read:	Press:	See:
{CLR}	SHIFT CLR/HOME	
{HOME}	CLR/HOME	
{UP}	SHIFT ↑ CRSR ↓	
{DOWN}	↑ CRSR ↓	
{LEFT}	SHIFT ← CRSR →	
{RIGHT}	← CRSR →	
{RVS}	CTRL 9	
{OFF}	CTRL 0	
{BLK}	CTRL 1	
{WHT}	CTRL 2	
{RED}	CTRL 3	
{CYN}	CTRL 4	

When You Read:	Press:	See:
{PUR}	CTRL 5	
{GRN}	CTRL 6	
{BLU}	CTRL 7	
{YEL}	CTRL 8	
{ F1 }	F1	
{ F2 }	SHIFT F1	
{ F3 }	F3	
{ F4 }	SHIFT F3	
{ F5 }	F5	
{ F6 }	SHIFT F5	
{ F7 }	F7	
{ F8 }	SHIFT F7	

When You Read:	Press:	See:
←	←	
↑	SHIFT ↑	

For Commodore 64 Only

[1]	COMMODORE 1	
[2]	COMMODORE 2	
[3]	COMMODORE 3	
[4]	COMMODORE 4	
[5]	COMMODORE 5	
[6]	COMMODORE 6	
[7]	COMMODORE 7	
[8]	COMMODORE 8	

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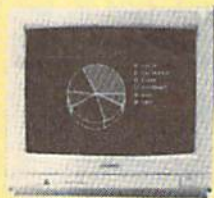


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MLX

Machine Language Entry Program for Commodore 64

Ottis R. Cowper

MLX is a labor-saving utility that allows almost fail-safe entry of Commodore 64 machine language programs.

Type in and save some copies of *MLX*—you'll want to use it to enter future ML programs from *COMPUTE!'s Gazette*. When you're ready to enter an ML program, load and run *MLX*. It asks you for a starting address and an ending address. These addresses appear in the article accompanying the *MLX*-format program listing you're typing.

If you're unfamiliar with machine language, the addresses (and all other values you enter in *MLX*) may appear strange. Instead of the usual decimal numbers you're accustomed to, these numbers are in *hexadecimal*—a base 16 numbering system commonly used by ML programmers. Hexadecimal—hex for short—includes the numerals 0–9 and the letters A–F. But even if you know nothing about ML or hex, you should have no trouble using *MLX*.

After you've entered the starting and ending addresses, you'll be offered the option of clearing the workspace. Choose this option if you're starting to enter a new listing. If you're continuing a listing that's partially typed from a previous session, don't choose this option.

A functions menu will appear. The first option in the menu is Enter Data. If you're just starting to type in a program, pick this. Press the E key and type the first number in the first line of the program listing. If you've already typed in part of a program, type the line number where you stopped typing at the end of the previous session (be sure to load the partially completed program before you resume entry). In any case, make sure the address you enter corresponds to the address of a line in the listing you are entering. Otherwise, you'll be unable to enter the data correctly. If you pressed E by mistake, you can return to the command menu by pressing RETURN alone when asked for the address. (You can get back to the menu from most options by pressing RETURN with no other input.)

Entering a Listing

Once you're in Enter mode, *MLX* prints the address for each program line for you. You then type in all nine numbers on that line, beginning with the first two-digit number after the colon (:). Each line represents eight data bytes and a checksum. Although an *MLX*-format

listing appears similar to the "hex dump" listings from a machine language monitor program, the extra checksum number on the end allows *MLX* to check your typing.

When you enter a line, *MLX* recalculates the checksum from the eight bytes and the address and compares this value to the number from the ninth column. If the values match, you'll hear a bell tone, the data will be added to the workspace area, and the prompt for the next line of data will appear. But if *MLX* detects a typing error, you'll hear a low buzz and see an error message. The line will then be redisplayed for editing.

Invalid Characters Banned

Only a few keys are active while you're entering data, so you may have to unlearn some habits. You *do not* type spaces between the columns; *MLX* automatically inserts these for you. You *do not* press RETURN after typing the last number in a line; *MLX* automatically enters and checks the line after you type the last digit.

Only the numerals 0–9 and the letters A–F can be entered. If you press any other key (with some exceptions noted below), you'll hear a warning buzz. To simplify typing, a numeric keypad function is included. The keypad is active only while entering data. Addresses must be entered with the normal letter and number keys. The figure below shows the keypad configuration.

7	8	9	0
4 U	5 I	6 O	F P
1 J	2 K	3 L	E :
A M	B ,	C .	D /
0 Space			

MLX checks for transposed characters. If you're supposed to type in A0 and instead enter 0A, *MLX* will catch your mistake. There is one error that can slip past *MLX*: Because of the checksum formula used, *MLX* won't notice if you accidentally type FF in place of 00, and vice versa. And there's a very

slim chance that you could garble a line and still end up with a combination of characters that adds up to the proper checksum. However, these mistakes should not occur if you take reasonable care while entering data.

Editing Features

To correct typing mistakes before finishing a line, use the INST/DEL key to delete the character to the left of the cursor. If you mess up a line badly, press CLR/HOME to start the line over. The RETURN key is also active, but only before any data is typed on a line. Pressing RETURN at this point returns you to the command menu. After you type a character, *MLX* disables RETURN until the cursor returns to the start of a line. Remember, press CLR/HOME to quickly get to a line-number prompt.

To make corrections in a line that *MLX* has redisplayed for editing, compare the line on the screen with the one printed in the listing and then move the cursor to the mistake and type the correct key. The cursor-left and -right keys provide the normal cursor controls. (The INST/DEL key now works as an alternative cursor-left key.) You cannot move left beyond the first character in the line. If you try to move beyond the rightmost character, you'll reenter the line. During editing, RETURN is active; pressing it tells *MLX* to recheck the line. You can press the CLR/HOME key to clear the entire line if you want to start from scratch or if you want to get to a line-number prompt to use RETURN to get back to the menu.

Display Data

The second menu choice, Display Data, examines memory and shows the contents in the same format as the program listing (including the checksum). When you press D, *MLX* asks you for a starting address. Be sure that the starting address you give corresponds to a line number in the listing. Otherwise, the checksum display will be meaningless. *MLX* displays program lines until it reaches the end of the program, at which point the menu is redisplayed. You can pause the display by pressing the space bar. (*MLX* finishes printing the current line before halting.) Press the space bar again to restart the display. To break out of the display and get back to the menu before the ending address is reached, press RETURN.

Other Menu Options

Two more menu selections let you save programs and load them back into the computer. These are Save File and Load File. When you press S or L, MLX asks you for the filename. You'll then be asked to press either D or T to select disk or tape.

You'll notice the disk drive starting and stopping several times during a load or save. This is normal behavior. MLX opens and reads from or writes to the file instead of using the usual LOAD and SAVE commands. Also note that the drive prefix 0: is added to the filename (line 750), so this should not be included when entering the name. This also precludes the use of @ for save-with-replace, so be sure to give each version saved a different name.

Remember that MLX saves the entire workspace area from the starting address to the ending address, so the save or load may take longer than you might expect if you've entered only a small amount of data from a long listing. When you're saving a partially completed listing, make sure to note the address where you stopped typing.

MLX reports the standard disk or tape error messages if any problems are detected during the save or load. It also has three special load error messages: INCORRECT STARTING ADDRESS, which means the file you're trying to load does not have the starting address you specified when you ran MLX; LOAD ENDED AT address, which means the file you're trying to load ends before the ending address you specified when you started MLX; and TRUNCATED AT ENDING ADDRESS, which means the file you're trying to load extends beyond the ending address you specified when you started MLX. If you see one of these messages and feel certain that you've loaded the right file, exit and rerun MLX, being careful to enter the correct starting and ending addresses.

The Quit menu option has the obvious effect—it stops MLX and enters BASIC. The RUN/STOP key is disabled, so the Q option lets you exit the program without turning off the computer. (Of course, RUN/STOP-RESTORE also gets you out.) You'll be asked for verification; press Y to exit to BASIC, or press any other key to return to the menu. After quitting, you can type RUN again and reenter MLX without losing your data, as long as you don't use the Clear Workspace option.

The Finished Product

When you've finished typing all the data for an ML program and saved your work, you're ready for the results. Refer to the corresponding article for details on loading and running the program.

An Ounce of Prevention

By the time you've finished typing in the data for a long ML program, you may have several hours invested in the project. Don't take chances—use *The Automatic Proofreader* to type the new MLX, and then test your copy thoroughly before first using it to enter any significant amount of data. Make sure all the menu options work as they should. Enter fragments of the program starting at several different addresses; then use the display option to verify that the data has been entered correctly. And be sure to test the save and load options several times to ensure that you can recall your work from disk or tape.

64 MLX

```
EK 100 POKE 56,50:CLR:DIM IN$,I,
J,A,B,AS,B$,A(7),N$
DM 110 C4=48:C6=16:C7=7:Z2=2:Z4=
254:Z5=255:Z6=256:Z7=127
CJ 120 FA=PEEK(45)+Z6*PEEK(46):B
S=PEEK(55)+Z6*PEEK(56):H$
="0123456789ABCDEF"
SB 130 RS=CHR$(13):L$="{LEFT}":S
$=" ":DS=CHR$(20):Z$=CHR$(
0):T$="{13 RIGHT}"
CQ 140 SD=54272:FOR I=SD TO SD+2
3:POKE I,0:NEXT:POKE SD+2
4,15:POKE 788,52
FC 150 PRINT"{CLR} CHR$(142)CHR$(
8):POKE 53280,15:POKE 53
281,15
EJ 160 PRINT TS" {RED}{RVS}
{2 SPACES}{8 @}{2 SPACES}
"SPC(28)" {2 SPACES}{OFF}
{BLU} MLX II {RED}{RVS}
{2 SPACES}"SPC(28)"
{12 SPACES}{BLU}"
FR 170 PRINT"{3 DOWN}{3 SPACES}C
OMPUTE!'S MACHINE LANGUAG
E EDITOR{3 DOWN}"
JB 180 PRINT"{BLK}STARTING ADDRE
SS{4}":GOSUB300:SA=AD:GO
SUB1040:IF F THEN180
GF 190 PRINT"{BLK}{2 SPACES}ENDI
NG ADDRESS{4}":GOSUB300:
EA=AD:GOSUB1030:IF F THEN
190
KR 200 INPUT"{3 DOWN}{BLK}CLEAR
{SPACE}WORKSPACE [Y/N]{4}
":AS:IF LEFT$(AS,1)<"Y" T
HEN220
PG 210 PRINT"{2 DOWN}{BLU}WORKIN
G...":FORI=BS TO BS+EA-S
A+7:POKE I,0:NEXT:PRINT"D
ONE"
DR 220 PRINTTAB(10)" {2 DOWN}
{BLK}{RVS} MLX COMMAND ME
NU {DOWN}{4}":PRINT TS"
{RVS}E{OFF}NTER DATA"
BD 230 PRINT TS"{RVS}D{OFF}ISPLA
Y DATA":PRINT TS"{RVS}L
{OFF}OAD FILE"
JS 240 PRINT TS"{RVS}S{OFF}AVE F
ILE":PRINT TS"{RVS}Q{OFF}
UIT{2 DOWN}{BLK}"
JH 250 GET AS:IF AS=N$ THEN250
HK 260 A=0:FOR I=1 TO 5:IF AS=MI
D$( "EDLSQ",I,1) THEN A=I:I
=5
FD 270 NEXT:ON A GOTO420,610,690
,700,280:GOSUB1060:GOTO25
0
EJ 280 PRINT"{RVS} QUIT ":INPUT"
{DOWN}{4}ARE YOU SURE [Y/
N]":AS:IF LEFT$(AS,1)<"Y
" THEN220
```

```
EM 290 POKE SD+24,0:END
JX 300 IN$=N$:AD=0:INPUTIN$:IFLE
N(IN$)<4 THENRETURN
KF 310 B$=IN$:GOSUB320:AD=A:B$=M
ID$(IN$,3):GOSUB320:AD=AD
*256+A:RETURN
PP 320 A=0:FOR J=1 TO 2:A$=MID$(
B$,J,1):B=ASC(A$)-C4+(A$>
"@")*C7:A=A*C6+B
JA 330 IF B<0 OR B>15 THEN AD=0:
A=-1:J=2
GX 340 NEXT:RETURN
CH 350 B=INT(A/C6):PRINT MID$(H$,
B+1,1):B=A-B*C6:PRINT M
ID$(H$,B+1,1):RETURN
RR 360 A=INT(AD/26):GOSUB350:A=A
D-A*26:GOSUB350:PRINT":";
BE 370 CK=INT(AD/26):CK=AD-Z4*CK
+Z5*(CK>Z7):GOTO390
PX 380 CK=CK*Z2+Z5*(CK>Z7)+A
JC 390 CK=CK+Z5*(CK>Z5):RETURN
QS 400 PRINT"{DOWN}STARTING AT
{4}":GOSUB300:IF IN$<N$
THEN GOSUB1030:IF F THEN
400
EX 410 RETURN
HD 420 PRINT"{RVS} ENTER DATA ":
GOSUB400:IF IN$=N$ THEN22
0
JK 430 OPEN3,3:PRINT
SK 440 POKE198,0:GOSUB360:IF F T
HEN PRINT IN$:PRINT"{UP}
{5 RIGHT}";
GC 450 FOR I=0 TO 24 STEP 3:B$=S
$:FOR J=1 TO 2:IF F THEN
{SPACE}B$=MID$(IN$,I+J,1)
HA 460 PRINT"{RVS}"B$S:;IF I<24
THEN PRINT"{OFF}";
HD 470 GET AS:IF AS=N$ THEN470
FK 480 IF (AS>"/" AND AS<"") OR (AS>
"@") AND AS<"G") THEN540
GS 485 A=- (AS="M") -2*(AS="") -3*(
AS=".") -4*(AS="/") -5*(AS
="J") -6*(AS="K")
FX 486 A=A-7*(AS="L") -8*(AS=":")
-9*(AS="U") -10*(AS="I") -1
1*(AS="O") -12*(AS="P")
CM 487 A=A-13*(AS="$"):IF A THEN
{SPACE}A$=MID$( "ABCD123E4
56F0",A,1):GOTO 540
MP 490 IF AS=RS AND ((I=0) AND (J=1)
OR F) THEN PRINT B$:;J=2:
NEXT:I=24:GOTO550
KC 500 IF AS="{HOME}" THEN PRINT
B$:J=2:NEXT:I=24:NEXT:F=
0:GOTO440
MX 510 IF (AS="{RIGHT}") AND F THEN
PRINT B$S:;GOTO540
GK 520 IF AS<>L$ AND AS<>D$ OR ((
I=0) AND (J=1)) THEN GOSUB10
60:GOTO470
HG 530 AS=L$+S$+L$:PRINT B$S:;J
=2-J:IF J THEN PRINT L$:;
I=I-3
QS 540 PRINT AS:;NEXT J:PRINT S$
;
PM 550 NEXT I:PRINT:PRINT"{UP}
{5 RIGHT}":;INPUT#3,IN$:I
F IN$=N$ THEN CLOSE3:GOTO
220
QC 560 FOR I=1 TO 25 STEP3:B$=MI
D$(IN$,I):GOSUB320:IF I<2
5 THEN GOSUB300:A(I/3)=A
NEXT:IF A<>CK THEN GOSUB1
060:PRINT"{BLK}{RVS} ERRO
R: REENTER LINE {4}":F=1:
GOTO440
HJ 580 GOSUB1080:B=BS+AD-SA:FOR
{SPACE}I=0 TO 7:POKE B+I,
A(I):NEXT
QQ 590 AD=AD+8:IF AD>EA THEN CLO
SE3:PRINT"{DOWN}{BLU}** E
ND OF ENTRY **{BLK}
{2 DOWN}":GOTO700
GQ 600 F=0:GOTO440
```

QA 610 PRINT{CLR}{DOWN}{RVS} DI SPLAY DATA ":GOSUB400:IF {SPACE}IN\$=NS THEN220	(PEEK(BS+I));:IF ST THEN8 00	XP 950 POKEL47,0:SYS 63562:IF ST >0 THEN970
RJ 620 PRINT{DOWN}{BLU}PRESS: {RVS}SPACE{OFF} TO PAUSE, {RVS}RETURN{OFF} TO BREA K{4}{DOWN}"	FC 790 NEXT:CLOSE1:CLOSE15:GOTO9 40	FR 960 GOSUB1080:PRINT"{BLU}** L OAD COMPLETED ***":GOTO220
KS 630 GOSUB360:B=BS+AD-SA:FORI= BTO B+7:A=PEEK(I):GOSUB35 0:GOSUB380:PRINT SS;	GS 800 GOSUB1060:PRINT"{DOWN} {BLK}ERROR DURING SAVE: {4}":GOSUB860:GOTO220	DP 970 GOSUB1060:PRINT"{BLK} {RVS}ERROR DURING LOAD: {DOWN}{4}":ON F GOSUB980, 990,1000:GOTO220
CC 640 NEXT:PRINT{RVS}";:A=CK:G OSUB350:PRINT	MA 810 OPEN 1,8,8,IN\$+"P,R":GOS UB860:IF A THEN220	PP 980 PRINT"INCORRECT STARTING {SPACE}ADDRESS (":GOSUB3 60:PRINT)":RETURN
KH 650 F=1:AD=AD+8:IF AD>EA THEN PRINT{DOWN}{BLU}** END O F DATA ***:GOTO220	GE 820 GET#1,A\$,B\$:AD=ASC(A\$+Z\$) +256*ASC(B\$+Z\$):IF AD<>SA THEN F=1:GOTO850	GR 990 PRINT"LOAD ENDED AT ";:AD =SA+AD:GOSUB360:PRINT DS: RETURN
KC 660 GET A\$:IF A\$=R\$ THEN GOSU B1080:GOTO220	RX 830 FOR I=0 TO B:GET#1,A\$:POK E BS+I,ASC(A\$+Z\$):IF(I<>B)AND ST THEN F=2:AD=I:I=B	FD 1000 PRINT"TRUNCATED AT ENDIN G ADDRESS":RETURN
EQ 670 IF A\$=SS THEN F=F+1:GOSUB 1080	FA 840 NEXT:IF ST<>64 THEN F=3	RX 1010 AH=INT(A/256):AL=A-(AH*2 56):POKE193,AL:POKE194,A H
AD 680 ONFGOTO630,660,630	FQ 850 CLOSE1:CLOSE15:ON ABS(F>0)1 GOTO960,970	FF 1020 AH=INT(B/256):AL=B-(AH*2 56):POKE174,AL:POKE175,A H:RETURN
CM 690 PRINT{DOWN}{RVS} LOAD DA TA ":OP=1:GOTO710	SA 860 INPUT#15,A,A\$:IF A THEN C LOSE1:CLOSE15:GOSUB1060:P RINT{RVS}ERROR: "A\$	FX 1030 IF AD<SA OR AD>EA THEN10 50
PC 700 PRINT{DOWN}{RVS} SAVE FI LE ":OP=0	GQ 870 RETURN	HA 1040 IF(AD>511 AND AD<40960)O R(AD>49151 AND AD<53248) THEN GOSUB1080:F=0:RETUR N
RX 710 IN\$=NS:INPUT{DOWN}FILENA ME{4}";IN\$:IF IN\$=NS THEN 220	EJ 880 POKEL83,PEEK(FA+2):POKE18 7,PEEK(FA+3):POKE188,PEEK (FA+4):IFOP=0THEN920	HC 1050 GOSUB1060:PRINT{RVS} IN VALID ADDRESS {DOWN} {BLK}":F=1:RETURN
PR 720 F=0:PRINT{DOWN}{BLK} {RVS}T{OFF}APE OR {RVS}D {OFF}ISK: {4}";	HJ 890 SYS 63466:IF(PEEK(783)AND 1)THEN GOSUB1060:PRINT" {DOWN}{RVS} FILE NOT FOUN D ":GOTO690	AR 1060 POKE SD+5,31:POKE SD+6,2 08:POKE SD,240:POKE SD+1 ,4:POKE SD+4,33
EP 730 GET A\$:IF A\$="T"THEN PRIN T{T{DOWN}":GOTO880	CS 900 AD=PEEK(829)+256*PEEK(830):IF AD<>SA THEN F=1:GOTO 970	DX 1070 FOR S=1 TO 100:NEXT:GOTO 1090
HQ 740 IF A\$<>"D"THEN730	SC 910 A=PEEK(831)+256*PEEK(832) -1:F=F-2*(A<EA)-3*(A>EA): AD=A-AD:GOTO930	PF 1080 POKE SD+5,8:POKE SD+6,24 0:POKE SD,0:POKE SD+1,90 :POKE SD+4,17
HH 750 PRINT"D{DOWN}":OPEN15,8,1 5,"I0":B=EA-SA:IN\$="0:"+ IN\$:IF OP THEN810	KM 920 A=SA:B=EA+1:GOSUB1010:POK E780,3:SYS 63338	AC 1090 FOR S=1 TO 100:NEXT:POKE SD+4,0:POKE SD,0:POKE S D+1,0:RETURN
SQ 760 OPEN 1,8,8,IN\$+"P,W":GOS UB860:IF A THEN220	JF 930 A=BS:B=BS+(EA-SA)+1:GOSUB 1010:ON OP GOTO950:SYS 63 591	
EJ 770 AH=INT(SA/256):AL=SA-(AH* 256):PRINT#1,CHR\$(AL);CHR \$(AH);	AE 940 GOSUB1080:PRINT"{BLU}** S AVE COMPLETED ***":GOTO220	
PE 780 FOR I=0 TO B:PRINT#1,CHR\$(PEEK(BS+I));:IF ST THEN8 00		

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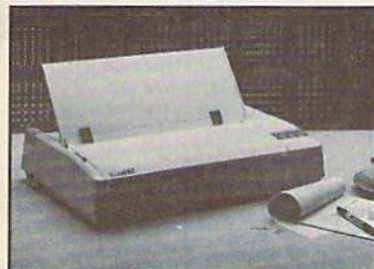
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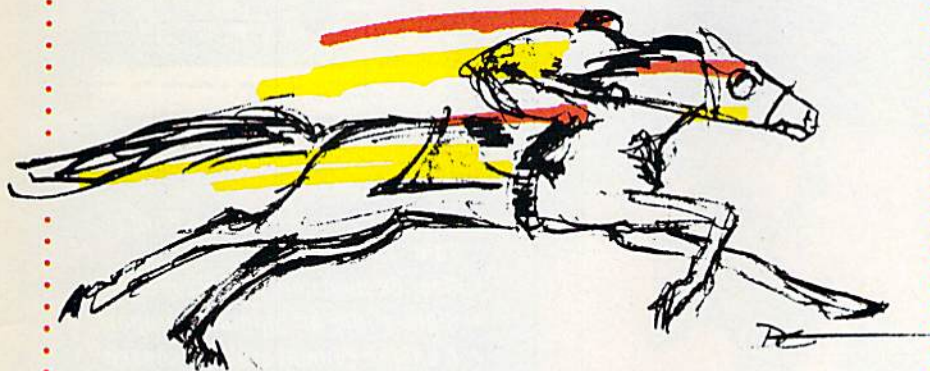
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COMMODORE CLIPS

NEWS, NOTES, AND NEW PRODUCTS

Edited by Mickey McLean



And They're Off!

Fast on the heels of its release of the popular sports simulation, *Omni-Play Basketball*, SportTime Computer Software (3187-G Airway Avenue, Costa Mesa, California 92626) has announced the availability of *Omni-Play Horse Racing* (\$34.95) for the Commodore 64.

Up to four players can compete, making computer wagers on 128 horses at each track. Before you make your bets, you can handicap each horse by studying sources that list each horse's performance in the last ten races and profiles of each jockey. You can also purchase tips from reliable and sometimes shady sources. Track conditions must also be taken into consideration. Tournament rules are determined by you. A joystick is required.

Lights! Camera! Action! Arcade!

Coming soon to a Commodore 64 near you, the latest release from Hollywood. The most recent translation from the silver screen to the computer screen is *Indiana Jones and the Last Crusade* (\$29.95) from Lucasfilm Games. It's distributed by Electronic Arts (1820 Gateway Drive, San Mateo, California 94404).

This three-level arcade game follows the same plot as the movie. The game begins in 1912 in Utah, with the young Indy trying to rescue the Cross of Coronado from a gang of grave robbers. If you're successful in retrieving the cross, you must make your getaway by jumping from car to car of a circus train while dodging knives, fists, and circus animals.

In level 2, you'll find yourself in the Venetian catacombs where the Grail Knight's shield must be found. Obstacles to your quest include fireballs, rats, and crumbling masonry. Succeed and you'll get to scale the walls of the castle, Schloss Brunwald, while dodging searchlights, lightning bolts, and falling rocks. You must learn to use Indy's whip to swing from ledge to ledge searching for Indy's dad, Henry.

When you reach the interior of the castle, you're ready for level 3. As Indy, you must prowl the catwalks of a giant Zeppelin, looking for a crucial key to the Grail puzzle while punching out Nazis. If you can make your way through the maze and sabotage the alarm system, you'll move on to the final challenge—the Grail Temple.

If you've seen the movie, you'll be familiar with the Temple's three trials. Your challenge is to survive and reach the Holy Grail before Henry's heart beats its last. Your score increases with every hazard dodged, valuable object found, and enemy defeated.

The *Action Game* features music from the movie and game graphics based on movie stills. Lucasfilm was also careful to capture Indy's walk.

Tax Time

The 1989 version of *Tax Master 20* (\$32) has been released by Master Software (6 Hillery Court, Randallstown, Maryland 21133). This Federal Income Tax preparation program covers all new tax laws and guides you through Forms 1040 and 4562, and Schedules A-F. *Tax Master* features built-in tax tables and can perform all calculations, figuring your tax automatically. It can also transfer results from one tax form to another.

Other features include a built-in calculator that can be accessed at any point in the program. The calculator's results can be transferred directly to the line of the tax form that you're working on.

The menu-driven program allows all data to be stored to and retrieved from disk, so that you can update a preliminary estimate as more information, such as W-2 forms and bank interest statements, becomes available. A file-coding system built into the program allows data for several taxpayers to be stored on one disk. Data from all forms can be either displayed onscreen or printed out.

RAM Up to 128K

Brown Boxes (26 Concord Road, Bedford, Massachusetts 01730) has introduced the QBB-B (\$119), a battery-backed cartridge enhancement for the 64 and 128. If you own the 64K Quick Brown Box, this 64K cartridge allows you to upgrade to 128K of program and data capability that remains intact even after the computer is turned off.

The QBB-B is the same size as the QBB and can be run on an extender card. Software included with the package makes the pair of cartridges appear and act as one contiguous 128K cartridge. The pair of cartridges can be set to operate in 64 or full 128 mode.

Brown Boxes is offering \$20 off or a free Arospond 64 extender card if the QBB-B is purchased with a regular 64K QBB.

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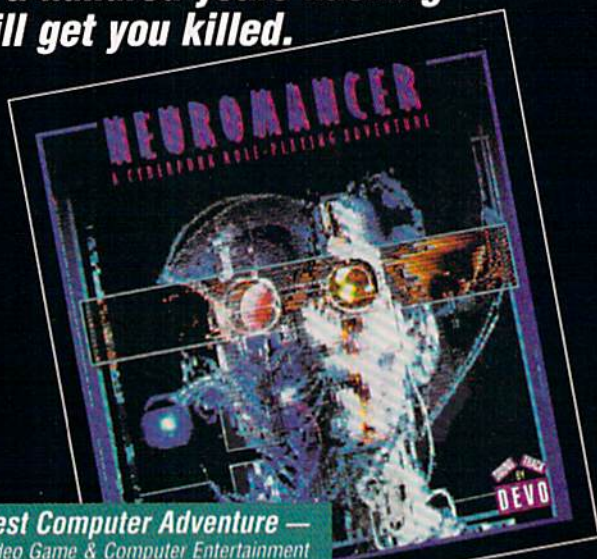
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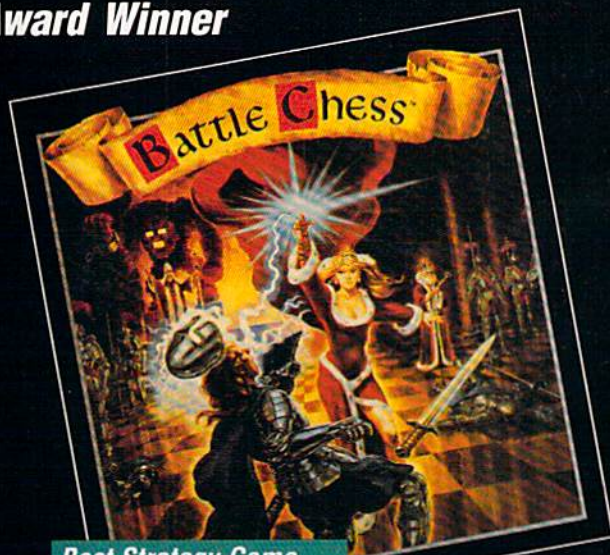
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"Madness in Murderworld"

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Famous Mutant Telepath Feared Captured By Arch-Nemesis Magneto and Evil Genius Arcade

NEW YORK, NY (MP) — Professor Charles Xavier, founder of the world-renowned mutant crime-fighting group known as the X-Men, has been kidnapped by his arch-rival Magneto, according to unconfirmed reports. "Professor X," as he is commonly known, is reportedly being held in Murderworld, a lethal amusement park of terror designed by the evil genius Arcade.

Although the X-Men refuse to comment on the rumor, sources close to the group claim that Magneto, the mutant master of magnetism, has abducted Xavier in an attempt to lure the X-Men to Murderworld. A source wishing not

to be identified also stated that six of the most powerful X-Men — Cyclops, Storm, Wolverine, Colossus, Nightcrawler and Dazzler — are preparing a rescue effort.

But according to Chief of Police F.J. Seremet, infiltrating Murderworld is no easy task. "Arcade designed Murderworld as an assassination tool, and he's fortified it with more traps and tricks than you can imagine," he said. "But the most dangerous part of Murderworld is the Fun House, and I'd bet

my life that's where the Professor is."

Seremet refused to confirm the rumor that Magneto and Arcade have also enlisted the aid of other evil mutants in their attempt to destroy the X-Men. Among the Super Villains said to be involved in the Murderworld plot are Blob, the Silver Samurai, the White Queen, Nimrod and Avalanche. The mutant-hunting Sentinels are also allegedly under Magneto's control.

"If those evil mutants are a part of this, there's going to be madness in Murderworld," Seremet said. "Not only are the X-Men going to have to deal with all of Arcade's dangerous tricks and obstacles, but they're going to

be fighting other evil mutants at every turn. The only chance they've got is if the group can make successful use of each member's individual powers. If just one of the X-Men dies, though, it's all over."

Not much is known about Murderworld or its Fun House "attraction." Arcade himself, however, in a rare interview granted recently to *Super Villain Quarterly*, revealed that the Fun House consists of over 25 individual levels and about 500 rooms — most of them

packed with surprises for the unwary. Surviving the Fun House, he said, requires extreme resourcefulness, ingenuity, and not a little courage and imagination.

"It's the ultimate challenge," Arcade said in the article. "I dare anyone to conquer it."



Although the X-Men refuse to acknowledge that a rescue attempt is being mounted, the Medalist Monitor has obtained these exclusive photographs of several members of the group battling Magneto's allies. It is also believed that Professor X (below left) has communicated telepathically with his team at least once.



Who Are The X-Men?

The X-Men are mutants born with strange powers that separate them from "normal" human beings. Their exploits have been chronicled in Marvel Comics since 1963. Here is a list of the six X-Men believed to be undertaking the rescue of Professor Xavier.

- Cyclops** The leader of the X-Men. His eyes release concentrated blasts of pure energy.
- Storm** Can control the weather itself, from driving rain to searing bolts of lightning.
- Wolverine** A mutant fighting machine with adamantium claws that can shred steel.
- Colossus** Can turn his skin into organic steel at will.
- Nightcrawler** His misshapen body provides uncanny dexterity and climbing abilities. He can also teleport anywhere instantly.
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foul shots, 3 point bombs and 3 kinds of slams — the Gorilla, the Rim Rockin' Reverse

and the In-Your-Face Jam!

Two can play at this game, or you can challenge the computer. Either way, it'll take all the runnin' and gunnin' you can muster if you hope to savor the taste of victory.



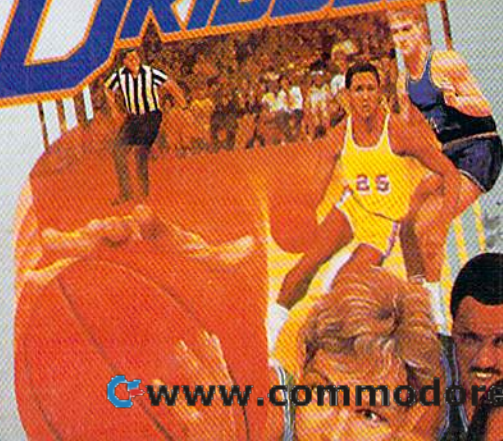
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