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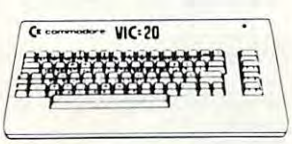

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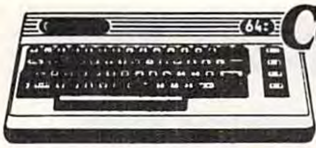

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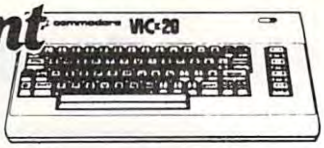

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Crossword Magic (D)	$ 34
Master Type	$ 27
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Wizard of Wor	(D) $27, (CT) $ 30
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Way Out (D)	$ 27
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Face Maker (D)	$ 23
Haunted Hill	(D) $20, (C) $ 17
Trivia Trek (D)	$ 20
Datalink (D)	$ 27
Space Shuttle (D)	$ 20
Jerry White's Music Lessons (D,C)	$ 20
Swifty Tach Master	(D) $20, (C) $ 17
Apocalypse (D, C)	$ 23
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The Guardian of Gorm	(D) $23, (C) $ 20
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Snapper (D)	$ 20
Twerps (D)	$ 23
Flip Out (D)	$ 20
The Birth of the Phoenix	$ 16
Protector II	(D) $23, (CT) $ 29

decoding subroutines:

Given a character C$, then the value C is computed by:

```
10 C=ASC(C$):C=C-40+(C>159)*64:RETURN
where (C>159) = -1 if C>159 and 0 if C=<159
```

Given a number D, then the character D$ is determined by:

```
20 IF D<56 THEN D$=CHR$(D+40):RETURN
30 D$=CHR$(D+104):RETURN
```

These routines yield a range from -8 to 119 with the quote mark at -6. The negative values were used internally as the special flags in my adventure game. In these routines, an open parenthesis is a zero; a close parenthesis is 1. A shifted back arrow is 119; a blank is -8. The encoding and decoding subroutines may have to be revised for other computers, depending on the code number schemes used.

Passages And Exits

To understand how one-byte pointers can be used to save memory in your game programs, consider the simple adventure map in Figure 1. You start at a crossroad (state 1). Movement to the north, south, and west places you in a forest or in houses of various colors. There is a secret, one-way passage from the red house to the blue house. Going east from the crossroad puts you in a cave from which there is no escape.

This adventure map can be expressed as a *state table*, as shown in Table 1. The rows of the table correspond to states (locations) in the map. The columns correspond to the possible movement directions (in this case north, south, east, and west). If you are in state 1 (the crossroad) and wish to move south, you end up in state 5 (the red house). (This state transition is shown in Table 1.) A further attempt to move south (while in state 5) has no path ("no exit"), indicated by the zero pointer. All exits from state 4 (the cave) put you back in state 4. This would appear as an endless cave to the person playing the game.

The state table can be programmed into the adventure game using the subroutines described above. The result is shown in Table 2. This encoded state table requires only 42 bytes of memory in the PET (including all overhead, as discussed below). Storing the table as a matrix of integer numbers would require 59 bytes on the PET. While the memory saved is not dramatic for this small example, when large tables are used, the memory saved can be quite substantial.

Ragged Tables

Suppose that we wish to add descriptions of each state to our game program. These would be printed on the screen each time a state was entered. A list for our simple adventure game map is shown in Table 3.

These could be stored in strings, but they would consume 118 bytes of memory (plus some overhead). Alternatively, these descriptions can be broken into phrases which are used in various combinations to make up the descriptions. These phrases are shown in Table 4. These phrases require only 53 bytes (plus some overhead), but we must also define the rules for combining phrases back into descriptions for each state. Once again, we use one-byte pointers. These new pointers can be simply added to the encoded state table, as shown in Table 5.

The procedure for creating a description when a state is entered is shown graphically in Figure 2. The BASIC code necessary to print the description of state 1 is as follows:

```
40 L=LEN(A$(I))   find length of string
50 FOR J=5 TO L   skip first four characters and scan
60 C$=MID$(A$(I),J,1)   select next character
70 GOSUB 10   convert to number C (see above)
80 PRINT B$(C)" ";   print phrase and blank
90 NEXT J
100 PRINT   end print line
```

Note that the number of characters in each state table entry shown in Table 5 is different. It is therefore a "ragged" table. It requires 18 additional bytes to store the pointers for all five state descriptions, a net savings of 47 bytes compared to storing the full descriptions (not including overhead).

Storage Methods

The techniques described above can be applied to computing problems other than games. The bigger the pointer tables are, the more advantages one-byte pointers offer. However, the tradeoff between one-byte pointers and simple integers is tricky because of the overhead required to set up strings or arrays of strings, and because extra programming is required to isolate and decode the stored character.

The storage technique used in my PET 2001 (original ROMs) requires seven bytes plus the number of characters for string variables. Thus, a single character pointer should never be used. When arrays are used, the tradeoff is dependent upon the number of rows and columns involved. For a ten by ten two-dimensional array, the memory used for a floating point array is 509 bytes. This is 500 bytes for the numbers and nine bytes for an array header (overhead). An integer array requires 209 bytes (200 bytes for the numbers and nine bytes for the header).

Using the one-byte variables reduces this array to a one-dimensional array of ten strings. Each string is ten characters long. The total memory requirement is 137 bytes. This is 100 bytes for the numbers, seven bytes for the header, three bytes for each string, for a total of 37 bytes overhead. As the arrays get larger, the one-byte approach uses approximately one-half the memory required by integer arrays and one-fifth of the memory required by floating point arrays. A more detailed explanation of the storage structures of Commodore computers can be found in *Programming The PET* (**COMPUTE! Books**, 1982).

The one-byte storage technique can be especially useful when: memory is at a premium, when large tables of pointers are needed, and when ragged tables provide a programming advantage.

When you're programming games into computers with limited memory (such as the unexpanded VIC-20), these techniques can be very advantageous.

Figure 1: Adventure Map

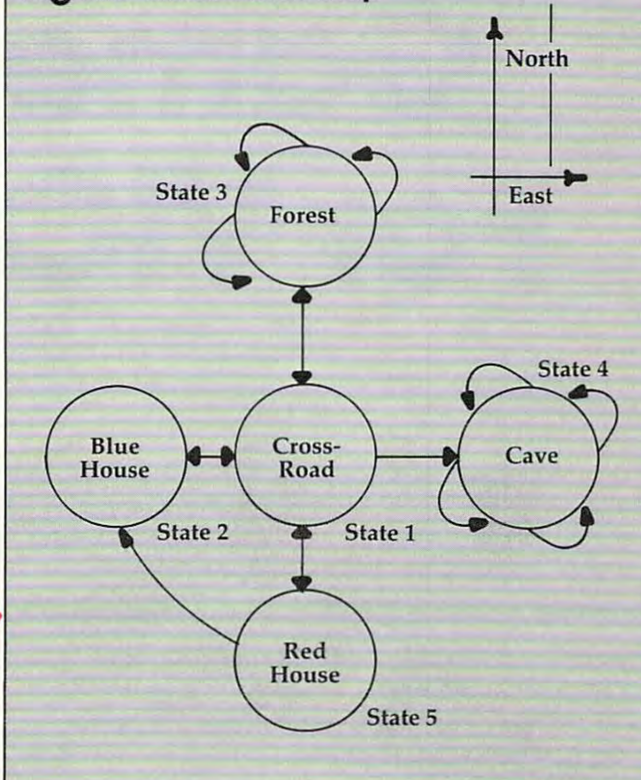


Table 1: State Table For The Adventure Map

	Movement Direction				
State	North	South	East	West	
1	3	5	4	2	59 bytes
2	0	0	1	0	required
3	3	1	3	3	in PET
State 4	4	4	4	4	to store
Transition 5	1	0	0	2	as integers

Table 2: Encoded State Table

A$(1) = + − , *
A$(2) = (( ) (
A$(3) = +) + +
A$(4) = , , , ,
A$(5) =) ((*

42 bytes required in PET

Table 3: State Descriptions

State 1 "YOU ARE AT A CROSSROAD"
State 2 "YOU ARE IN A BLUE HOUSE"
State 3 "YOU ARE IN A FOREST"
State 4 "YOU ARE IN A CAVE, YOU ARE LOST"
State 5 "YOU ARE IN A RED HOUSE"

118 bytes required plus overhead

Table 4: Phrase Table

B$(1) = "YOU ARE"
B$(2) = "IN A"
B$(3) = "AT A CROSSROAD"
B$(4) = "BLUE"
B$(5) = "RED"
B$(6) = "HOUSE"
B$(7) = "FOREST"
B$(8) = "CAVE,"
B$(9) = "LOST"

53 bytes required plus overhead

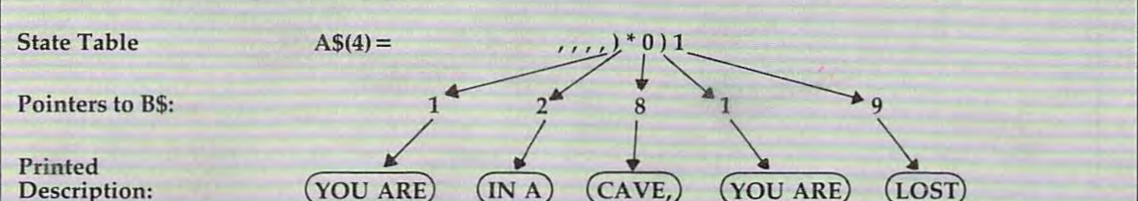
Table 5: Ragged State Table With Descriptor Pointers

A$(1) = + − , *) +
A$(2) = (( ) ( ) * , .
A$(3) = +) + +) * /
A$(4) = , , , ,) * 0) 1
A$(5) =) ((*) * − .

pointers to phrase table

18 added bytes for a total of 60 bytes required in PET

Figure 2: Decoding Example



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Game POKEr For VIC And 64

Dan Carmichael, Assistant Editor

With one touch of the finger and the "Screen-plot," you can easily determine the screen locations of your PEEKs and POKEs. This can be of great help when designing games or graphics. For the VIC and 64.

When you're writing or designing programs, especially games, that use a lot of POKEs and PEEKs to the screen, one of the most time-consuming tasks can be to determine the screen locations of those POKEs and PEEKs. With the VIC-20 or the Commodore 64, you can use the charts supplied with either the instruction book or the *Programmer's Reference Guide,* or you can take a guess and do a number of POKEs until you "hit" the position you desire. But both methods can be time-consuming.

To solve this problem, you can use this useful "Screen-plot" utility program. The program will, with the touch of one finger, move a blinking ball ("●"-CHR$113) to any position on the screen while continuously displaying both the screen and color POKE locations of the blinking ball.

This is a machine language program written to run in the cassette buffer (but you can use it even if you don't understand machine language). It will require only one BASIC statement; otherwise, it will leave your available BASIC programming memory untouched.

First, type in the program. If you're going to use Screen-plot in conjunction with the program you are currently working on, either append the screen-plotter to it or load your program and then type in the screen-plotter after it. The line numbers, starting at 59995, should insure that it will always remain at the end of your program.

After entering the program, SAVE it before running. As is true with all machine language programs, even a slight error in the DATA statements can cause your system to crash, forcing you to turn off your computer to recover. Then run the program by entering "RUN 59995", and after a pause of about two seconds, the "READY" will be displayed. The Screen-plot program is now POKEd into memory and ready to run.

To run the Screen-plot utility, enter "RUN 60000". If you entered the program correctly, a blinking ball will be displayed on your screen, along with two numbers in the upper left-hand corner. The first number is the screen position of the blinking ball; the second is the color location. As you move the ball around the screen, these numbers will change, reflecting the changes in the screen and color locations.

Controlling The Program

Movement of the ball is accomplished via the F-keys. The following table shows which F-key controls which direction of movement.

F-Key	Blinking Ball Direction
F-1	→
F-3	←
F-5	↓
F-7	↑

Screen-plot has a built-in safety feature that prevents you from leaving the screen with the blinking ball and thereby altering other important memory locations in your computer.

This utility program runs in the cassette buffer, so you cannot use the cassette tape while this program is running. For you machine language programmers, the screen-plotter uses the zero-page locations hex $FB and $FC, so they are unavailable to you.

Also, because of Commodore's automatic scrolling feature, the screen display would scroll if you were to move the blinking ball to the very last position on the screen (lower right-hand corner). So the program prevents you from moving the ball into this position. To find the screen and color POKE locations of this position, simply move the blinking ball to the second to last position and add 1.

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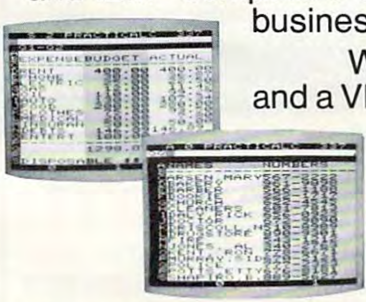

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Hints And Tips

After the program has been successfully POKEd into memory and tested, you may delete lines 59994-59999. The only line necessary to support the running of Screen-plot is line 60000. Also, the screen-plotter will not clear the screen upon initialization, so you may use it successfully with whatever screen display your program generates. To stop the screen-plotter, simply press the STOP key.

> BEGINNING PROGRAMMERS
> **If you're new to computing, please read "How To Type COMPUTE!'s Programs" and "A Beginner's Guide To Typing In Programs."**

Program 1:
Screen-plot For The Unexpanded VIC

```
59994 FORA=828TO921:READB:POKEA,B:NEXT:EN
      D
59995 DATA165,197,166,251,164,252,201,39,
      208,6,224,21,240,2,230,251,201,47,
      208,6,224,0
59996 DATA240,2,198,251,201,55,208,6,192,
      22,240,2,230,252,201,63,208,6,192,
      0,240,2,198
59997 DATA252,166,252,164,251,224,22,208,
      7,192,21,208,3,202,198,251,24,32,2
      40,255,169
59998 DATA113,32,210,255,162,0,160,0,232,
      208,253,200,192,32,208,248,169,157
      ,32,210,255
59999 DATA169,32,32,210,255,96,234
60000 SYS828:A=PEEK(251)+PEEK(252)*22+768
      0:PRINT"{RED}{HOME}"A;A+30720"
      {BLU}":GOTO60000
```

Program 2:
Screen-plot For The Expanded (8K Or More) VIC

```
59994 FORA=828TO921:READB:POKEA,B:NEXT:EN
      D
59995 DATA165,197,166,251,164,252,201,39,
      208,6,224,21,240,2,230,251,201,47,
      208,6,224,0
59996 DATA240,2,198,251,201,55,208,6,192,
      22,240,2,230,252,201,63,208,6,192,
      0,240,2,198
59997 DATA252,166,252,164,251,224,22,208,
      7,192,21,208,3,202,198,251,24,32,2
      40,255,169
59998 DATA113,32,210,255,162,0,160,0,232,
      208,253,200,192,32,208,248,169,157
      ,32,210,255
59999 DATA169,32,32,210,255,96,234
60000 SYS828:A=PEEK(251)+PEEK(252)*22+409
      6:PRINT"{RED}{HOME}"A;A+33792"
      {BLU}":GOTO60000
```

Program 3: Screen-plot For The 64

```
59994 FORA=828TO921:READB:POKEA,B:NEXT:EN
      D
59995 DATA165,197,166,251,164,252,201,4,2
      08,6,224,39,240,2,230,251,201,5,20
      8
59996 DATA6,224,0,240,2,198,251,201,6,208
      ,6,192,24,240,2,230,252,201,3,208,
      6
59997 DATA192,0,240,2,198,252,166,252,164
      ,251,224,24,208,7,192,39,208,3,202
      ,198
59998 DATA251,24,32,240,255,169,113,32,21
      0,255,162,0,160,0,232,208,253,200,
      192
59999 DATA32,208,248,169,157,32,210,255,1
      69,32,32,210,255,96,234
60000 SYS828:A=PEEK(251)+PEEK(252)*40+102
      4:PRINT"{HOME}"A;A+54272:GOTO60000
```

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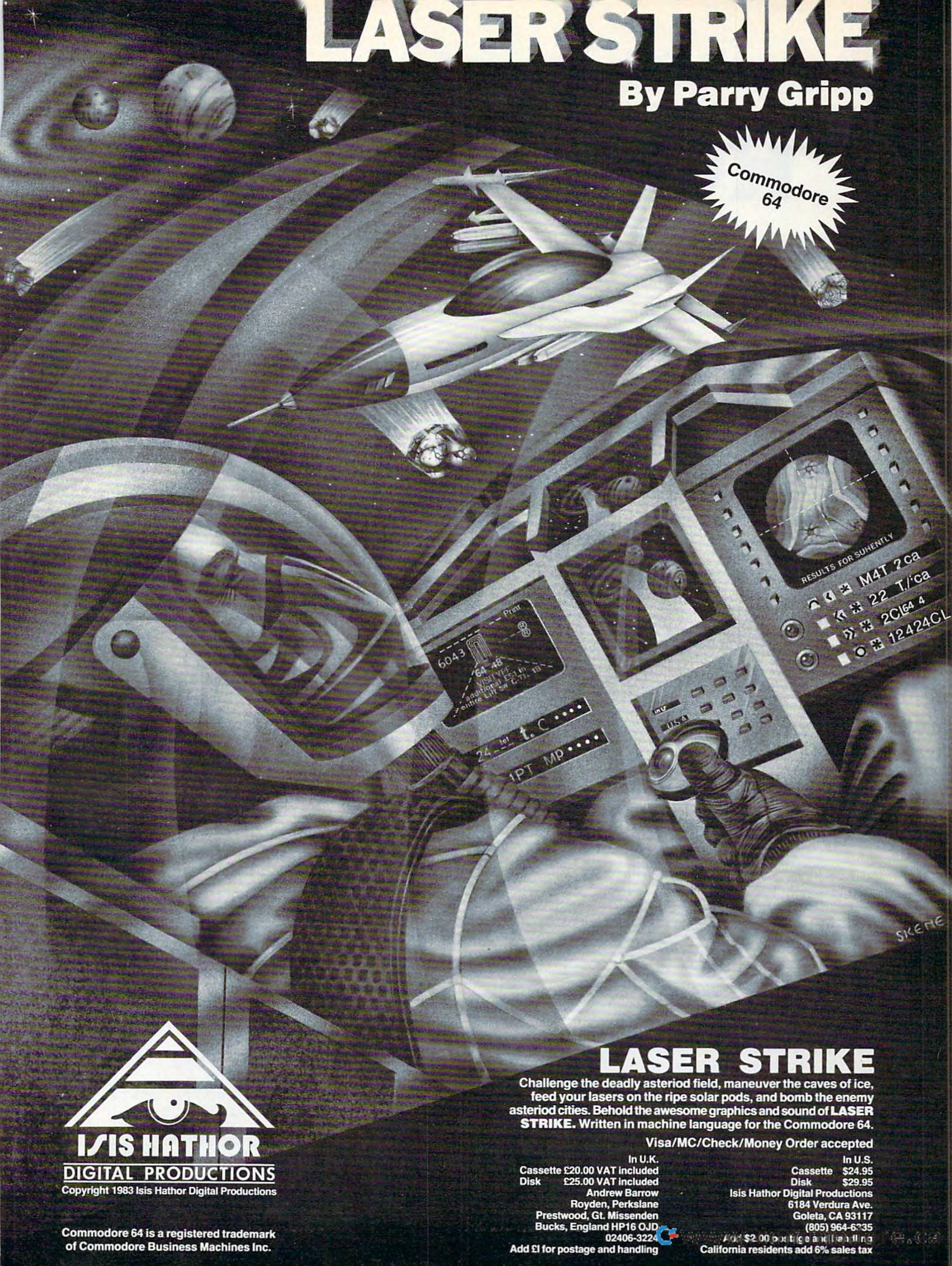

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ROADBLOCK

Brian Holness

There's a bit of typing here, but it's worth it. This game, written entirely in machine language, is fast and flexible. You have a choice of five speeds, up to four players simultaneously, or you can compete directly against the computer. You try to control an ever-growing line without running into a boundary, another player, or yourself. For the Atari.

In **COMPUTE!** (August 1981) there was an action game called "Blockade," written entirely in BASIC. The idea is simple. Each player controls a line which continually grows in an enclosed box. The first player who crashes into anything (himself or herself included) loses a point. Players start with nine points, and when they reach zero they're out of the game.

The use of BASIC prevented the possibility of allowing increased speeds, multiple players, or computer play options. I wrote this version of Blockade – called "Roadblock" in machine language to add these options. If you don't know machine language you can still type it in and use it; the program contains all the DATA statements required to run the program via a USR statement.

One of the major stumbling blocks I had in writing this program was the use of graphics in machine language. Fortunately, Bill Wilkinson's "Insight: Atari" article in **COMPUTE!** (February 1982) came to my rescue; those familiar with his article will recognize his code.

When the main menu comes up, you are instructed to use the select, option, or start button. The option button controls the speed, from 1 to 5, where 1 is the slowest speed. The select button controls both the number of players (2, 3, or 4) and the computer play option. When the computer plays, it always plays as player number 2 and is included in the total number of players. Thus, if three players are indicated and the computer is playing, then player numbers 1 and 3 are the humans, and player number 2 is the computer.

BEGINNING PROGRAMMERS

If you're new to computing, please read "How To Type COMPUTE!'s Programs" and "A Beginner's Guide To Typing In Programs."

Roadblock

```
10 FOR I=13824 TO 15010:READ B:POKE
   I,B:NEXT I
15 A=USR(14788)
1010 DATA 16,83,58,0,2,96,64
1020 DATA 37,21,16,21,1,0,46
1030 DATA 27,40,40,29,23,5,43
1040 DATA 1,255,0,0,0,0,1
1050 DATA 255,1,2,3,1,7,0
1060 DATA 9,9,8,15,37,64,4
1070 DATA 8,12,16,2,48,16,176
1080 DATA 48,0,0,7,11,14,13
1090 DATA 32,32,112,114,101,115,115
1100 DATA 32,239,240,244,233,239,238
1110 DATA 32,102,111,114,155,32,32
1120 DATA 112,114,101,115,115,32,243
1130 DATA 229,236,229,227,244,32,102
1140 DATA 111,114,155,112,114,101,11
     5
1150 DATA 115,32,243,244,225,242,244
1160 DATA 32,116,111,32,98,101,103
1170 DATA 105,110,155,32,32,32,32
1180 DATA 32,82,111,193,228,32,66
1190 DATA 108,207,227,75,155,32,32
1200 DATA 66,121,32,194,114,73,225
1210 DATA 206,32,104,79,236,206,101
1220 DATA 83,243,155,155,32,83,80
1230 DATA 69,69,68,58,32,180,155
1240 DATA 32,80,76,65,89,69,82
1250 DATA 83,58,32,178,155,32,67
1260 DATA 79,77,80,85,84,69,82
1270 DATA 32,80,76,65,89,83,58
1280 DATA 32,206,155,78,89,231,225
1290 DATA 237,229,160,239,246,229,24
     2
1300 DATA 155,13,66,40,40,23,23
1310 DATA 5,43,1,255,0,0,0
1320 DATA 0,1,255,169,9,162,3
1330 DATA 157,33,54,202,16,250,174
1340 DATA 11,54,202,189,5,54,141
1350 DATA 10,54,169,21,32,150,56
1360 DATA 173,48,2,133,203,173,49
1370 DATA 2,133,204,160,3,169,71
1380 DATA 145,203,160,6,152,145,203
1390 DATA 169,3,160,3,32,195,56
1400 DATA 169,0,162,2,160,3,32
```

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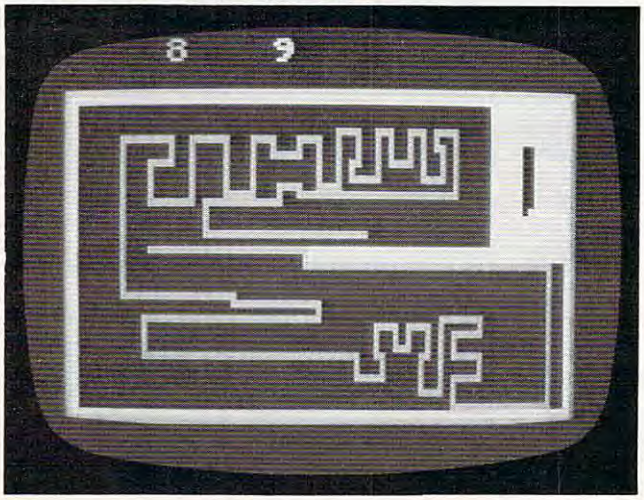
```
1410 DATA 232,56,169,0,162,2,160
1420 DATA 46,32,23,57,169,0,162
1430 DATA 79,160,46,32,23,57,169
1440 DATA 0,162,79,160,3,32,23
1450 DATA 57,169,0,162,2,160,3
1460 DATA 32,23,57,162,15,189,204
1470 DATA 54,157,13,54,202,16,247
1480 DATA 32,81,57,166,205,208,82
1490 DATA 134,206,174,31,208,224,7
1500 DATA 240,3,76,11,58,174,10
1510 DATA 54,32,53,57,166,207,240
1520 DATA 60,174,4,54,172,4,54
1530 DATA 202,189,33,54,208,39,136
1540 DATA 192,1,208,34,32,81,57
1550 DATA 169,2,133,87,162,6,160
1560 DATA 1,169,0,32,225,56,169
1570 DATA 194,160,54,32,199,56,173
1580 DATA 31,208,205,31,208,240,248
1590 DATA 76,11,58,224,0,208,207
1600 DATA 134,207,76,240,54,166,205
1610 DATA 189,33,54,208,3,76,133
1620 DATA 56,166,205,189,120,2,168
1630 DATA 166,205,192,14,208,10,169
1640 DATA 255,157,25,54,169,0,157
1650 DATA 21,54,192,7,208,10,169
1660 DATA 1,157,21,54,169,0,157
1670 DATA 25,54,192,11,208,10,169
1680 DATA 255,157,21,54,169,0,157
1690 DATA 25,54,192,13,208,10,169
1700 DATA 1,157,25,54,169,0,157
1710 DATA 21,54,24,189,13,54,125
1720 DATA 21,54,157,13,54,24,189
1730 DATA 17,54,125,25,54,157,17
1740 DATA 54,168,189,13,54,170,169
1750 DATA 0,32,1,57,201,0,240
1760 DATA 99,166,205,224,1,208,85
1770 DATA 173,50,54,240,80,230,206
1780 DATA 165,206,201,3,240,72,201
1790 DATA 2,240,19,173,10,210,41
1800 DATA 1,174,26,54,208,3,24
1810 DATA 105,2,141,51,54,76,61
1820 DATA 56,173,51,54,73,1,170
1830 DATA 188,52,54,173,26,54,240
1840 DATA 16,201,1,208,6,206,18
1850 DATA 54,76,178,55,238,18,54
1860 DATA 76,178,55,173,22,54,201
1870 DATA 1,208,6,206,14,54,76
1880 DATA 178,55,238,14,54,76,178
1890 DATA 55,166,205,32,129,57,76
1900 DATA 133,56,166,205,189,29,54
1910 DATA 32,195,56,188,17,54,189
1920 DATA 13,54,170,169,0,32,232
1930 DATA 56,166,205,232,138,56,237
1940 DATA 4,54,48,2,162,0,134
1950 DATA 205,76,76,55,72,162,96
1960 DATA 169,12,157,66,3,32,86
1970 DATA 228,162,96,169,3,157,66
1980 DATA 3,169,1,157,68,3,169
1990 DATA 54,157,69,3,104,157,75
2000 DATA 3,41,240,73,16,9,12
2010 DATA 157,74,3,32,86,228,96
2020 DATA 141,0,54,96,162,96,157
2030 DATA 68,3,152,157,69,3,169
2040 DATA 255,157,72,3,157,73,3
2050 DATA 169,9,157,66,3,32,86
2060 DATA 228,96,134,85,133,86,132
2070 DATA 84,96,32,225,56,162,96
2080 DATA 169,11,157,66,3,169,0
2090 DATA 157,72,3,157,73,3,173
2100 DATA 0,54,32,86,228,96,32
2110 DATA 225,56,162,96,169,7,157
2120 DATA 66,3,169,0,157,72,3
2130 DATA 157,73,3,32,86,228,96
2140 DATA 32,225,56,173,0,54,141
2150 DATA 251,2,162,96,169,17,157
2160 DATA 66,3,169,12,157,74,3
2170 DATA 169,0,157,75,3,32,86
2180 DATA 228,96,224,255,240,5,160
2190 DATA 168,140,1,210,160,255,142
2200 DATA 0,210,136,208,253,202,208
2210 DATA 245,162,255,160,0,140,1
2220 DATA 210,96,162,0,142,45,54
2230 DATA 169,2,133,87,174,45,54
2240 DATA 24,189,33,54,125,46,54
2250 DATA 32,195,56,189,41,54,170
2260 DATA 160,0,152,32,232,56,238
2270 DATA 45,54,174,45,54,236,4
2280 DATA 54,208,222,169,5,133,87
2290 DATA 96,166,205,189,37,54,141
2300 DATA 2,210,169,104,141,3,210
2310 DATA 189,196,2,72,169,54,157
2320 DATA 196,2,162,255,32,53,57
2330 DATA 32,53,57,32,53,57,166
2340 DATA 205,104,157,196,2,162,255
2350 DATA 32,53,57,166,205,222,33
2360 DATA 54,169,0,141,3,210,169
2370 DATA 1,133,207,96,169,150,160
2380 DATA 54,32,199,56,96,169,18
2390 DATA 32,150,56,169,32,141,12
2400 DATA 54,169,194,141,200,2,169
2410 DATA 0,170,160,4,32,225,56
2420 DATA 169,115,160,54,32,199,56
2430 DATA 32,188,57,169,131,160,54
2440 DATA 32,199,56,162,176,32,53
2450 DATA 57,173,196,2,72,162,1
2460 DATA 189,196,2,157,195,2,232
2470 DATA 224,4,208,245,104,141,199
2480 DATA 2,206,12,54,208,225,24
2490 DATA 173,11,54,105,176,141,159
2500 DATA 54,173,4,54,105,176,141
2510 DATA 171,54,174,50,54,189,192
2520 DATA 54,105,128,141,190,54,169
2530 DATA 2,32,150,56,162,0,169
2540 DATA 0,168,32,225,56,169,56
2550 DATA 160,54,32,199,56,169,151
2560 DATA 160,54,32,199,56,32,188
2570 DATA 57,169,75,160,54,32,199
2580 DATA 56,169,161,160,54,32,199
2590 DATA 56,169,173,160,54,32,199
2600 DATA 56,32,188,57,169,94,160
2610 DATA 54,32,199,56,172,31,208
2620 DATA 192,7,240,249,204,31,208
2630 DATA 240,251,192,5,208,24,174
2640 DATA 4,54,232,224,5,208,10
2650 DATA 162,2,173,50,54,73,1
2660 DATA 141,50,54,142,4,54,76
2670 DATA 11,58,192,3,208,16,174
2680 DATA 11,54,232,224,6,208,2
2690 DATA 162,1,142,11,54,76,11
2700 DATA 58,76,220,54
```



Maneuvering around the roadblocks. ©

COMPUTE's Author Guide

Most of the following suggestions serve to improve the speed and accuracy of publication. **COMPUTE!** is primarily interested in new and timely articles on VIC, Apple, PET/CBM, Commodore 64, Atari, Timex/Sinclair, TI/99-4A, and Radio Shack Color Computer. We are much more concerned with the content of an article than with its style. Above all, articles should be clear and well-explained.

The guidelines below will permit your good ideas and programs to be more easily edited and published:

1. The upper left corner of the first page should contain your name, address, telephone number, and the date of submission.

2. The following information should appear in the upper right corner of the first page. If your article is specifically directed to one make of computer, please state the brand name and, if applicable, the BASIC or ROM or DOS version(s) involved. In addition, *please indicate the memory requirements of programs.*

3. The underlined title of the article should start about 2/3 of the way down the first page.

4. Following pages should be typed normally, except that in the upper right corner there should be an abbreviation of the title, your last name, and the page number. For example: Memory Map/Smith/2.

5. All lines within the text of the article must be double- or triple-spaced. A one-inch margin should be left at the right, left, top, and bottom of each page. No words should be divided at the ends of lines. And please do not justify. Leave the lines ragged.

6. Standard typing paper should be used (no erasable, onionskin, or other thin paper) and typing should be on one side of the paper only (upper- and lowercase).

7. Sheets should be attached together with a paper clip. Staples should not be used.

8. If you are submitting more than one article, send each one in a separate mailer with its own tape or disk.

9. Short programs (under 20 lines) can easily be included within the text. Longer programs should be separate listings. *It is essential that we have a copy of the program, recorded twice, on a tape or disk.* Please use high quality 10 or 30 minute tapes with the program recorded on both sides. The tape or disk should be labeled with the author's name, the title of the article, and, if applicable, the BASIC/ROM/DOS version(s). Atari tapes should specify whether they are to be LOADed or ENTERed. We prefer to receive Apple programs on disk rather than tape. On the other hand, tapes are preferred for the Radio Shack computer. Tapes are fairly sturdy, but disks need to be enclosed within plastic or cardboard mailers (available at photography, stationery, or computer supply stores).

It is far easier for others to type in your program if you use CHR$(X) values and TAB(X) or SPC(X) instead of cursor manipulations to format your output. For five carriage returns, FOR I=1 TO 5:PRINT:NEXT is far more "portable" to other computers with other BASICs and also easier to type in. And, instead of a dozen right-cursor symbols, why not simply use PRINT SPC(12)? A quick check through your program – making these substitutions – would be greatly appreciated by your editors and by your readers.

10. A good general rule is to spell out the numbers zero through ten in your article and write higher numbers as numerals (1024). The exceptions to this are: Figure 5, Table 3, TAB(4), etc. Within ordinary text, however, the zero through ten should appear as words, not numbers. Also, symbols and abbreviations should not be used within text: use "and" (not &), "reference" (not ref.), "through" (not thru).

11. For greater clarity, use all capitals when referring to keys (RETURN, TAB, ESC, SHIFT), BASIC words (LIST, RND, GOTO), and three languages (BASIC, APL, PILOT). Headlines and subheads should, however, be initial caps only, and emphasized words are not capitalized. If you wish to emphasize, underline the word and it will be italicized during typesetting.

12. Articles can be of any length – from a single-line routine to a multi-issue series. The average article is about four to eight double-spaced, typed pages.

13. If you want to include photographs, they should be either 5x7, black and white glossies or color slides.

14. We do not consider articles which are submitted simultaneously to other publishers. If you wish to send an article to another magazine for consideration, please do not submit it to us.

15. **COMPUTE!** pays between $50 and $600 for published articles. In general, the rate reflects the length of the article. Payment is made upon acceptance of an article. Following submission (Editorial Department, **COMPUTE!** Magazine, P.O. Box 5406, Greensboro, NC 27403) it will take from four to eight weeks for us to reply. If your work is accepted, you will be notified by a letter which will include a contract for you to sign and return. *Rejected manuscripts are returned to authors who enclose an SASE.*

16. If your article is accepted and you have since made improvements to the program, please submit an entirely new tape or disk and a new copy of the article reflecting the update. We cannot easily make revisions to programs and articles. It is necessary that you send the revised version as if it were a new submission entirely, but be sure to indicate that your submission is a revised version by writing "Revision" on the envelope and the article.

17. **COMPUTE!** does not accept unsolicited product reviews. If you are interested in serving on our panel of reviewers, contact the Review Coordinator for details.

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Time Bomb

Doug Smoak

This program is deceptively short – it is easily one of the best games we've ever seen for the VIC. You're in a maze, larger than your screen will show. You must move through it, trying to defuse a ticking bomb hidden somewhere at the top of the puzzle. As you move, the screen will move, but you must learn from your mistakes or the ticking will grow more shrill until all is lost. For the unexpanded VIC.

You play "Time Bomb" against the clock. You start at the bottom of a maze, which is about three times the size of the VIC's screen. At the top of the maze is a time bomb ticking away. The closer it gets to blowing up, the higher pitched the ticking becomes. If you reach the bomb, you must steer the pointer into it to defuse it. If you are successful, you have a go at the same maze, but with the bomb in a different place and with a shorter fuse. This continues until you run out of time. If you fail to defuse it, you get a new maze and a new bomb with a longer fuse.

Friends I've played this with usually don't consider it a game for competition. Instead, they become back-seat drivers, telling the player where to go and pulling for him or her at every turn.

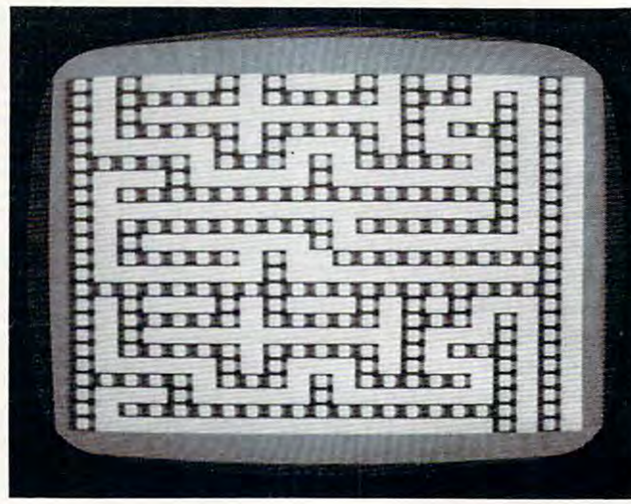
Time Bomb is quite challenging to a player's memory of spatial relationships. People who are at first intimidated by seeing only a portion of the maze quickly become accustomed to thinking ahead and remembering the dead ends and clear paths through the maze. An ability to recall the good and bad moves is crucial to getting into the later rounds.

I started thinking about this game when I saw Kenneth Szajda's "Mastermaze" (**COMPUTE!**, February 1983). I wanted to create something more challenging than a single screen maze, but I didn't want to duplicate his game and I also had to consider the VIC's smaller memory. I then hit onto the idea that makes this game so entertaining: to make the maze larger than the screen and bring it on and off the display by scrolling it out of a much larger block of memory.

How The Idea Came

It sounded great, but how would I do it? The secret lies in a short machine code routine that is "called" to update the display whenever the player goes up or down in the maze. It does this so quickly that I used the BASIC joystick routine from *COMPUTE!'s First Book of VIC* just to keep things at a reasonable pace.

There are actually three separate machine language routines that are represented by the DATA statements. One fills the maze area with the proper character, another fills the screen's "color RAM" with the proper color, and the third



Searching for a time bomb.

one scrolls the maze. I could have used BASIC POKEs to do all these things, but the time consumed would be too great. It would be impossible to use POKEs to do the scrolling of the maze with enough speed to be any fun at all.

When typing in the program, be sure to SAVE it before you RUN it, since a typo in the DATA statements could cause you to lose the whole program. Be very careful as you enter the DATA statements. If you have a bug in the program, it is most likely in the DATA statements, so look there first.

When you do RUN it, there will be a slight pause while the machine language parts are POKEd into the cassette buffer. Then the screen should clear, and the words "Making Maze" should appear. Because of the size of the maze, the VIC needs almost a minute to draw it, so be patient. When the maze is complete, a little musical announcement alerts you to begin playing. Don't give up if you are eliminated on the first round; it takes a while to get used to looking ahead in the maze and planning your route.

If you don't want to type in the program, I will make copies for the usual $3, a cassette, and

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Time Bomb

```
2 POKE56,24:POKE55,103:GOSUB29
3 D=37154:P1=D-3:P2=D-2:DF=30720:V=36878
  :S=V-4:M1=30:X=50:GOTO19
4 FORT=240TO208STEP-4:POKES,T:FORTT=0TO3
  0:POKEV,TT/2:NEXT:NEXTT:POKES,0:ME=793
  2
5 POKEOM,32:POKEOM+DF,10:POKEME,M1:POKEM
  E+DF,7:IFFTHEN40
6 K=K+1:ON-(K/2<>INT(K/2))GOTO8:IFK>600T
  HEN37
7 FORT=1TO2:POKEV,T*4:POKES+1,128+K/5:NE
  XT:POKES+1,0
8 POKED,127:P=PEEK(P2)AND128:J0=-(P=0)
9 POKED,255:P=PEEK(P1):J1=-((PAND8)=0):J
  2=-((PAND16)=0):J3=-((PAND4)=0)
10 IFJ0THENC=1:M1=62:GOTO14
11 IFJ1THENC=22:M1=22:GOTO14
12 IFJ2THENC=-1:M1=60:GOTO14
13 IFJ3THENC=-22:M1=30
14 OM=ME:ME=ME+C:C=0
15 IFPEEK(ME)<>32ANDPEEK(ME)<>42THENME=O
   M
16 IFPEEK(ME)=42THENF=1:GOTO5
17 ON-(ME>7921)GOTO18:SYS887:ME=ME+22:GO
   TO5
18 ON-(ME<7944)GOTO5:SYS905:ME=ME-22:GOT
   O5
19 DIMA(3):A(0)= 2:A(1)=-44:A(2)=-2:A(3)
   =44:WL=209:HL=32:SC=6228:A9=6943
20 SYS861:PRINT"{CLR} {DOWN}MAKING MAZE"
21 FORT=SC+21TO7679STEP22:POKET,32:NEXT:
   FORT=SCTOSC+21:POKET,32:NEXT
22 J=INT(RND(1)*4):X3=J
23 B=A9+A(J)
24 IFPEEK(B)=WLTHENPOKEB,J:POKEA9+A(J)/2
   ,HL:A9=B:GOTO22
25 J=(J+1)*-(J<3):IFJ<>X3THEN23
26 J=PEEK(A9):POKEA9,HL:IFJ<4THENA9=A9-A
   (J):GOTO22
27 TB=SC+INT(RND(0)*20)+220:ON-(PEEK(TB)
   <>32)GOTO27:POKETB,42
28 SYS830:POKE828,204:POKE829,28:SYS923:
   GOTO4
29 FORI=830TO974:READA:POKEI,A:NEXT:RETU
   RN
30 DATA169,238,141,15,144,169,0,133,251,
   169,150,133,252,160,0,169,10,145,251,
   200,208
31 DATA251,230,252,165,252,201,152,208,2
   41,96,169,84,133,251,169,24,133,252,1
   60,0,169
32 DATA209,145,251,200,208,251,230,252,1
   65,252,201,30,208
33 DATA241,96,173,60,3,56,233,22,176,3,2
   06,61,3,141,60,3,56,176,19,234,173,60
   ,3,24,105
34 DATA22,144,3,238,61,3,141,60,3,24,144
   ,1,234,169,0,133,0,169,30,133,1,173,6
   0,3,133
35 DATA254,173,61,3,133,255,169,0,133,25
   3,160,0,177,254,164,253,145,0,132,253
   ,230,253
36 DATA234,208,2,230,1,230,254,208,2,230
   ,255,169,32,197,1,208,227,96
37 POKEV,15:FORT=255TO127STEP-2:POKES,T:
   POKEV-9,255:FORG=1TO10:NEXT
38 POKEV-9,242:FORG=1TO10:NEXT:POKEV-9,2
   40:NEXT:POKEV-1,220:FORG=15TO0STEP-.0
   5
39 POKEV,G:POKEV+1,G*10:NEXT:POKEV-1,0:P
   OKEV+1,238:GOSUB42:RUN
40 POKETB,32:POKEV-1,253:FORG=30TO0STEP-
   .15:POKEV,G/2:NEXT:X=X+50:IFX>449THEN
   X=450
41 POKEV-1,0:F=0:K=X:R=R+1:GOSUB42:GOTO2
   7
42 PRINT"{HOME}ROUND"R"{LEFT} ":PRINT"
   {DOWN}PRESS F7 ":A$="":GETA$:ON-(A$<>
   "{F7}")GOTO42:RETURN
```

UNDERLINE = SHIFT,
[ ] = COMMODORE KEY,
{ }= SPECIAL.
REFER TO LISTING CONVENTIONS ©

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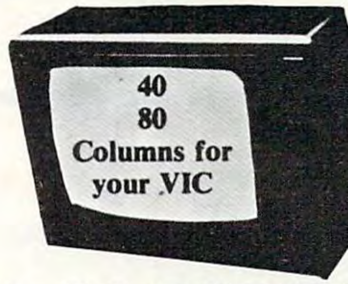

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Copy-Writer Word Processor

Louis F. Sander

Copy-Writer is a full-featured program that merits the close attention of any Apple, Commodore 64, PET, or CBM owner needing a word processor. It has most of the useful features found in other word processing systems, plus several that are unique. *Copy-Writer* is easy to use, clearly documented, and comes with a guarantee that future enhancements, no matter how extensive, will be offered to registered users for a nominal disk copying charge.

The developers of *Copy-Writer*, the IDPC Co. of Philadelphia, originally wrote it in 1979. Since then, it has been used by professional programmers and technical writers, and extensively revised. It seems to be a solid program with good features and few bugs.

Since a detailed discussion of software features can be confusing to those who haven't used similar programs, let's start our review with something easy to comprehend. *Copy-Writer* is available for the PET/CBM with 2040, 4040, 8050, or PEDISK II drives; it supports all ROM variations and virtually any printer from any manufacturer. The program is also available for the Apple II with 3.2 or 3.3 disks, for the Apple III, and for the Commodore 64 with 1541 or PEDISK III drives. The version I have worked with is for the PET/CBM with PEDISK II drive, but the other versions are identical to it in all important respects.

A Special, Tailored Program

The software consists of one diskette and a small, but thorough, manual. There are no ROMs or other plug-in devices. The diskette cannot be copied, but that is not a problem – you use it to create a machine language program configured especially for your own ROMs, screen size, keyboard, and printer, and *that* program can be saved and copied without limit. If you change printers or upgrade your computer, you load the master diskette, answer eight simple questions, and within a few seconds you have a reconfigured and copyable program in memory.

The 44-page instruction manual is remarkable for its clarity and usefulness, as well as for its brevity. In spite of never having learned to use a commercial word processor before, I was able to sit down with it and quickly master most of its features. The manual contains a useful table of contents and a well-thought-out index, both of which are quite helpful in using the program itself. It is written for the reader who is familiar with elementary computer operation, and who knows what he wants his word processor to accomplish.

Using *Copy-Writer* is exceptionally easy and straightforward. There is no need for sheets of stick-on key labels, or for a two-pound reference manual. When the system comes up, a "paper scale" appears at the bottom of the screen; tab stops are marked on it in reverse field. The number of the text line at the top of the screen and the number of lines still available in memory also appear down here, as does a line for special commands and error messages.

Editing Features

Routine typing and text editing is done in the Edit Mode, in which the cursor moves freely about the screen. The PET's familiar cursor control keys are used to move, insert, and delete characters. The up arrow, left arrow, HOME and RVS keys are used for opening up lines, moving words around, etc., and it is very easy to remember which key does what.

The STOP key puts the system in the "Command Mode." In that mode, the cursor jumps to a special area at the bottom of the screen and waits for your instructions. There are about 30 of these, most having to do with disk file handling, searching and replacing text, and printing. *Copy-Writer*'s authors have made the commands *very* easy to remember: A means append a file, D means down scroll, S means save a file on disk, etc. For those who haven't used the commands enough to have memorized them, they are listed in a table in the index of the instruction manual, which also notes the page where the command is described in detail.

The process of entering text and moving it around is similar to that in most good word processors. *Copy-Writer* seems to have all the necessary features in this area, and most of the typical frills.

Copy-Writer has two separate buffers for handling changes and text movement. Buffer #1 is used for moving entire para-

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graphs from place to place and is activated from Command Mode. Buffer #2 is used in Edit Mode and is ideally suited for moving words and short phrases, although it has a 1000-character capacity. To use it, you place the cursor on the first letter to be saved, and press the shifted left arrow key. Letter-by-letter, text is "sucked" from the screen into the buffer.

When you've picked up everything you want to move, you put the cursor wherever you want it, and press the unshifted left arrow key, which automatically inserts the buffered text at that point. The text remains in the buffer, so you can insert it as many places as you'd like. This feature can save time and keystrokes whenever the same phrase is used repeatedly in the text (as are the words "*Copy-Writer*" in this review). You can put such a phrase in the buffer and use one key to print it out every time it is used.

Another feature worthy of note is the ability to input repeated characters, such as a series of dashes, just by entering: a special character, the character to be repeated, and the number of repeats desired. There is also a graphics mode which allows dot-by-dot control over printers having that capability. Neither of these features is a necessity, but their presence is an indication of the authors' attention to detail in making the program useful.

Copy-Writer is extremely powerful for formatting the printed page. Format control is done by special commands embedded in the text, and there are many to choose from. Once again, the commands are easily understood by themselves, alphabetically listed in the index, and well-described in the manual. AP means append a file, LM sets the left margin, HD defines a page heading, and so on for over two dozen commands. The power here is really impressive – you can print things in double columns (like this magazine is printed), customize page breaks (based on a variety of conditions), and on and on.

By using a special format command, you can send individual hex characters to your printer, for control of character size, impact, or whatever features the printer happens to have. The capability is completely general, so if you know what character code switches your printer into Martian Hieroglyphic mode, you can put it there whenever you want. This is a very desirable feature and it's one of many desirable features available on this most impressive product.

Copy-Writer
CGRS Microtech
P.O. Box 102
Langhorne, PA 19047
$145

©

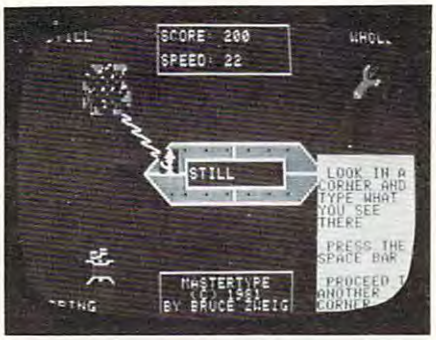
Mastertype

Tina Halcomb

Mastertype, by Bruce Zweig (Atari version by Aric Wilmunder), makes learning touch-typing fun.

As an educational program, *Mastertype* is impressive. It is menu-driven and the lesson plan begins with basic keyboard and finger placement presentations. In the manual supplied with *Mastertype* are illustrations and diagrams which clearly show proper finger placement. Your skill builds from this point. You begin to practice typing single letters or simple three- to four-letter words. Once you are comfortable with these, you move on to longer words, numbers, and symbols.

Each lesson can run in either of two modes. The Beginner mode displays single letters only, and the Normal mode asks you to type the complete word and press the space bar.



You can even create your own word lists to practice with words that are related to your occupation. After first booting *Mastertype*, you will see this option offered, and you respond by typing an "M" (make your own lesson). Each word list consists of 40 words ranging from one to nine characters. You *must* enter 40 words – there's no way around it. If you make any errors when entering the words, you may edit them after you complete the 40th word. Once satisfied with your customized lesson, you can name it and save it on your disk.

In each lesson you control the mode, the speed, and any upper- and lowercase variations.

Battle Of Words

But what makes this a truly effective, pleasant learning experience is the *game* it becomes. You, the Command Ship, are hovering out in space. Look out! Four enemy words have just appeared in the corners of your computer screen. They're sending satellites, missiles, and atomic meteors to destroy you. You are not helpless, though. If you can type the enemy words correctly, you can eliminate them. You won't destroy the enemy word unless you fire your laser before or just as the enemy word releases its weapon.

Even when you need not be particularly concerned with the exact path of your laser, you must type the word correctly before the laser is released.

As soon as you successfully defend your ship by destroying all enemy words, you can see your game score and typing speed. You may get so involved in playing the game that you won't even realize you're acquiring a very useful skill.

Mastertype is available on disk for a 32K Atari or 48K Apple.

Mastertype
Lightning Software
P.O. Box 11725
Palo Alto, CA 94306
$39.95

©

Claim Jumper For Atari

Fred Pinho

Synapse Software has produced a number of high-quality game packages in the past. In *Claim Jumper,* the company has done nothing to damage that reputation. *Claim Jumper* is basically a combination shoot-'em-up and strategy game for one or two players. I found it fascinating.

Two cowboys (brown and pink) are controlled by the players using joysticks. The cowboys act out their lives on a playfield consisting of: (a) two banks (one for each player); (b) an assay office; (c) two hospitals; (d) assorted other houses and cacti. At intervals during the game, a gold nugget will appear. The object is to pick up the nugget, take it to the assay office, and exchange it for cash. The cash must then be taken and deposited in your bank "to buy a house" (ten bills are needed). House buying is completely immaterial to the game. The object is solely to collect the ten bills.

While this all sounds easy, it can be frustratingly difficult. While performing these functions, you must also dodge your opponent's bullets while avoiding numerous obstacles. Although diagonal movement is the fastest, the cowboys can shoot only when moving horizontally or vertically.

The animation of the cowboys is relatively crude, but this in no way detracts from the game. If you shoot your opponent, his hat comes off and he drops whatever he is carrying (gold or money). He is then transported to one of the two hospitals (chosen by moving the joystick left or right). While in the hospital, he cannot shoot. After a very brief stay, however, he recovers completely and can re-enter the fray.

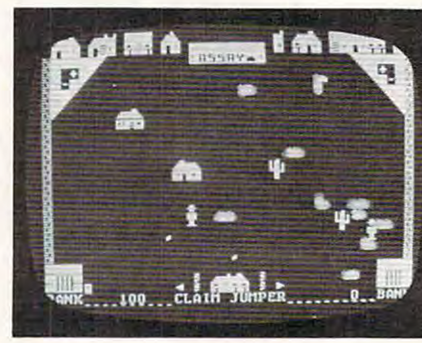
How They Get Your Treasure

The real fun in the game, and much of the strategy, involves the obstacles. Specifically, watch out for the notorious snakes and tumbleweeds. Shortly after the game starts, these objects start to appear. The pink snakes chase the brown cowboy while the brown tumbleweeds stalk the pink cowpoke. If you touch the opposite creature, you will be paralyzed for two seconds and drop whatever you are carrying. This allows your opponent to steal your treasure. After the two seconds are up, you're fit and ready to go as before. Mercifully, you will have a brief period of immunity which will allow you to move away from your pursuing tormentors. The creature graphics are very well done.

How can you fight off these unpleasant intrusions? One way is to shoot things. Plugging them with your trusty "shootin' ahrn" will turn the creature into the opposite type, which then promptly goes off after your opponent. However, there is a second tactic which adds considerably to the game. This involves dropping seeds or eggs. To do so, you must stop and then press your joystick button. The brown cowboy drops tumbleweed seeds. If a snake eats a seed, it turns into a tumbleweed. Conversely, the pink cowboy can drop snake eggs. If a tumbleweed hits the egg, it turns into a snake. A maximum of six eggs and six seeds can be on the screen at any one time. If you drop a seventh seed or egg, the oldest one disappears.

As you can imagine, *Claim Jumper* gets quite hectic. In addition to pursuing the gold, shooting creatures and your opponent, and dropping eggs/seeds, the cowboy must also avoid other obstacles. If the brown cowboy touches anything pink or a cactus, he experiences the two-second freeze. Pink obstacles include a pink house, the pink bank, one of the playfield borders and, of course, snake eggs. The opposite is true for the pink cowboy.

It's more difficult to explain this game than to play it. The nuances of the game are easily learned, and built-in prompts help during play. When you pick up the gold, a flashing arrow indicates where to deposit it in



Cowboys, cacti, snakes, Western buildings, and drifting tumbleweeds set the scene for Claim Jumper.

the assay office. Similarly, once you get the money, another arrow indicates the correct bank.

Option Menus

There are also two option menus for game variations. The first features the normal game and two options: Buy Bullets and Head Start. In Buy Bullets, you no longer have an unlimited supply of bullets. You start with ten. When you run out, you must take money to the bullet store to buy ten more. Head Start allows you to start with five bills already in the bank.

The second menu allows you to select either the normal game or a single-player game with two levels of difficulty. In the single-player game, you must destroy all the snakes and tumbleweeds before you are paralyzed for the third (and last) time. The problem is that you start with no bullets and thus must buy some with your gold. Again, you can buy only ten bullets at a time.

Although I have high praise for this game, I do have one gripe involving the scoring system. The winner is the first player to reach 25,000 points. You score 100 points for each snake or tumbleweed that you convert. But the first player to reach ten bills then gets 20,000 points! Somehow it doesn't seem fair. Here you are in a close battle with each player at about 6000 points and nine bills. Then your opponent gets one more bill, and you lose 26,000 to 6000! The final score does not reflect the intensity and closeness of such a contest. There *is* an option to continue the game until 50,000 which does help somewhat. A better way might be to receive a given number of points for each bill deposited until the winner reaches the target score.

Claim Jumper
Synapse Software
5327 Jacuzzi St.
Suite 1
Richmond, CA 94804
Requires 16K RAM
Disk/Cassette
$34.95

©

Courseware Report Card And *Educational Software Directory*

Sheila Cory

Just a couple of years ago, the greatest concern of parents and educators interested in the educational use of microcomputers was which computer to buy from the great variety available. Hardware selection was a major topic of discussion whenever the subject of computers came up. More and more, however, the questions posed these days relate to software selection. A number of schools and homes already have their computers and are trying to determine the best use of their machines.

Fortunately, some excellent educational software is now on the market. But parents and educators need to sift through an enormous amount of software in order to find what's best for their application. Educational software directories and evaluation journals have recently been developed to cope with this problem. This review looks at two of them.

Courseware Report Card

Courseware Report Card provides in-depth reviews and evaluations of both elementary and secondary software. Unlike many software review journals, it reviews software for more than one computer: Apple, Atari, PET/CBM, and TRS-80.

Selection of software to review is based primarily on software publishers' response to requests for review copies. A secondary source is software made available by teachers, software dealers, or educational media centers. To be of value to all people interested in educational computing, the journal covers a cross-section of subject area and grade level.

Most *Courseware Report Card* reviews are prepared by members of the editorial staff, all of whom are former teachers with experience in curriculum evaluation and design. A few of the reviews are prepared by non-staff members. These reviews are signed, and the qualifications of the reviewer are listed in the introduction.

Graded In Six Categories

The standard format of the reviews makes it easy to find information. A box at the top of the first page of each review highlights subject area, grade level, type of program (drill and practice, tutorial, or game), system requirements, price, and publisher's name and address. A box at the bottom of the page gives a letter grade (A through F) for performance, ease of use, error handling, appropriateness, documentation, and educational value. These two boxes, plus a short summary of the program, provide all the information necessary to decide whether or not to read the entire review.

The reviews proper begin with a description of the program, explaining exactly what the student sees as the program progresses. Screen representations and photographs make it easy to visualize what the text is describing. The "performance" section of the evaluation explores the overall quality of the program. Errors of punctuation in the text, problems with speed of operation, and sound that can't be turned off are examples of comments made in this section.

Ease Of Use And Error Handling

The "ease-of-use" comments focus on standardization of commands, use of menus in the program, and other programming possibilities that make the program as easy as possible for the user. How well a program accepts input from the keyboard is among the criteria evaluated under "error handling."

The value of the computer over other modes of instruction is addressed under "appropriateness." The editors take a firm position on the appropriateness of drill and practice software by having a policy of never awarding a grade higher than C to any software designed for drill and practice unless it is enhanced by additional features. (This view is not universally shared, but it is constantly discussed.)

Documentation And Educational Value

The paragraph of each review covering documentation looks at the books, pamphlets, and other hard copy provided to supplement the software. "Educational value," perhaps the most important of all of the evaluation components, examines whether the particular area covered by the software has any real place in the curriculum.

The evaluations included in *Courseware Report Card* are well written and complete. However, you must keep in mind (as the introduction to the journal states) that much software evaluation is subjective. There is room for disagreement, and you should make the decision of whether to use software with your students or your own children only after looking at the software from beginning to end yourself.

Apple, Atari, PET/CBM, And TRS-80

This review of *Courseware Report Card* is based on the first issue, dated September 1982. *Course-*

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SUPER-10" ABCDEFGHIJKLMNOPQRSTUVWXYZ
ABCDEFGHIJKLMNOPQRSTUVWXYZ 1234567890

ware Report Card/Elementary evaluated 22 programs, including 16 for the Apple, 11 for the Atari, seven for the PET/CBM, and seven for the TRS-80 (many programs are designed to run on more than one computer). *Courseware Report Card/Secondary* also evaluated 22 programs – 18 for the Apple, eight for the Atari, seven for the PET/CBM, and ten for the TRS-80. Future editions of the *Courseware Report Card* promise to be quite interesting: software publishers will have opportunity to respond to reviews, and teachers and administrators will have a chance to hear corroborating or dissenting opinions. A forum for such a dialogue is a welcome addition for people excited about possibilities in educational microcomputing.

Courseware Report Card
(five issues per year)
Educational Insights, Inc.
150 W. Carob St.
Compton, CA 90220
Elementary Edition $49.50
Secondary Edition $49.50
both editions $95
single copies $12.50

Educational Software Directory

The *Educational Software Directory* is designed to help educators determine exactly what software is available in their subject area. It can answer such questions as "How can I use the computer when teaching a poetry class?" or "Is there any software available for the PET that teaches grammar?" It tells what software is available, but makes no attempt to evaluate it.

The directory covers programs for grades kindergarten through 12 and includes all categories of educational software (except programs intended primarily for administrative purposes). Software selected for inclusion in the directory met a set of criteria: the software had to be usable for the grade level for which it was intended, the subject matter had to be appropriate to the learning environment and to the computer medium itself, and the listing of the software in the catalog had to be clear and complete. No software was actually examined in the process of compiling the directory; descriptions given in software catalogs were used instead.

Software listed in the directory includes general software (encompassing more than one subject), basic living skills, business education, computer literacy, courseware development (teacher utilities), fine arts, foreign language, language arts, library skills, math, science, and social studies. Each entry in the directory contains the program name, publisher's name, availability (which suppliers sell it), release date, grade level, hardware configuration required, storage medium (diskette or cassette), the computer language it's written in, price, availability of the source code (original program code), and a description of the program.

The value of this book results from the ease with which information can be found. *Educational Software Directory* is excellent. It has both a subject and a title index and cover markings to allow the user to locate a specific subject quickly. Addresses and the policies of publishers and distributors of educational software are also listed, making purchase of desired software easy.

Educational Software Directory
Libraries Unlimited, Inc.
P.O. Box 263
Littleton, CO 80160
$22.50

Legionnaire For Atari

E. P. McMahon

Chris Crawford has created a playable, fast, and enjoyable war game called *Legionnaire*. This game is sure to be compared with his magnum opus, *Eastern Front*, and, indeed, there are some similarities. He has retained the attractive features of fine-scrolling across a detailed map and the simple joystick input command concept from *Eastern Front*. But there are significant differences. The most striking difference is that *Legionnaire* is realtime. That is, once START is pressed, the enemy launches its attack and does not stop until the game is over.

Legionnaire is a simulation of Roman-barbarian conflict during Julius Caesar's campaigns in Gaul. You define the scenario by selecting one to ten legions to command. Of the ten, two are cavalry, Crassus and Labienus, and the rest are infantry. Caesar's legion, the Tenth, is the strongest and steadiest.

After choosing the number of legions you wish to command, you must select the tribes of barbarians to be the enemy. The barbarians come as infantry and cavalry, and range from the inept Aedui and sword-fodder Auscii up to the very challenging Helvetii and Huns. Once the order of battle is defined (by joystick), each group of combatants is placed on the map in (almost) random locations.

The Barbarians Are On The March

Before pressing START, you

move the hollow square cursor over the map to locate the units and inspect the terrain so you can plan your strategy. Roman units appear in an orange-pink color, and the barbarians are blue. Infantry is symbolized by swords, cavalry by horse heads, and Caesar's unit by an eagle. As you move the cursor to the edge of the screen, the map will fine-scroll under the cursor to show the entire 2¼ by 3½ screen map. Details on the map include effectively visual elevation contour lines and various forest symbols.

Now push START. A drumbeat signals that the barbarians are on the march. They continue to march and attack until they are all eliminated or until Caesar is destroyed. They march whether or not you give orders to your troops. It is in this sense that the game is played in realtime.

Let's examine the differences from *Eastern Front* for a moment. *Legionnaire*'s continuous action and ten units make it a reasonably fast game (it takes roughly between 2 to 15 minutes to play). It is fast enough when battle is joined to keep the interest of an arcade-game aficionado, but it also rewards good tactics enough to give those of us with slower reflexes a chance to win. Good tactics lead to fewer command corrections or panic moves.

While commanding your units, you should be aware of the effects of fatigue, slope, forests, and the differences in direct and flank attacks. Some units tire easily when marching or fighting and must rest to recover strength. Some units break up easily and should be backed up and given a chance to reorganize. Some are better at defense than offense. All these characteristics are spelled out in the 20-page booklet that accompanies the game. The booklet also has short sections on getting started, Caesar's campaigns, and helpful tactics.

Legionnaire

The Legion That Has Trouble Standing Up

Crawford points out that the traits of each tribe are fictitious and are not meant to be historically precise, but do offer you a wide selection of game scenarios. By the way, as you choose more and more legions to command, the added legions are, generally, less and less capable. On your tenth pick, you get Sabinus, whose legion has trouble standing up, let alone fighting. Oh yes. For every legion you pick, the enemy gets two units: one infantry and one cavalry. That can make things interesting.

You might want to play your first game against the Aedui and Auscii to become familiar with the mechanics of the game. Count the loss of any of your units against these tribes as a devastating defeat, and aim for a score in the 30s.

On the other hand, choose the Huns as opponents only when you want the ultimate challenge, feel lucky, and want to play for the least negative score. It doesn't matter which tribe you select for the enemy infantry. The Huns will get to you first and the game will be over before the infantry arrives. When I can reduce the Huns from five to three units before losing, I consider it a success.

The middle choices are fun. One of the most enjoyable games I played was against the Senones ("average troops... neither aggressive nor steady... unreliable when attacked from the flanks or the rear") and the Nervii ("most circumspect...generals value preparation...do not recover from combat shock easily"). The random placement was favorable, and allowed me to deploy my five units in good order at the top of a hill and then rest before the Nervii cavalry arrived.

I counterattacked their uphill charge and hit their flanks with Crassus and Labienus. They broke, and I eventually conquered them with the loss of only one unit, but with permanent reduction in strength to my remaining units. By this time I was on low ground, so I fell back to the forests and allowed the Senones to tire from marching.

They did not immediately attack when they got close, but stopped to rest to rebuild their strength, so I had to attack before they recovered too much. Since the enemy was tired, I was able to break their units away from each other one by one and use the speed of Caesar and the cavalry to surround and then reduce each unit. Without too much fight left in any of my units, I finally won.

Legionnaire is not the historical simulation that *Eastern Front* is, but I think it will appeal to a much broader audience because the game is faster-paced, has fewer units to control, and is, therefore, a faster game. The choice of scenarios makes the game rich enough to hold your interest and offers a variety of skill levels. *Legionnaire* is an entertaining, attractive game in which thinking is more important than fast reflexes.

Legionnaire comes on cassette tape for the Atari 400 and 800, and requires at least 16K RAM.

Legionnaire
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How To Type COMPUTE!'s Programs

Many of the programs which are listed in **COMPUTE!** contain special control characters (cursor control, color keys, inverse video, etc.). To make it easy to tell exactly what to type when entering one of these programs into your computer, we have established the following listing conventions. There is a separate key for each computer. Refer to the appropriate tables when you come across an unusual symbol in a program listing. If you are unsure how to actually enter a control character, consult your computer's manuals.

Atari 400/800

Characters in inverse video will appear like: INVERSE VIDEO
Enter these characters with the Atari logo key, {⅄}.

When you see	Type	See	
{CLEAR}	ESC SHIFT <	↰	Clear Screen
{UP}	ESC CTRL -	↑	Cursor Up
{DOWN}	ESC CTRL =	↓	Cursor Down
{LEFT}	ESC CTRL +	←	Cursor Left
{RIGHT}	ESC CTRL *	→	Cursor Right
{BACK S}	ESC DELETE	◀	Backspace
{DELETE}	ESC CTRL DELETE	◧	Delete character
{INSERT}	ESC CTRL INSERT	◨	Insert character
{DEL LINE}	ESC SHIFT DELETE	⬒	Delete line
{INS LINE}	ESC SHIFT INSERT	⬓	Insert line
{TAB}	ESC TAB	▶	TAB key
{CLR TAB}	ESC CTRL TAB	◧	Clear tab
{SET TAB}	ESC SHIFT TAB	◨	Set tab stop
{BELL}	ESC CTRL 2	◳	Ring buzzer
{ESC}	ESC ESC	↰	ESCape key

Graphics characters, such as CTRL-T, the ball character ● will appear as the "normal" letter enclosed in braces, e.g. {T}.

A series of identical control characters, such as 10 spaces, three cursor-lefts, or 20 CTRL-R's, will appear as {10 SPACES}, {3 LEFT}, {20 R}, etc. If the character in braces is in inverse video, that character or characters should be entered with the Atari logo key. For example, {■} means to enter a reverse-field heart with CTRL-comma, {5■} means to enter five inverse-video CTRL-U's.

Commodore PET/CBM/VIC

> *Please refer to "A Beginner's Guide To Typing In Programs" for an explanation of the changes in Commodore listing conventions.*

Generally, any PET/CBM/VIC program listings will contain bracketed words which spell out any special characters: {DOWN} would mean to press the cursor-down key; {3DOWN} would mean to press the cursor-down key three times.

To indicate that a key should be *shifted* (hold down the SHIFT key while pressing the other key), the key would be underlined in our listing. For example, S would mean to type the S key while holding the shift key. This would result in the "heart" graphics symbol appearing on your screen. Some graphics characters are inaccessible from the keyboard on CBM Business models (32N, 8032).

Sometimes in a program listing, especially within quoted text when a line runs over into the next line, it is difficult to tell where the first line ends. How many times should you type the SPACE bar? In our convention, when a line breaks in this way, the ~ symbol shows exactly where it broke.

All Commodore Machines

Clear Screen	{CLEAR}	Cursor Left	{LEFT}
Home Cursor	{HOME}	Insert Character	{INST}
Cursor Up	{UP}	Delete Character	{DEL}
Cursor Down	{DOWN}	Reverse Field On	{RVS}
Cursor Right	{RIGHT}	Reverse Field Off	{OFF}

VIC/CBM 64 Conventions

Set Color To Black	{BLK}	Function Two	{F2}
Set Color To White	{WHT}	Function Three	{F3}
Set Color To Red	{RED}	Function Four	{F4}
Set Color To Cyan	{CYN}	Function Five	{F5}
Set Color To Purple	{PUR}	Function Six	{F6}
Set Color To Green	{GRN}	Function Seven	{F7}
Set Color To Blue	{BLU}	Function Eight	{F8}
Set Color To Yellow	{YEL}	Any Non-implemented Function	{NIM}
Function One	{F1}		

To enter any color code, hold down CTRL and press the appropriate color key. Use CTRL-9 for RVS on and CTRL-0 for RVS off.

8032/Fat 40 Conventions

Set Window Top	{SET TOP}	Erase To Beginning	{ERASE BEG}
Set Window Bottom	{SET BOT}	Erase To End	{ERASE END}
Scroll Up	{SCR UP}	Toggle Tab	{TGL TAB}
Scroll Down	{SCR DOWN}	Tab	{TAB}
Insert Line	{INST LINE}	Escape Key	{ESC}
Delete Line	{DEL LINE}		

When you see an underlined character in a PET/CBM/VIC program listing, you need to hold down SHIFT as you enter it. Since the VIC-20 and Commodore 64 have fewer keys than the PET/CBM, some graphics are grouped with other keys and have to be entered by holding down the Commodore key. If you see any of the symbols in the left column underlined in a listing, hold down the Commodore key and enter the symbol in the right column. Just use SHIFT to enter all other underlined characters.

!	K	←	*	1	E
"	I	↑	PI	2	R
#	T	.	S	3	W
$	@	–	Z	4	H
%	G	=	X	5	J
'	M	<	C	6	L
&	+	>	V	7	Y
\	–	,	D	8	U
;	F	/	P	9	I
?	B	*	N	@	SHIFT*
(	£	+	Q	[	SHIFT +
)	SHIFT-£	0	A	]	SHIFT –

Apple II / Apple II Plus

All programs are in Applesoft BASIC, unless otherwise stated. Control characters are printed as the "normal" character enclosed in brackets, such as {D} for CTRL-D. Hold down CTRL while pressing the control key. You will not see the special character on the screen.

TRS-80 Color Computer

No special characters are used, other than lowercase. When you see letters printed in inverse video (white on black), press SHIFT-0 to enter the characters, and then press SHIFT-0 again to return to normal uppercase typing.

Texas Instruments 99/4

No special control characters are used. Enter all programs with the ALPHA lock on (in the down position). Release the ALPHA lock to enter lowercase text.

Timex TS-1000, Sinclair ZX-81

Study your computer manual carefully to see how to enter programs. Do not type in the letters for each command, since your machine features single-keystroke entry of BASIC commands. You may want to switch to the FAST mode (where the screen blanks) while entering programs, since there will be less delay between lines. (If the blanking screen bothers you, switch to the SLOW mode.)

A Beginner's Guide To Typing In Programs

A Change In Commodore Listing Conventions

Commodore owners may notice some slightly unfamiliar characters in a few of the programs this month. We're making a transition to new listing conventions for Commodore machines which should make typing in listings easier.

By next month, all listings will conform to the new conventions. Most of the changes should be fairly easily understood. Brackets still indicate special characters, although a few labels have been changed to make them more nearly match their equivalent keys. For example, {CLEAR} has been replaced with {CLR}. In the old conventions, underlining was used to indicate both shifted characters and (for the VIC and 64) graphics characters accessed with the Commodore logo key. In the new conventions, underlining is used *only* to indicate characters which should be typed while holding down the SHIFT key.

A new set of brackets has been introduced to indicate characters accessed with the Commodore logo key. Whenever you see a character surrounded by E3, you should hold down the Commodore logo key and type the indicated key. For example, the graphics ball character is represented by EQ3. As with the other brackets, a character preceded by a number indicates how many times you should type the specified character. For example, E22 T3 means to hold down the Commodore key and type T twenty-two times.

BASIC Programs

Computers can be picky. Unlike the English language, which is full of ambiguities, BASIC usually has only one "right way" of stating something. Every letter, character, or number is significant. Also, you must enter all punctuation such as colons and commas just as they appear in the magazine. Spacing can be important. To be safe, type in the listings *exactly* as they appear.

Brackets And Special Characters

The exception to this typing rule is when you see the curved bracket, such as "{DOWN}". Anything within a set of brackets is a special character or characters that cannot easily be listed on a printer. When you come across such a special statement, refer to the appropriate key for your computer. For example, if you have an Atari, refer to the "Atari" section in "How to Type COMPUTE!'s Programs."

About DATA Statements

Some programs contain a section or sections of DATA statements. These lines provide information needed by the program. Some DATA statements contain actual programs (called machine language); others contain graphics codes. These lines are especially sensitive to errors.

If a single number in any one DATA statement is mistyped, your machine could "lock up," or "crash." The keyboard, break key, and RESET (or STOP) keys may all seem "dead," and the screen may go blank. Don't panic – no damage is done. To regain control, you have to turn off your computer, then turn it back on. This will erase whatever program was in memory, so always SAVE a copy of your program before you RUN it. If your computer crashes, you can LOAD the program and look for your mistake.

Sometimes a mistyped DATA statement will cause an error message when the program is RUN. The error message may refer to the program line that READs the data. *The error is still in the DATA statements, though.*

Get To Know Your Machine

You should familiarize yourself with your computer before attempting to type in a program. Learn the statements you use to store and retrieve programs from tape or disk. You'll want to save a copy of your program, so that you won't have to type it in every time you want to use it. Learn to use your machine's editing functions. How do you change a line if you made a mistake? You can always retype the line, but you at least need to know how to backspace. Do you know how to enter inverse video, lowercase, and control characters? It's all explained in your computer's manuals.

A Quick Review

1) Type in the program a line at a time, in order. Press RETURN or ENTER at the end of each line. Use backspace or the back arrow to correct mistakes.

2) Check the line you've typed against the line in the magazine. You can check the entire program again if you get an error when you RUN the program.

3) Make sure you've entered statements in brackets as the appropriate control key (see "How To Type COMPUTE!'s Programs" elsewhere in the magazine.)

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Sesame Street And Interactive TV

It was like Super TV. I was sitting in a folding chair in the Grand Ballroom at the Hyatt Regency Hotel in Tampa, Florida. In front of me was a giant TV screen. Behind me was an audience numbering in the hundreds. Nearby were all sorts of mysterious high-technology devices. Writhing across the floor, like rainbow-colored pythons from a tropical rainforest, were dozens of cables.

The room darkened. The screen grew bright.

A big, blue, scruffy-looking creature appeared on the screen. It was Cookie Monster. He was wearing a chef's hat and munching a chocolate chip cookie. Crumbs flew in all directions.

It wasn't TV after all. It was a new computer game from the Children's *Computer* Workshop (CCW). CCW is a new division of Children's Television Workshop (CTW), the producers of *Sesame Street*, *Electric Company*, *3-2-1 Contact* and other children's educational programs and materials.

Last year CCW released its first four electron learning disk packages:

Ernie's Quiz (For children 4 to 7)*
Instant Zoo (Ages 7 to 10)*
Spotlight (Ages 9 to 13)*
Mix and Match (For the whole family)

Each package contains four programs that run on a 48K Apple. The starred packages (*) require Integer BASIC. The unstarred package (*Mix and Match*) requires Applesoft BASIC. *Ernie's Quiz* and *Spotlight* require paddles. All packages are more effective if you have a color TV. The packages each cost $49.95. For more information, contact your local Apple dealer, or write:

Apple Computer Company
20525 Mariani Avenue
Cupertino, CA 95014
408/996-1010

Cookie Monster Munch

Barbara Stewart, a project manager from CCW, had brought Cookie Monster to the Hyatt Regency Hotel in Tampa. The occasion was the third annual Florida Instructional Computing Conference, one of the largest regional educational computing conferences in the country, held from March 28-30.

Barbara was the conference's keynote speakér. In her speech, she announced that CCW was producing a new line of educational programs for the Radio Shack Color Computer (16K) and for the Atari 2600 VCS computer and game system. CCW plans to develop each cluster of programs on a particular machine and have the computer manufacturer distribute them through its standard outlets. Eventually, at least one set of CCW packages will be available for many of the bestselling computers. In 1983, CCW will be producing 24 children's learning games. Half of the games will be for classroom use, half for home use.

Cookie Monster Munch is typical of the new Atari games. The game is a numerical maze game for kids ages three to seven. It comes with a colorful booklet explaining how the game works. The Table of Contents and other sections are all hand printed, as if by Cookie himself. I like the "Note to Parents" at the beginning of the booklet. Also, a symbol of a parent with his or her arm around the shoulders of a child is used throughout the booklet. The symbols are accompanied by suggestions to increase and enrich parent-child interactions with the computer and *with each other*.

And how do the kids and their parents interact with the computer? They use the new Atari Kid's Controller. CCW worked with Atari to develop the Controller. It's a large numerical keypad with big buttons and is very sturdy. It plugs into the left controller jack at the back of the Atari 2600 VCS and is an easy-to-use keyboard or joystick for game play. Each CCW package contains a colorful plastic overlay that fits atop the Kid's Controller.

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Cookie Monster's Munch *for the Atari.*

Cookie Monster Munch is a maze game, so the child has to make characters in the game move up and down, left and right, through the maze. Accordingly, the overlay has a big picture of Cookie Monster and designates buttons (hidden underneath the overlay) as movement buttons with big arrows for all four directions. It's so easy to use that even toddlers with small hands and adults with keyboard phobia will be able to play.

Another nice feature of the games is the Read Aloud Story in the beginning of each booklet. With personal computer graphics (especially VCS graphics) still at a relatively primitive level, the images of the Sesame Street characters, like Cookie Monster, are nowhere near as nice looking as they are on TV. But the story helps remedy this problem. *It engages the child's and the parent's imagination, and it gives the simple looking game on the TV display meaning and depth.*

Cookie Monster discovers a chocolate chip cookie garden. He begins running around the garden picking up cookies. He takes the cookies and puts them in his cookie jar. Cookie's intentions are sensible, but he can't resist eating the cookies before he makes it to the jar. A little kid appears – the Cookie Kid. Cookie Kid tries to collect the cookies and put them in the jar before Cookie can eat them.

The paths in the cookie garden are like a maze. There are ten different game levels and mazes. The easier games are one-person games. The harder games are one- and two-person games.

Like the *Sesame Street* TV program, the games are designed as entertaining ways to teach kids prereading skills. The kids get to move Cookie Monster or the Cookie Kid through the mazelike cookie garden. Tracing the maze pattern while remaining within its borders helps kids practice the hand-eye coordination they'll need for beginning reading and writing. Also they learn to follow directional arrows and become familiar with the relational concepts of up, down, left, and right.

Peanut Butter Panic

Here are some other new CCW games:

• *Ernie's Magic Shapes.* This is a home game for kids ages three to six that runs on the TRS-80 (16K) Color Computer. Kids help Ernie zap geometric shapes and use them to build colorful figures. The games help kids develop classification skills including matching shapes, recognizing embedded figures, structuring parts of an object into a meaningful whole, and discriminating between similar and different shapes.

Ernie's Magic Shapes *on TRS/80 Color Computer 16K.*

• *Grover's Number Rover.* This is a home game for kids ages three to six that runs on the (16K) Color Computer. Grover floats across the top of the screen in his Number Rover. The child helps Grover find the answer to his arithmetic problem. When the child discovers the number that solves Grover's problem, Grover picks up that number of Twiddlebugs. This is a humorous part of the game. The Twiddlebugs are upside down.

Grover's Number Rover *on TRS/80 Color Computer 16K.*

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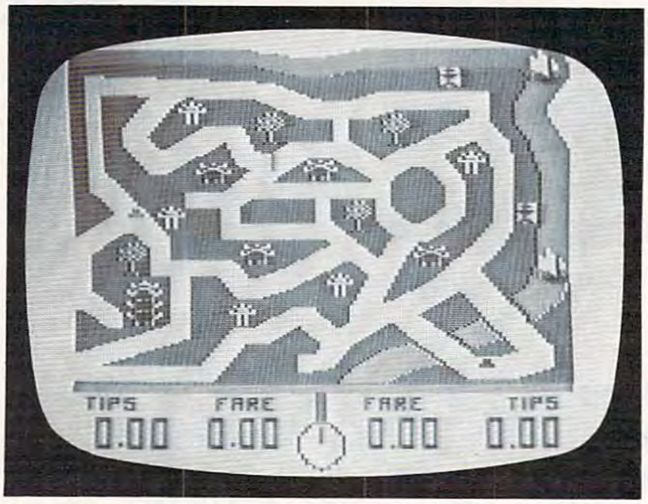
• *Taxi.* This is a home game for kids ages seven and up that runs on the 16K Color Computer. This is a junior adventure game. Kids get to operate a two-cab company in any one of six cities around the world. They pick up passengers, deliver them to their destinations, and earn fares and tips. The game encourages visual problem-solving in a cooperative environment.



Screen from Taxi *game on TRS/80 Color Computer 16K.*

• *Peanut Butter Panic.* This is another funny game. It is a home game for kids seven and up that runs on the 16K Color Computer. Two little nutniks try to catch stars that zip by above them in the sky. Kids control the nutniks and launch them from a platform that resembles a giant seesaw. The nutniks can jump up and down on their own, or two kids can launch them from the seesaw.

When the nutniks jump up and down they lose weight and get real skinny. When they get skinny, they can't jump as high. To get fat again they have to eat peanut butter sandwiches. They build a peanut butter sandwich by catching stars. They have to watch out for mean snarfs who swoop down out of the sky and steal their sandwiches.

Screen from Peanut Butter Panic *on TRS/80 Color Computer 16K.*

The primary objective of this delightful game is teamwork and cooperation.

• *Picture Place.* This *school* game is for kids ages five and up. (I think that it is a good game for preschoolers, too.)

Kids get to choose a picture from a library of six background scenes, including a city and a countryside. At the bottom of the screen are word boxes with words inside like dragon, car, bicycle, family, and castle. Kids choose a word by moving a joystick and positioning a big "cursor box" so that it overlaps with one of the word boxes. They pick up the word box and move it up the screen and position it on the background scene. Then, when they press the RETURN button, the word transforms into a picture. For example, the word "dragon" becomes a picture of a dragon, set in the world pictured in the background scene.

CCW's Values And Goals

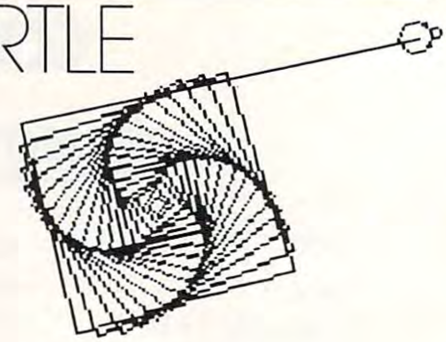
Barbara Stewart thinks that personal computers will evolve into "interactive TV." She wants to create programs for TV that will accomplish the same goals as the *Sesame Street* programs on regular TV. The programs will focus primarily on developing math and reading readiness skills. But they will also stress certain fundamental *Sesame Street* values, including teamwork, cooperation, and nonsexist, nonviolent, pro-social play.

Screen from Picture Place *on TRS/80 Color Computer 32K.*

The programs are to be appropriate to their target age group and appealing to both girls and boys. They should meet educational goals for children of each age group and development level. They should be easy to understand, easy to play, and nonjudgmental. They should not frustrate children. Instead, they should encourage a child to grow and improve his or her self-image.

If these games prove to be as thoughtfully and as creatively executed as *Sesame Street* itself, children (and parents) everywhere can look forward to exceptionally rewarding educational experiences via "interactive television." ©

FRIENDS OF THE TURTLE



David D. Thornburg, Associate Editor

PILOT And Logo – A Tale Of Two Languages

PILOT and Logo are two of the most popular user-friendly computer languages available for personal computers. Because Atari PILOT and Apple SuperPILOT both contain a powerful turtle graphics environment, many people wonder if PILOT might not be a substitute for Logo.

As I will show, Logo and PILOT are quite different languages. Although they can be used for many of the same applications, each language has special features that make it more appropriate for some applications than for others. The goal of this article is to provide enough information about both languages to aid someone who is trying to decide which to use. I will assume that you are already familiar with turtle graphics.

PILOT

PILOT stands for Programmed Inquiry, Learning Or Teaching. It was so named by its developer, John Starkweather, because he wanted to create a programming language that easily allowed teachers to generate computer-aided instructional materials. Research in the late 1960s by Dean Brown showed that PILOT was also a good programming language for children.

The key to PILOT's appeal is its simple command structure and powerful ability to manipulate text-oriented material. At its core, PILOT has only eight commands, yet these eight commands allow the creation of quite sophisticated programs. The core commands for PILOT are shown below:

PILOT Command	Function
T:	*T*ypes text and variables on the screen.
A:	*A*ccepts input from the keyboard.
M:	*M*atches words or phrases against the result of the most recent accept command.
J:	*J*umps execution to a label.
U:	*U*ses a labeled procedure.
C:	*C*omputes the value of a variable.
R:	allows *R*emarks to be added to a procedure.
E:	*E*nds a program or procedure.

Notice that none of these commands has anything to do with graphics. The incorporation of turtle graphics in PILOT is a fairly recent event. Also, most versions of PILOT have additional text manipulation commands that add significantly to its power.

Core PILOT's most powerful command is M:, the match command. To see why this command is so powerful, consider the following PILOT procedure:

```
*QUESTION1
  T: WHAT GROWS ON TREES?
  A:
  M: MOSS, LEAVES, BUGS, INSECTS, NEEDLES
     TY: YOU ARE CORRECT
     TN: ARE YOU SURE? LET'S TRY AGAIN.
     JN: *QUESTION1
  E:
```

This PILOT procedure works in the following way. First, a question is typed on the screen. The user then types a response that is saved in the "accept buffer." The match command then checks to see if any of the words, MOSS, LEAVES, etc., appear anywhere in this buffer. If there is a match, a "yes flag" (Y) is set to be true and a "no flag" (N) is set to be false. The execution of any PILOT command can be made conditional on the status of these flags by entering Y or N after the command name. For example, the command TY: will print on the screen only if the yes flag is true. The JN: command causes the procedure to be used over again if the user's response is *not* matched.

As a result of PILOT's ability to manipulate words and phrases, many of the early uses of PILOT by children involved the creation of word games and "poetry generators."

What About PILOT Graphics?

As mentioned, graphics is a recent addition to PILOT. Turtle graphics is incorporated through the use of special commands. In Atari PILOT, for example, this command is GR: followed by specific graphics instructions. The fundamental graphics commands allow the turtle to be moved in its present heading or to have its heading changed.

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Here's a list of the more commonly used Atari PILOT graphics commands:

PILOT Command	Function
GR: DRAW x	Draws a line of length x in the present heading.
GR: TURN x	Rotates the turtle by x degrees.
GR: PEN UP	Raises the turtle's pen.
GR: PEN YELLOW	Sets the pen color to yellow and sets the pen down.
GR: GOTO x, y	Moves the turtle to absolute coordinates x,y.
GR: TURNTO x	Rotates the turtle to absolute orientation of x degrees measured to the right of straight up.

These commands (and several others) allow the creation of procedures that draw complete figures. For example, the PILOT procedure shown below draws a square 50 units on a side:

```
*SQUARE
  GR: 4(DRAW 50 ; TURN 90)
E:
```

To use this procedure, one would type:

```
U: *SQUARE
```

Logo

Logo is a computer language that was designed by Seymour Papert to be an easy, yet powerful tool which would let children use the computer to explore topics on their own. While designed to be used by children, Logo is a user-friendly version of the tremendously powerful language, LISP. Since LISP is the language of choice for many researchers in the field of artificial intelligence, clearly Logo is a programming language for adults as well.

The key to Logo's appeal is its simple syntax (compared with LISP) and its ability to manipulate data structures called *lists*. A list is a collection of words, Logo commands, numbers, or other lists. Logo allows lists to be constructed, modified, examined, reordered, and (if the list consists of Logo procedures or primitive commands) executed. Here are some core Logo commands which are comparable to the core PILOT commands:

Logo Command	Function
PRINT	Prints a list of text on the screen.
READLIST	Reads a list from the keyboard.
MEMBERP	A predicate that matches a word against the elements of a list.
MAKE	Assigns (or "binds") a number, word, or list to a variable named by a word.
END	Ends a procedure.
FIRST	Returns the first element of a list.
BUTFIRST	Returns all but the first element of a list.
LAST	Returns the last element of a list.
BUTLAST	Returns all but the last element of a list.

Notice that none of these commands has anything to do with graphics. Turtle graphics was incorporated into Logo after the language had been in use for a while. The list of Logo primitives shown above is quite incomplete, but it allows us to build a procedure comparable to the QUESTION1 procedure we wrote in PILOT:

```
TO QUESTION1
   PRINT [WHAT GROWS ON TREES?]
   MAKE "ANSWER READLIST
   TEST MEMBERP FIRST :ANSWER [MOSS
      LEAVES BUGS INSECTS NEEDLES]
      IFTRUE [PRINT [YOU ARE CORRECT]]
      IFFALSE [PRINT [ARE YOU SURE? LET's
      TRY AGAIN]
         QUESTION1]
END
```

This procedure performs a function similar to that of the PILOT procedure except that it only looks to see if the first word on the answer is contained in the answer list. The commands following the words IFTRUE are executed only if the result of TEST is true. If the result is false, the commands following IFFALSE are executed instead. Notice that a Logo procedure is treated just as if it were a Logo primitive. To execute the procedure QUESTION1, you merely type its name.

As with PILOT, many of the early uses of Logo by children involved the creation of word games and poetry.

What About Logo Graphics?

A list of the more common Logo turtle graphics commands is shown below:

Logo Command	Function
FORWARD x	Draws a line of length x in the present heading.
RIGHT x	Rotates the turtle by x degrees.
PENUP	Raises the turtle's pen.
PENDOWN	Sets the pen down.
SETPOS x y	Moves the turtle to absolute coordinates x,y.
SETHEADING x	Rotates the turtle to absolute orientation of x degrees measured to the right of straight up.

These commands (and several others such as BACK and LEFT) allow the creation of procedures that draw complete figures. For example, the following procedure draws a square of any size:

```
TO SQUARE :SIZE
   REPEAT 4 [FORWARD :SIZE RIGHT 90]
END
```

To use this procedure to draw a square 50 units on a side, one would enter:

```
SQUARE 50
```

Differences Between Logo And PILOT

The previous sections have suggested that PILOT and Logo are similar in application areas and syntax. In fact, there are some major differences between the languages that may cause one to be clearly the language of choice for a particular task.

For example, PILOT makes it very easy to create programs in which the contents of variables are printed along with text. Also, the match command will compare each element of a list with the entire response. In Logo, you would have to write a procedure to do this.

Another important feature of PILOT is its compactness. Most Logo implementations require large amounts of RAM. Most (but not all) versions of PILOT will operate in 16K of RAM with plenty of space left for the user's program.

In terms of overall symbol manipulation, Logo is the more powerful of the two languages. The ability to write programs that generate other programs is of great utility when constructing environments that "learn from experience." The fact that user-defined procedures are treated exactly as if they were Logo primitives gives Logo a feature called *extensibility*. This means that you can add new words to Logo's vocabulary (as we did with QUESTION1 and SQUARE). There is no need in Logo for the *jump* or *use* commands. To execute a procedure, you just type its name.

Logo also supports *local variables*. This means that the value associated with a variable is assigned to the specific procedure (and level) in which it is used. This allows you to write procedures that use themselves recursively. For more information on this topic, you might want to read the "Friends of the Turtle" columns on recursion that appeared a few months back.

Logo's turtle graphics commands are, perhaps, easier to grasp than PILOT's, but there are indications that this will not always be the case as new versions of PILOT are likely to become more "Logo-like."

Apart from these differences, Logo and PILOT both encourage a procedure-oriented programming style that makes complex programs easy to read and correct.

I use both languages regularly and find that I would be reluctant to abandon either one. Your application areas might indicate that one of these languages has a clear advantage over the other. No matter which you choose, you will be using a language that allows the creation of very sophisticated and powerful programs.

Notes From All Over

I have just heard from my Argentinian friend, Horacio Reginni, who has just started the Asociacion Amigos de Logo (Logo Friends Association) to promote the development of Logo centers, sponsor meetings, and spread information about Logo all over the world. The association can be reached at 2969 Salguero St., Buenos Aires, 1425 Argentina. True Logophiles will be interested in attending their first International Logo Conference in Buenos Aires on September 16-18. Registration is only $25. As for the air fare ....

©

Glenn M. Kleiman

A Library At Your Fingertips

The ability to use computers to efficiently access, organize, and analyze information is becoming a critically important skill. In fact, knowing how to use computerized information bases is rapidly becoming as important as knowing how to use a library. People in many occupations – travel agents, bank tellers, librarians, stockbrokers, and insurance agents – already use computerized information bases every day. Doctors, lawyers, scientists, teachers, and many others will be added to the list in the next few years.

There are many computerized information bases. In this column, I discuss my favorite one, which is called *DIALOG*. DIALOG is the world's largest computer storehouse of information available to the public. It contains over 170 data bases with a total of more than 75 million records of references, abstracts, and statistical data on a great diversity of topics. A simple set of commands lets you locate information quickly and easily. Widely used by libraries and businesses, DIALOG and its new cousin, *Knowledge Index*, can also be used by schools and individuals.

To use DIALOG, you need a terminal or a computer with the hardware (a modem and interface) and software to make it function as a terminal. You also need an account number on the DIALOG system and a telephone. Like other large data base systems, DIALOG uses special networks (Telenet and Tymnet) so you can access it with a local telephone call from most places in the United States.

An Example Information Search

I've recently used DIALOG to search for information about one of my main professional interests, the use of computers by children who have learning disabilities. There has not been a great deal of research in this area, and reports of the research that has been done are scattered in many different journals and books. A data base on the DIALOG system, called ERIC, lets me search an enormous body of literature for relevant references, and to do so in a few minutes.

ERIC is an acronym for Educational Resources Information Center. It is an index to the contents of more than 700 journals in education, as well as a large number of books, technical reports, conference papers, government agency reports, and other documents. It contains approximately 500,000 references, dating back to 1966. The index is kept up-to-date and about 3,000 references are added each month.

All the information about each journal article or document is grouped together into what is called a *record*. Each record contains the title, author, journal and date of publication (or other information needed to locate the actual document), the language in which it is written, a set of descriptive (subject indexing) terms and an abstract (short summary). The descriptive terms are keywords which characterize the contents of the document. There is also a *Thesaurus of ERIC Descriptors* which enables you to find the best descriptor terms for each topic.

The many volumes of printed ERIC indexes are familiar to many educators and researchers. For some of my articles and research projects in years past, I've spent hours scanning through many pages of small print, hunting for relevant references. I can now accomplish the same work in a few minutes via the computer on my desk.

After using a modem and telephone to connect my computer to the DIALOG computer, I enter my account number and password. My search for references about computers and learning disabled children then proceeds as shown below. (In some cases, I have slightly altered the computer's response, leaving out code numbers and other extraneous information and spelling out abbreviations for clarity.)

First, I tell the system I want to use the ERIC data base (which happens to be number 1). I enter:

BEGIN 1

(My commands will be underlined throughout this column.) The computer responds:

NEW MULTI-USER SOFTWARE LETS THE WHOLE FAMILY SHARE IN THE JOY OF LEARNING.

Is the personal computer doing all it can to help our children learn?

To some degree, no, although it's not fair to blame it entirely on the computer. After all, computers are only as good as their software.

How can we improve this situation?

A solution already exists. But first, some background.

Where personal computers fail.

For years, studies have shown that children learn more efficiently in group situations. Peer groups, for example, motivate slower learners to persevere. Groups of older and younger children encourage divergent thinking. Even the simple "group" of a parent and child promotes faster acceptance of new ideas by combining education with trust and confidence.

But personal computers and their programs are designed to be personal. One computer, one child. It's hard for anyone else to be part of the learning experience, even you.

At least not until today.

A simple solution.

When two educational researchers, Dr. Matilda Butler and Dr. William Paisley, observed this problem they proposed an interesting, yet simple, solution. Instead of writing programs that shut out brothers, sisters, friends, and parents, why not give everyone the opportunity to share learning simultaneously. This one idea sparked an entire line of unique educational programs and gave birth to a new company, Edupro.

Software that shares.

With Edupro's Microgroup™ computer programs, up to eight players work at solving math, language, social studies, or science problems which are presented as contests, races, and puzzles. The players work together, either competitively or cooperatively, as they race against time, each other, or both.

The *Math-Race* program, for example, converts your computer into an electronic race track where children compete to answer math problems and advance toward the finish line. *Picture-Play* encourages everyone to create pictures together, teaching both spatial relationships and the value of cooperation. And *Team-Work* combines both cooperation and competition by pitting two teams (of up to four players) against each other in a race to solve word and number puzzles.

For the first time, your personal computer can bring all the benefits of group learning into your home. With a little assist from Edupro.

Designed for the simplest computers.

These unique programs run on the Atari 400 or 800, two of the world's most popular home computers. Remember, these aren't game cartridges, they're full *computer programs*, designed by educators. All are available on floppy disk or cassette, and each one requires the minimum amount of computer memory (16K for cassette, 24K for disk). That means the simplest Atari computer can let your children share the learning experience with up to seven additional friends. Joysticks required for *Word-Draw*, *Math-Hunt*, and *Picture-Play*; paddles required for *Word-Race*, *Math-Race*, and *Team-Work*.

Trust your own experience.

At the fall 1982 Computer-Using Educators Conference hundreds of educators witnessed hands-on demonstrations of our programs. Many of them said that this was a most effective way to judge their potential. But we want to offer you an even better opportunity. One those educators missed.

We want you and your children to experience this new way to learn. So choose one or more programs on either disk or cassette. Try them yourself. Watch your children get more excited about learning. Enjoy the thrill of sharing the experience with them. We know of no other software that can turn a personal computer into a tool for sharing the joy of learning.

Fill out the order form and see the results for yourself.

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I want to share the joy of learning with my children. Please send me the programs I've indicated below. I understand that each program is available on either disk or cassette (my choice) and comes with a complete set of instructions and catalog listing over 50 programs. Plus a coupon good for a 10% discount on my next order.

Quantity	Program Description	# of Disk	# of Cassette
	STORYBOOK FRIENDS: Ages 5–9		
_____	WORD-DRAW: Storybook People and Places	_____	_____
_____	MATH-HUNT: Number Relationships	_____	_____
	AMERICAN THEMES: Ages 8–13		
_____	TEAM-WORK: Social Studies	_____	_____
_____	MATH-HUNT: American Years: Multiplication and Division	_____	_____
	THE WORLD AROUND US: Ages 12–Adult		
_____	WORD-DRAW: Science	_____	_____
_____	MATH-RACE: Powers and Roots	_____	_____
	JUST FOR FUN: All Ages		
_____	PICTURE-PLAY	_____	_____

Total #		Total Amount $
_____	programs on disk @ $24.95 each	_____
_____	programs on cassette @ $19.95 each	_____
_____	Picture-Play, disk @ $19.95	_____
_____	Picture-Play, cassette @ $14.95	_____
	CA residents add sales tax	_____
	Postage and handling	$2.50
	Total	_____

My check or money order is enclosed for $_____

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27 Feb 83 12:59:37 File:ERIC

This search, and the other examples in this column, were all done on February 27, 1983.

Next, I give the computer the words for which I want it to search. It searches through all the information in each record, including the abstract. (You can limit the search to the descriptor terms or title if you prefer.)

SELECT LEARNING DISABILITIES

DIALOG responds:

1 4734 LEARNING DISABILITIES

I've told the computer to select all references about learning disabilities. It gives this set the number 1, so I can refer to it later. The number following the set number shows how many relevant records have been found. I then enter:

SELECT COMPUTER

DIALOG responds:

2 16684 COMPUTER

So now I know that there are 4734 references about learning disabilities and 16684 about computers in the ERIC data base. But what I really want to know is how many are about both computers and learning disabilities. The appropriate command is:

COMBINE 1 AND 2

DIALOG responds:

3 70 1 AND 2

This tells me that 70 references appear in both set 1 and set 2 (i.e., the learning disabled set and the computer set).

DIALOG also allows more complex combinations using OR and NOT. This provides tremendously powerful searching capabilities. I could, for example, further restrict the search to references that are about reading disabilities or language disabilities, while excluding references about hyperactivity. I could also restrict the search to particular years, journals, authors, types of publications, languages, or any combination of these. Since you work on-line with DIALOG, you can expand or restrict the search as you go. For example, if I find more references than I want on a topic, I usually restrict the search to articles published in the last year or two.

Next, I want to see the titles of some of the references:

DISPLAY 3/6/1-5

This command tells the computer to display the references in set 3. The 6 is a code number telling it that I only want to see the titles, not the other information in the record. The 1-5 tells it to display references number 1 through 5. The computer responds with:

1. Remediating Spelling Problems of Learning Handicapped Students Through the Use of Microcomputers.

2. Microcomputers: Powerful Learning Tools with Proper Programming.

3. Microcomputers: An Available Technology for Special Education.

4. How Can Microcomputers Help?

5. Instructional Technology for Special Needs.

Item 3 sounds interesting, and I haven't seen it before. I therefore tell the computer to print the full record:

DISPLAY 3/7/3

This command says display from set 3 the full record (code 7) of item 3. The computer responds with:

Microcomputers: An Available Technology for Special Education.

Joiner, Lee Marvin; and Others

Journal of Special Education Technology, Vol. 3, number 2, pages 37-47. Winter, 1980.

Language: English

Document Type: Journal Article; Teaching Guide

Abstract: The article describes the capabilities of features of basic microcomputer systems and describes special education applications: computer assisted instruction, testing communication, and enhancing personal relations. Problems such as the availability of authoring languages, high quality educational software, and computer safety are described.

My entire search took less than five minutes, most of which I spent examining the titles of articles. I next instructed DIALOG to print all 70 records about computers and learning disabilities, with the citation and abstract for each. To save time and expense, I had this done off-line by high-speed printers at DIALOG and mailed to me. The 25 pages of materials arrived a few days later. I then used DIALOG to order complete copies of several of the articles.

Other Data Bases

ERIC is just one of over 170 data bases available on DIALOG. There are data bases covering the sciences, business, law, current affairs, humanities, books, book reviews, foundations, biographies, patents, dissertations – an incredible array of information. Some of the data bases likely to be of interest to readers of this column are described below.

The *Magazine Index* covers 435 of the most popular magazines in North America, including all those indexed by the *Readers' Guide to Periodical Literature*. It contains over one million records, dating back to 1969. Approximately 12,000 records are added each month. There is also a *National Newspaper Index*.

I was curious about whether magazines have reflected the increase in interest about computers in education during the last few years. I therefore checked the number of articles in the Magazine Index on computers and education for each year from 1976 to 1982. In about two minutes I obtained the following answer:

Year	Computers & Education Articles
1976	2
1977	19
1978	9
1979	27
1980	39
1981	59
1982	145

Clearly, the number of articles has been growing rapidly.

Newsearch is an index of current news stories, information articles, and book reviews from over 1,400 newspapers, magazines, and periodicals. Newsearch is updated daily, so most items are added the day after they are published. At the end of each month, the information is transferred to the Magazine Index, the National Newspaper Index, and other relevant indexes.

The *Books in Print* index contains records on virtually all books published in the United States, including books that have gone out of print in the last few years and books that are to be published in the next few months. A quick check found 6,450 books on computers, 46,478 on education, and 168 about computers and education. There is also a *Book Reviews* index.

The *Microcomputer Index* is a new one which contains citations about the use of microcomputers in business, education, and the home. Magazine articles, as well as software and hardware reviews, new product announcements, and book reviews are included. Over 25 microcomputer periodicals are currently indexed, along with selected articles from other publications. A quick check showed 1,294 articles on education.

The International Software Database is another new one. It contains over 10,000 records on all types of software, classified by application, machine, operating system, vendor and price.

Classroom Instruction

The cost of using the indexes I have described ranges from $25 per hour for ERIC to $95 per hour for Newsearch. The cost of off-line printing is typically 20 cents for each full record. Since DIALOG makes finding information so efficient, I regard it as an excellent value for professional use. DIALOG has also introduced lower-cost special arrangements for schools that want to teach students to use it and for individuals who want to use the system during evenings, nights, and weekends.

The Classroom Instruction Program provides access to most of the DIALOG data bases at a special rate of $15 per hour. This rate is available only to academic institutions for instructional purposes. A special students' workbook is also available.

Knowledge Index is a new service which provides access to the most popular data bases at the reduced price of $24 per hour. It is not available during business hours, so this service is designed mostly for individuals. All the data bases I have described are available, except for Books in Print and Book Reviews. In addition, Knowledge Index includes data bases covering business, agriculture, computers and electronics, engineering, government publications, medicine, and psychology.

DIALOG Information Services, Inc.
3460 Hillview Ave.
Palo Alto, CA 94304
(800) 227-1960 (except California)
(800) 982-5838 (from California)

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Superbaby Meets The Computer

Fred D'Ignazio, Associate Editor

If you haven't seen it already, you should go to a library and find the March 28, 1983, issue of *Newsweek* magazine. Turn to page 62 and read the cover story, "Bringing Up Superbaby." The story is about how parents are pushing their kids to learn earlier and earlier. Kids who are only a few months old are studying art books, gazing at flash cards, doing toddler gymnastics, going to dance class, putting together puzzles, taking swimming lessons, and *learning how to compute*. In the article there's a picture of a little kid who is pounding away on the keyboard of an IBM Personal Computer.

Just a few years ago, Elizabeth Wall (a media specialist in Sarasota, Florida, and author of *The Computer Alphabet*, Avon, 1983) sat down next to one of the pioneers of personal computing. He asked her what she was up to. "Teaching elementary school kids how to use computers," she told him. He was shocked. "There's no future in teaching little kids computers," he said. "They will never get the hang of it."

Since that expert made his remark, use of computers has dribbled downward, from college to high school kids; from high school kids to middle schoolers; from middle schoolers to kids in elementary school – and beyond.

In Bruce and Diane Mitchell's Small World preschool and kindergarten, in Durham, North Carolina, four-year-olds and five-year-olds are playing educational games on Atari computers and Timex Sinclairs. They are programming a Turtle robot by tapping on the keyboard of an Atari 800.

But preschoolers and kindergartners are old. They're almost over the hill! The *Newsweek* article mentioned a school called Tiny Bytes where kids can begin computing before they've celebrated their first birthday.

Computer Literacy Or Else

Some toddlers are going to be victimized by pushy parents trying to fill their offsprings' "little sponges" with computer facts even before they've learned to walk or talk. I can imagine an "enlightened" household where the parents are trying to give their three-month-old an early start on her way to a high-tech future. The baby, blithely unaware of her parents' designs, is reaching for a rubber ducky. The mother pushes the duck away. "Too easy," she says. She whips out a stack of big white flash cards. "Let's practice these first, then you can see the duck on your lunch break." As the baby gazes sweetly at her mother, the mother runs through the flash cards. "RAM!" she calls out. "RAM .. R .. A .. M .. RAM! BIT! .. B .. I .. T .. BIT! CHIP! .. C .. H .."

One wonders what a kid who gets computer flash cards at three months is going to be like when she gets to the ripe old age of five years, or ten, or fifteen. She may have a lot of computer facts under her belt, but how well adjusted will she be? What will be the result of all this parental prodding?

This is not to say that computers shouldn't be introduced to kids who are still wandering around the house in dirty diapers. Because they should be!

The question is *how*.

Parents who are pushing their babies and toddlers into computer literacy are missing the point – at least as far as computer literacy is defined. We are presently in the Age of Computer Literacy. But we are quickly moving beyond it.

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Pretty soon it will not be productive for us to study such arcane terms as *bit, byte,* and *CPU*. We won't have to know how a computer works, just how to work a computer. We will be leaving the age of computer literacy and entering the Age of Computer *Intimacy*.

Take the TV or the car. These are high-tech machines that are part of almost every little kid's environment, right from birth. Do parents go around with flash cards with words like CHANNEL SELECTOR or PHOSPHOR SCREEN? Or with words like CARBURETOR or PISTON? Of course not. Nevertheless, the smallest children learn how to operate TVs, almost before they can walk. And little kids play with model cars, toy cars and trucks, all through their childhood. And when their magic birthday arrives and they can get their driving license, they quickly learn to drive and operate an automobile.

How many kids suffer from automobile anxiety or TV phobia? Very few.

Even more important, how many kids can expect to find a job when they grow up as an automobile mechanic or an expert in TV repair? Again, very few.

Yet TVs and cars are far more common than personal computers.

The point is that we have moved beyond "TV literacy" and "automobile literacy" to a new age of intimacy with both these machines. The technologies have matured. They are black boxes, idiot boxes that almost anyone can learn how to use. They're everywhere. We're comfortable with them in our garages, our living rooms and bedrooms.

This is where computers are headed, too. They've just started, but, at the speed they're going, it won't take long. By the end of the 1980s, computers will be black boxes, just like cars and TVs. They will be in most people's homes. They will become so common that they will cease being an eye-catching phenomenon. In fact, they will almost be invisible. Like electric motors, they will slip into other appliances and disappear from view.

Kids who are less than one year old in 1983 will be less than seven in 1990. So why are parents teaching them computer literacy terms and concepts, preparing them for a job market that exists in 1983, but will change radically even before the kids have made it through elementary school?

Parents are pushing because they are panicking. The swift pace of computer technology has them running scared.

And they are pushing their kids because of the status of having them say "floppy disk" as their first word.

What they don't realize is that they are training their kids in what will soon be an obsolete technology and, worse, an obsolete approach to technology. They are being trained to become the automobile mechanics and TV repairpersons of the 21st century. These are honorable professions. But is this what the parents intend?

Computer Osmosis Vs. Computer Bullying

Millions of personal computers are going into people's homes. Millions and millions of little children are waking up each morning and walking or being carried past computers on their way to their bottle, their Boo Berries, or baby cereal. For them, computers are no more wondrous or rare than the floor lamp, vacuum cleaner, or telephone. They're just one of the many things that "belong" in their lives. They have a place, along with everything else.

This is exactly as it should be. Computers *are* a big deal to us. And our kids will see that. When we spend all night in front of a keyboard trying to debug a program or escape from the wizard's castle in an adventure game, they'll notice. If we shout and point at the new computer and say "Gee whiz!" and "Oh, gosh!" enough times, they'll notice. And if we get frustrated with the computer and begin saying unkind things to it or give it a good bop, they'll notice that, too. Whether positive or negative, our kids will pick up on the attention we give to computers and the amount of emotional involvement we have with them. Kids are very sensitive about this sort of thing.

Growing Up Together

You and I are already grown. We're big people. But computers and kids haven't stopped growing. In fact, they've just begun. Both are going to change rapidly over the next 20 years.

At the end of that 20 years, what will they be like?

We imagine that our kids will end up pretty much like us. But how about computers? When kids enter the job market in the late 1990s or early 21st century, what will computers be like?

According to experts, we are quickly entering a new era of personal computers. I call this era the Age of Computer Intimacy. Others call it: The Age of User Friendliness. The Age of Forgiving Systems. The Age of Easy Computing. The Age of Humanlike Machines.

As anyone who has struggled with a cranky program recorder, or with a cryptic BASIC error message, or with computer cables, plugs, and connections knows, we have not reached computer heaven yet. Far from it!

But we are moving closer. While at the West Coast Computer Faire in San Francisco, I attended a seminar on "Second Generation PC Software." It was mind-boggling.

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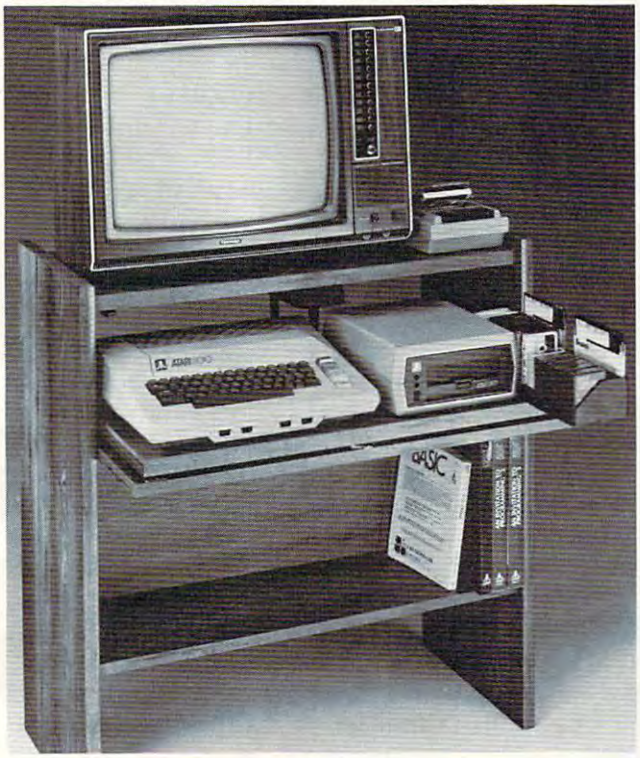

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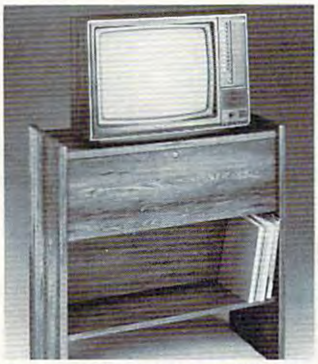

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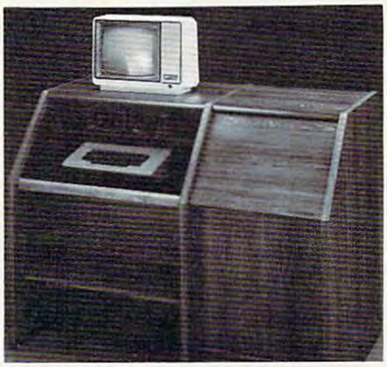

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Both the CS-1632 and CS-2748 ship unassembled in two cartons. Assembly requires only a screwdriver, hammer, and a few minutes of your time.
Choice in simulated woodgrain of warm golden oak or rich natural walnut finish.

The two slide-out shelves put the keyboard at the proper operating height while allowing easy access to the disk drives.
The bronze tempered glass door protecting the keyboard and disk drives simply lifts up and slides back out of the way during use.
Twist tabs on the back of the center panel allow for neat concealed grouping of wires while a convenient storage shelf for books or other items lies below.
The printer sits behind a fold down door that provides a work surface for papers or books while using the keyboard. The lift up top allows easy access to the top and rear of the printer. A slot in the printer shelf allows for center as well as rear feed printers.
Behind the lower door are a top shelf for paper, feeding the printer, and a bottom shelf to receive printer copy as well as additional storage.
Stand fits same computers as the CS-1632 as well as the Apple I and II, IBM-PC, Franklin and many others.
The cabinet dimensions overall: 39-1/2" high x 49" wide x 27" deep.
Keyboard shelf 20" deep x 26" wide. Disk drive shelf 15-34" deep x 26" wide. Top shelf for monitor 17" deep x 27" wide. Printer shelf 22" deep x 19" wide.

HYTEC SYSTEMS

I learned that if you have enough money, you can buy computer programs and computers that are really, truly friendly. They hold your hand. They speak English (most of the time). They help you out of tight spots. They remind you of what you are supposed to be doing when you get lost.

And, boy, are they powerful! With just one package, one electronic mouse, and 45 windows, you can figure out your income tax, send electronic mail, draw pie charts and bar charts, do word processing, and file, sort, and retrieve records. All with the same set of commands.

At present, these systems are extremely expensive. Only the folks who carry around Pierre Cardin calculators can afford them: But computers, in general, used to be this way, too. Only wealthy, technically sophisticated organizations (universities, large corporations, the government, and the military) could afford them. But computers have come a long way. Now you can buy a programmable computer for under 60 dollars. Pretty soon the price will be even lower, and the computer will be more powerful and easier to use.

The new generation of "easy" computers and "friendly" computer software is coming. And it will include machines and programs that we can all afford.

What Do We Tell Our Kids?

If we're not supposed to tell our children (and babies) about bits and bytes, then what do we tell them?

Nothing is okay. Unless they ask. Or unless you're so excited about something neat that you just feel like babbling.

Just have a computer around the house. That's enough. Treat it like you'd treat a typewriter, a telephone, or a calculator. *But let your kids touch it.* That's the best way for them to learn. For example, my four-year-old son, Eric, drives me crazy when he uses a computer. He has grimy, dirty fingers. He presses buttons in such a way as to make a computer act like an amnesiac. But he loves to play on the computers because he is allowed to play freely. And (with quiet wincing and cringing) I let him. One of his favorite games is filling up the picture screen with graphics symbols, multicolored bars (using color keys and the reverse-video button), and random letters, numbers, and punctuation symbols.

Another of his games is to use the computer as a Gobbledygook Processor (that's "GP"). He types all sorts of strange looking words like

IXCCY##559 ISK ERIC !!!!! AAAAAAAAAAAA

then sends them to the computer's printer. He rips off the printer paper (in the same lavish, boisterous way he handles toilet paper) and tapes it up around the house as a sign of who knows what. Or he stuffs a wad of it in an envelope, and it becomes a letter. Or he gives it, as a gift, to me, to his mother, his sister, his kitty, or his toy robot, Denby.

A Tool Or A Crutch?

Actually, there's more to computer education than this. Our responsibility as parents (and teachers) extends beyond just making computers available to our children. Much further, in fact.

When our youngest children start entering the job market, in another 15 to 20 years, *all* computers will be "easy" computers; *all* programs will be "friendly." Computers and programs will also be a lot more intelligent than they are now. There will be a tremendous temptation to let computers take over many of the thinking chores that we humans find bothersome, tiresome, boring, or too difficult. At some point, for many people, the computer will cease to be a support and start to be a crutch.

Our responsibility, as parents and teachers, is to teach our children the value of using computers in the proper way: to help them do their *own* thinking.

What Do You Think?

What do *you* think? How early should kids begin learning about computers? What should be the role of parents (and teachers)? What should kids learn? How should they learn it?

Please send your ideas and comments to me:

Fred D'Ignazio
2117 Carter Road, SW
Roanoke, VA 24015

I'll return to this subject in a future issue of **COMPUTE!**, and I'll reprint a number of your letters.

New Resources

A book has just been published for parents of older children (ages nine and up) who are interested in computers. I recommend the book because it is a practical guide to the technology *as it exists today*. If you want to launch yourself and your family into computing today (and you should), then you need a survival manual. The best survival manual of all is this magazine (**COMPUTE!**), with all its tutorials, articles for beginners, practical programming tips, and actual programs for you to copy into your machine. But, if you're a parent, you should also take a look at:

Eugene Galanter, *Kids and Computers: The Parent's Microcomputer Handbook* (Perigee Books, The Putnam Publishing Group, 200 Madison Avenue, New York, NY 10016; $7.95; Paperback; 7-page index; 190 pages)

Sample chapters: Microcomputers and Your Child; What Is a Microcomputer?; The Microcomputer's Parts; Programming by, for, and with Children; Running the Machine; Kids Can Write Programs; Evaluating Computer Education.

The author, Eugene Galanter, has been teaching kids about computers for several years. You can write his school for additional information or to ask him specific questions about kids and computers:

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How To Create A Data Filing System

Part I. Choosing The Right File Type

Jim Fowler

It's always a good idea to analyze your data storage problems and plan your solution carefully before you start programming. This article begins a four-part series on writing a data file/retrieval system for any computer.

Remember how your disk drive was going to solve your data storage problems? All those address cards, recipe files, inventories, and accounts were somehow going to become organized and never frustrate you again. It *can* happen, but you will have to do some thinking about the problem before you solve it satisfactorily.

Of course, the commercial data base systems can serve you very well, but you ought to know something about such systems before you spend money for features you may never use. It is not impossibly hard to write a program that does everything you want. I have lived through a couple of such projects so maybe I can point out areas to think about and where you might take a wrong turn.

Planning is the name of the game. I can recommend writing your own system. If you like programming, you can easily develop a system that fits your needs, and you will know it well enough to alter it when you need to make changes. One thing to keep in mind as you plan is that once you begin to put the data on a disk you are, in a sense, a hostage to your own work. The more time you have spent typing in the data, the more reluctant you will be to start over. So *plan ahead*.

Another bit of advice – automation is not automatically a good thing. If you have a recipe card file with the cards filed under a few headings ("salads," "desserts," "meats," etc.) and if there are only 30 or so cards in each section, you can probably find the one you want faster by flipping through the cards by hand. I remind you of that eternal verity: "If it works, don't fix it."

Pick Your Goals

The first step is to draw up a list of what you want. Actually write down what you hope a session with the file would be like: you turn on the computer, insert the disk, sit down to the keyboard, then what? Do you want a long list printed out (address labels?) or are you going to look for a needle in a haystack, such as the one record with exactly the right data to match your needs? It is well worth writing such scenarios several times on different days.

Another important consideration is flexibility. Whenever you are faced with a choice, always pick the one that gives you the greatest future flexibility. Of course, most of your choices will be made for you by the necessities of your data, your hardware, its operating system, etc. But keep flexibility in mind. This applies to every feature of your system – the number of records you expect to store, the amount of information in each, the "keys" you might use to retrieve records, and so on.

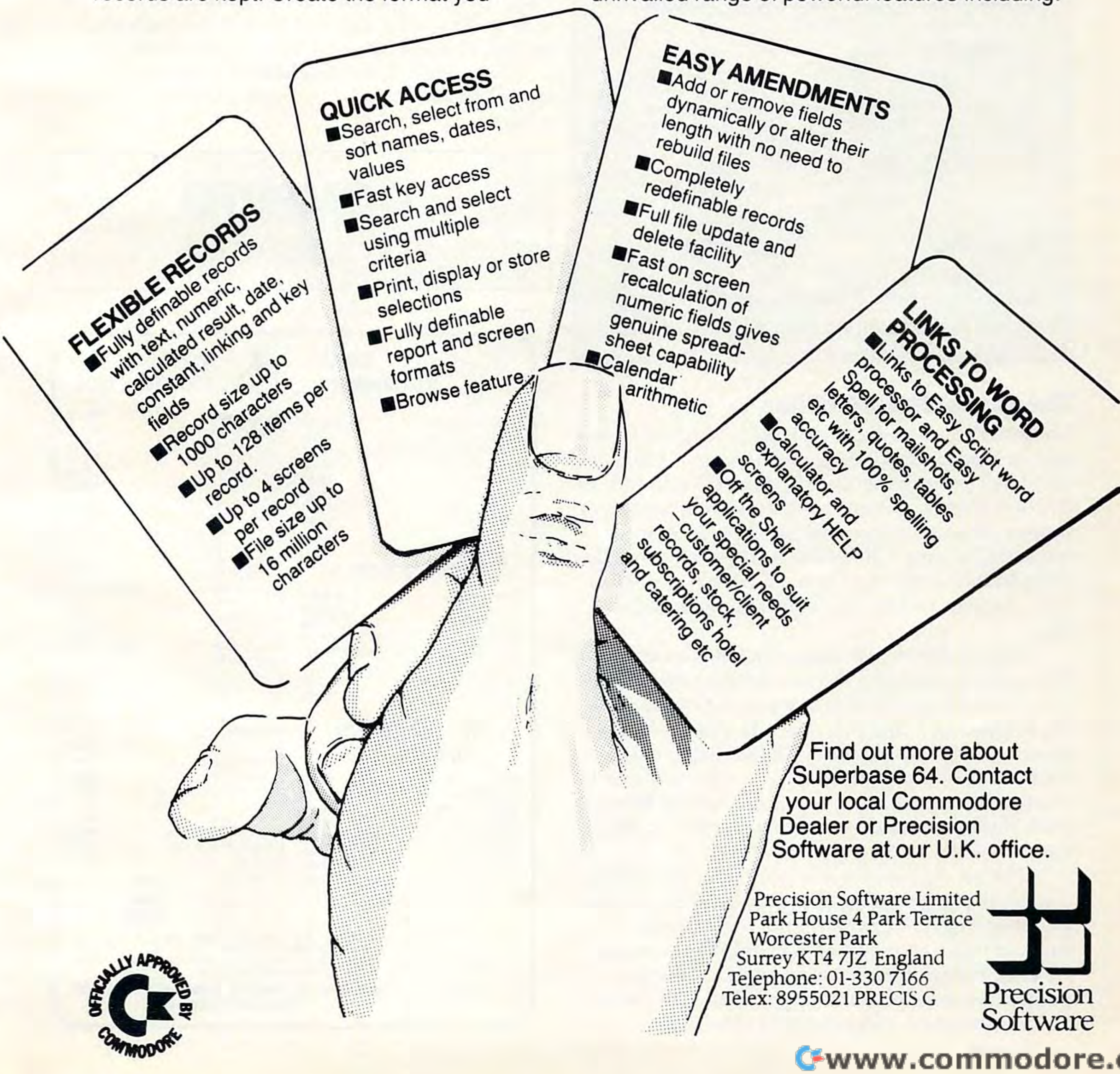
The *key* for an address file which is organized alphabetically by last names would be the last names of each entry. The key allows for quick searches and for sorting and entering new items into the proper order.

Finally, go to great lengths to make your system easy to use. It is so tempting to short-cut some tedious programming by saying to yourself, "Oh well, I can always remember that hitting RETURN without any input will drop me out of the program. After all, I've been running this machine for awhile, and I don't make that mistake any more."

The important thing about data file systems is that you enter and retrieve records hundreds of times. A small stone in your shoe is no big deal if you are sitting down, but walk a few miles and see how important it gets! A small annoyance in a program is tolerable if you only encounter it once

Strengthen your hand with Superbase 64

The complete information control system for the Commodore 64. Ideal for any home, business or professional environment where records are kept. Create the format you need and enter your records. If the layout or data field sizes are not quite right, correct them and carry on. Superbase gives you an unrivalled range of powerful features including:



Find out more about Superbase 64. Contact your local Commodore Dealer or Precision Software at our U.K. office.

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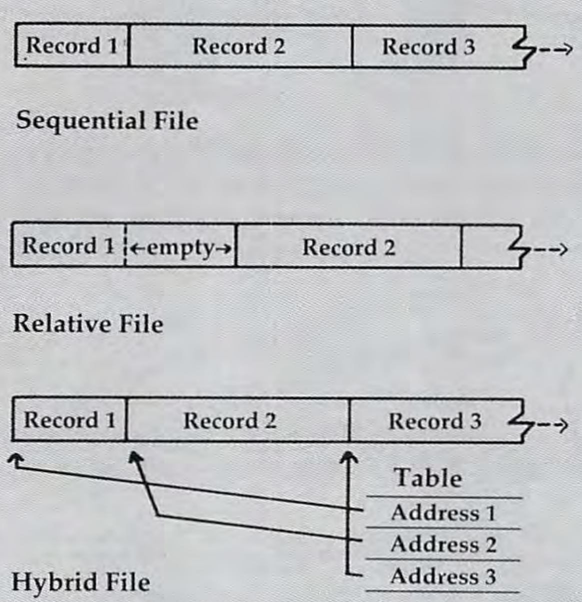
in a while, but in a data entry or retrieval operation it can doom the whole system. Many a card file has been restored to active duty because, for reasons like these, its owner got fed up with automation. So, be prepared to go to great lengths to make life easy for the user.



The three types of files. Record 1 is shown as if it is only half as long as Record 2.

The Three Kinds Of Files

There are three kinds of disk files. The first is one you probably already know, a *Sequential File*. All the data is strung together head to tail and put on the disk that way. Your programs are recorded on tape or disk in a sequential file. If you use a sequential file, you will need to put separators (called *delimiters*) of some kind between items of data so that you know where one ends and the next begins.

One problem with sequential files arises when you want to change a record and the new one is of a different length. It is like putting books on a shelf: take out a thin one and put a fat one in its place – you'll have to move all the rest to make room. If you rarely make any changes, it might be worthwhile just erasing the old record by filling it with blanks and adding the new version at the end.

The second kind is a *Relative File*. This is like a series of pigeon holes. One may be filled, another partially empty, but you do not have to move them to make room when you enlarge a record. As long as each hole is big enough to take the biggest record, you have no problem. This is the kind I use for my most complex data file.

The third kind is a sequential file, but with a "Table of Contents" like the directory on a disk. Call it a *Hybrid File*. To use this kind takes a lot of programming. I cannot recommend it unless the saving in space is much greater than the space taken by the extra programming and the table. Only big professional systems are likely to go this route.

The figure diagrams the three file types. If your disk operating system supports relative files (also called *random-access files*), you will probably want to use that kind unless you are going to be very short of space on the disk. If your system doesn't automatically support relative files, you can make your program do it. Keep a table or use a formula which turns a record number into its "address" on the disk – its track and sector. Then you read or write a record directly by track and sector. This is a bit complicated, but worth doing.

Next month, we will look at methods of retrieval and how they can affect the way you keep records. ©

How To Make Backup Disks For VIC And 64

Harvey B. Herman, Associate Editor

LOAD, switch disks, SAVE, LOAD, switch, SAVE – it can be cumbersome and tedious to make backups of disks when you don't have a dual disk drive. What's worse, you need to go through special extra steps to transfer machine language programs. This utility, for any 64 or expanded VIC, makes creating safe backups on single disk drives nearly automatic.

I recently purchased a 1541 disk drive for my expanded VIC. The diskette that came with it included a few sample programs. Conspicuous by its absence, however, was a program to make duplicate copies of diskettes for *backup* purposes. I have learned the hard way that diskettes do not last forever and it is foolish to have only one copy of important programs.

What do to? Well, I was lucky to have acquired an excellent backup program for the Commodore 2031 single disk drive (written by Jim Law and Keith Hope and distributed by the Toronto PET User's Group). I adapted this program to work on the Commodore 64 and expanded VIC-20 computers. One program works for both. The modifications in the original program were quite modest – a few PEEKs and POKEs were changed, and the machine language portion was relocated to the cassette buffer and POKEd in from DATA statements.

The program is quite easy to use; no knowledge of machine language is necessary. First, the destination diskette is formatted, a good idea if you will be using it later on the same drive. Please be careful to format only blank diskettes, or ones that are no longer needed. Next, the diskettes are swapped and the source diskette is read to determine how much to copy. Successive blocks are then read from the source into the available computer memory. (I can read 124 blocks on the Commodore 64 and proportionately less on the expanded VIC, which has less memory.) The diskettes are swapped again, and identical blocks on the destination disk are written from data saved in memory. The swapping of source and destination diskette continues, until the entire diskette has been copied.

Of course, it would be easier (but not much faster) if a second drive were available. However, this program is the next best thing. It surely beats loading and saving BASIC programs, one at a time, or finding the loading address of machine language files. Try *that* sometime if you doubt it.

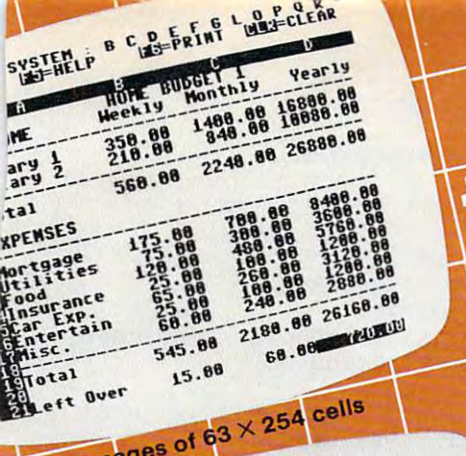
One caution – the program will not work on an unexpanded VIC. I have added 24K of RAM, by means of the Cardboard, and this minimizes swapping. Much less than 16K may not be practical, as too few blocks are copied in one swap. Obviously, the Commodore 64 does not have this problem.

If you want to save the trouble of typing this in, I will make a copy for you on cassette or diskette (1540/1541 format) for $3. Just send me the medium, a self-addressed mailer, and proper postage. If you have any questions please enclose an SASE. My address is:

Harvey B. Herman
Chemistry Department
UNC-Greensboro
Greensboro, NC 27412

VIC/64 Disk Backup

```
1 FORI=828TO883:READA:POKEI,A:NEXTI
10 REM"D=DSAVE"@BACK2",D0:?DS$:CATALOGD0
20 BB=PEEK(44)+27:POKE995,BB
30 POKE998,PEEK(55):POKE999,PEEK(56):POKE
   55,0:POKE56,BB:CLR
40 BB=PEEK(995)
50 N=PEEK(999)-BB-1:BA=BB*256:MA=828
60 DIMBM%(35,24)
70 FORJ=0TO7:TA(J)=2↑J:NEXT
80 PRINT"{CLEAR}{03 RIGHT}{REV}BACKUP 154
   1{OFF}"
```



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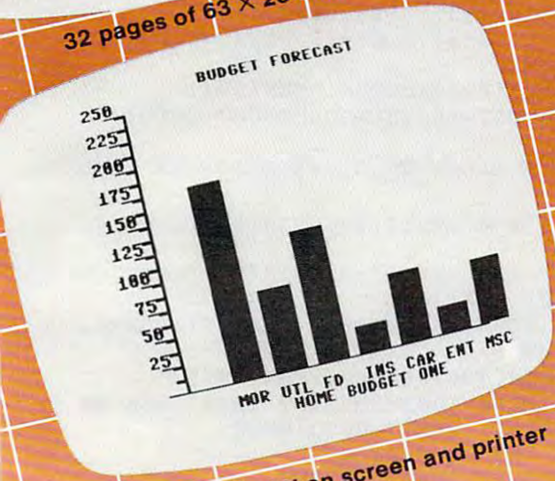

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```
90 PRINT"{DOWN}'GOTO10000' IF PROGRAM QUI
   TS ABNORMALLY"
100 PRINT"{DOWN}"N"BUFFERS AVAILABLE"
110 OPEN1,8,15
200 REM *** MAIN FUNCTIONS ****
210 GOSUB1000
220 D$="S":GOSUB3200:I2$=IR$
230 IFDR$<>"2A"THENPRINT"{REV}ILLEGAL DOS ~
   1.0 DISK{OFF}":GOTO10000
240 IFI2$=I1$THENPRINT"{REV}SOURCE AND DES
   TINATION HAVE SAME ID CODE{OFF}":
   GOTO10000
250 GOSUB2500
260 T=TS:S=0:NU=1:T1=T:S1=S
270 PRINT#1,"I0":OPEN3,8,3,"#"
280 PRINT"READING BLOCK #";
290 IFBM%(T1,S1)=0THENGOSUB2000:NU=NU+1:IF
   NU>NTHEN320
300 S1=S1+1:IFS1>20THENS1=0:T1=T1+1
310 IFT1<TF+1THEN290
320 PRINT"{DOWN}"
330 CLOSE3
340 D$="D":GOSUB3200:IFIR$<>I1$THENGOTO340
350 PRINT#1,"I0":OPEN3,8,3,"#"
360 PRINT"WRITING BUFFER #";
370 NU=1:T1=T:S1=S
380 IFBM%(T1,S1)=0THENGOSUB2200:NU=NU+1:IF
   NU>NTHEN410
390 S1=S1+1:IFS1>20THENS1=0:T1=T1+1
400 IFT1<TF+1THEN380
410 PRINT"{DOWN}"
420 CLOSE3
430 S=S1+1:IFS>20THENS=0:T1=T1+1
440 T=T1:IFT>TFTHEN500
450 D$="S":GOSUB3200:IFIR$<>I2$THEN450
460 NU=1:T1=T:S1=S:GOTO270
500 REM FINISHED XFERS
510 CLOSE1
520 POKE55,PEEK(998):POKE56,PEEK(999):CLR
530 PRINT"{02 DOWN}BACKUP COMPLETE"
540 OPEN1,8,0,"$0"
550 GET#1,A$:IFA$<>"{REV}"THEN550
560 PRINTA$;:GOTO610
570 GET#1,A$:SS=ST:A=LEN(A$):IFATHENA=ASC(
   A$)
580 GET#1,B$:SS=ST:B=LEN(B$):IFBTHENA=ASC(
   B$)
590 IFSSTHEN660
600 IFA=1ANDB=1THENGOSUB630
610 GET#1,A$:IFA$=""THENPRINT:GOTO570
620 PRINTA$;:GOTO610
630 GET#1,A$:SS=ST:A=LEN(A$):IFATHENA=ASC(
   A$)
640 GET#1,B$:SS=ST:B=LEN(B$):IFBTHENB=ASC(
   B$)
650 N=B*256+A:PRINTN;:RETURN
660 CLOSE1
670 END
1000 REM HEADER DEST DISK
1010 PRINT"{DOWN}INSERT DESTINATION DISK TO
   BE FORMATTED"
1020 INPUT"{02 DOWN}DISK NAME{03 RIGHT}_    ~
            {19 LEFT}";DN$
1030 IFDN$="_"THENPRINT"{03 UP}";:GOTO1020
1040 IFLEN(DN$)>16THENCLR:GOTO40
1050 F=0:FORJ=1TOLEN(DN$):S1$=MID$(DN$,J,1)
1060 IFS1$="_"ORS1$=CHR$(34)THENF=1
1070 NEXTJ:IFFTHENPRINT"{03 UP}";:GOTO1020
1080 INPUT"{DOWN}UNIQUE DISK ID{03 RIGHT}_  ~
                  {23 LEFT}";I1$
1090 IFI1$="_"THENPRINT"{02 UP}";:GOTO1080
1100 IFLEN(I1$)<>2THENPRINT"{02 UP}";:GOTO1
 080
1110 PRINT#1,"N0:"+DN$+","+I1$
1120 GOSUB3000
1130 IFERTHENPRINTER$:GOTO10000
1140 RETURN
2000 REM READ BLOCK T1,S1 TO BUFFER # NU
2010 C=.
2020 PRINT#1,"U1";3;0;T1;S1
2030 GOSUB3000:IFNOTERTHEN2060
2040 C=C+1:IFC<3GOTO2020
2050 PRINTER$:FORJ=(BB+NU)*256TO(BB+NU)*256
   +255:POKEJ,.:NEXTJ:GOTO2100
2060 PRINT#1,"B-P";3;0
2070 IFNU<>0THENPRINT"    {03 LEFT}";RIGHT$(
   "  "+STR$(NU),3);"{03 LEFT}";
2080 POKE996,PEEK(3):POKE997,PEEK(4):POKE4,
   BB+NU:SYSMA
2085 POKE3,PEEK(996):POKE4,PEEK(997)
2090 IFST<>.ANDST<>64THENGOSUB3000:GOTO2050
2100 RETURN
2200 REM WRITE BLOCK T1,S1 FROM BUFFER # NU
2210 C=.
2220 PRINT#1,"B-A";0;T1;S1:PRINT#1,"B-P";3;
   0
2230 PRINT"    {03 LEFT}";RIGHT$("  "+STR$(N
   U),3);"{03 LEFT}";
2240 POKE996,PEEK(3):POKE997,PEEK(4):POKE4,
   BB+NU:SYSMA+3
2245 POKE3,PEEK(996):POKE4,PEEK(997)
2250 IFST<>.ANDST<>64THENPRINT"{REV}IEEE WR
   ITE ERROR"ST"{OFF}":GOTO10000
2260 PRINT#1,"U2";3;0;T1;S1
2270 GOSUB3000:IFNOTERTHEN2300
2280 C=C+1:IFC<3THEN2260
2290 PRINT"{REV}UNRECOVERABLE WRITE ERROR"E
   R$:GOTO10000
2300 RETURN
2500 REM GET BAM TO BM%(T,S)
2510 TS=1:TF=.
2520 PRINT#1,"I0":OPEN3,8,3,"#"
2530 S9=0
2540 PRINT"{DOWN}TRACK #   BLOCKS TO XFER"
2550 PRINT"########################"
2560 NU=0:T1=18:S1=0:C0$=CHR$(.):GOSUB2000
2570 BY=4
2580 T%=(BY-4)/4+1
2590 PRINT"  ";T%;
2600 IFPEEK(BA+BY)=.THENFORJ=.TO20:BM%(T%,J
   )=.:NEXT:BY=BY+4:GOTO2650
2610 S=0
2620 BY=BY+1:A0=PEEK(BA+BY):FORJ=.TO7:BM%(T
   %,S)=A0ANDTA(J):S=S+1:NEXT
2630 IFS<22THEN2620
2640 BY=BY+1
2650 ES=21:IFT%>17THENES=19
2660 IFT%>24THENES=18
2670 IFT%>30THENES=17
2680 FORJ=ESTO24:BM%(T%,J)=-1:NEXT
2690 SM=.:FORJ=.TO20:IFBM%(T%,J)=.THENSM=SM
   +1
2700 NEXT:PRINT TAB(12);SM:S9=S9+SM
2710 IFSM=.ANDTS=T%THENTS=TS+1:GOTO2730
2720 IFSM<>.THENTF=T%
2730 IFBY<143THEN2580
2740 CLOSE3
2750 PRINT"START =";TS;" FINISH =";TF
2760 PRINT"{DOWN}A TOTAL OF";S9;"BLOCKS TO ~
   XFER"
2770 S8=90+25+(.650+.980)*S9
2780 S7=INT(S8/60):PRINT"APPROX";S7":"INT(S
   8-S7*60);"FOR COPY"
2790 RETURN
3000 REM READ ERR CH TO ER,ER$
3010 INPUT#1,E0$,E1$,E2$,E3$:ER$=E0$+","+E1
```

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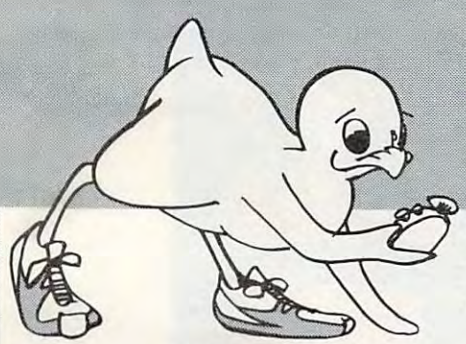

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```
      $+","+E2$+","+E3$
3020 ER=LEN(E0$):IFERTHENER=VAL(E0$)
3030 RETURN
3200 REM INSTRUCT TO SWAP TO DISK GIVEN IN ~
     D$
3210 IFD$="D"THENS1$="DESTINATION":GOTO3230
3220 S1$="SOURCE"
3230 PRINT"{DOWN}INSERT ";S1$;" DISK, PRESS
      {REV}SPACE{OFF}"
3240 GETA$:IFA$<>" "THEN3240
3250 OPEN2,8,0,"$0"
3260 GOSUB3000:IFER>0THEN10000
3270 FORJ=1TO26:GET#2,A$:NEXTJ
3280 GET#2,A$:GET#2,B$:IR$=A$+B$
3290 GET#2,A$:GET#2,A$:GET#2,B$:DR$=A$+B$
3300 CLOSE2:RETURN
10000 REM DROP OUT
10010 POKE55,PEEK(998):POKE56,PEEK(999):
      CLR:STOP
15000 DATA 76,66,3,76,91,3,162,3,32,198,255,
    160,0,132,3,32,207,255,145
15010 DATA 3,165,144,208,3,200,208,244,32,
      204,255,96,162,3,32,201,255,160
15020 DATA 0,132,3,177,3,32,210,255,165,144,
      208,3,200,208,244,32,204,255,96
```

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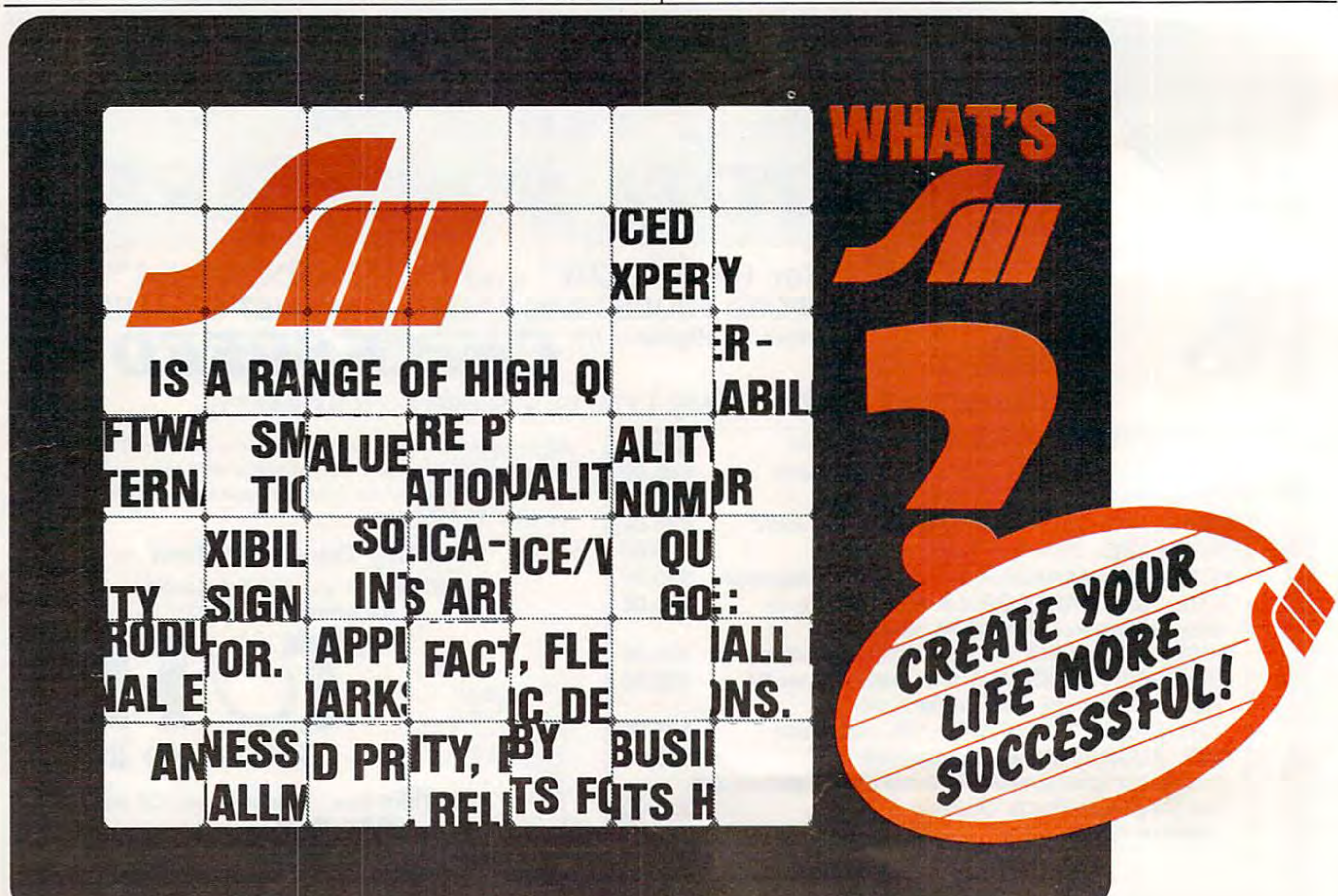

CIRCLES

Jeffrey S. McArthur

Every Atari graphics programmer needs to draw circles. This tutorial will show you how to draw a circle – and draw one fast – without jumping through hoops. There are several drawing utilities here, from an elementary BASIC routine which takes 60 seconds to a machine language version that finishes in a fraction of a second. Even if you're not interested in the methodology, you can still use these subroutines in your graphics and games.

Program 1 draws circles, but takes more than a minute to draw a circle, no matter how big or small it is.

Reflections

A circle is symmetrical, so why don't we take advantage of its symmetry? If we know the value of one point, we can reflect it across the X-axis or across the Y-axis. That is, if we know (X,Y) is a point on the circle, then so is (X,-Y). The same is true for (-X,Y) and (-X,-Y). So we have to do only a quarter of the work. Circles are also symmetrical along the X=Y line. If we know (X,Y) is on the circle, then so is (Y,X). Now we have to find only an eighth of the points. Program 2 uses that method.

Unfortunately, even doing only one-eighth of the work, we still need more than ten seconds to draw the circle. Perhaps there is a better way. Instead of using sines and cosines, use the equation:

X*X + Y*Y = R*R

That isn't very useful, but we can rearrange the equation and get:

Y = SQRT (R*R - X*X)

So all we have to do is find Y for X= -R to R. However, since the square root function returns only the positive square root, we also have to plot the negative square root. Program 3 is an example of how to do that. This method is faster than using sines or cosines, but it still takes more than 16 seconds. So using Program 4, we reflect it, like we did in Program 2.

Now we have a method that takes only five seconds on a large circle and is a lot faster on the smaller ones. If you take a close look at how Program 4 draws the circle, you see it draws lines of different lengths. This method works fine on a screen, but on a plotter the circle has flat spots.

A Faster Circle

The screen is made up of an array of points. Each point is addressed by two coordinates (X,Y). However, X and Y are *always* integers. In Atari BASIC you can PLOT 0.5,0.5, but the points are rounded to integers. So if you are at one point on the circle and are trying to figure where the next point is, you can go in eight directions.

If you divide the circle into quarters, then only three of those directions are valid. If you divide the circle into eight parts, you can go in only two directions. For example, if you are on the circle at (R,0), the next point is either (R-1,0) or (R-1,1). This method is called a *potential function*. Since the screen cannot plot points except with integers, there is a small error that is not always equal to zero.

We want to keep the error as small as possible. We also reflect it eight ways as before. That takes only three seconds, and we never have to draw any long lines. Program 5 uses this method.

Notice also that you can achieve the entire result using only addition and subtraction. Such programs can be easily converted to machine language since we don't have to multiply or divide. Program 7 is a machine language program to draw a circle. Program 6 calls the machine language and takes less than two-tenths of a second to draw a circle.

The machine language is called by a USR function. The parameters that are passed to it are, in order: the address of the code, the X coordinate of the center of the circle, the Y coordinate of the center of the circle, the radius, and the mode of drawing. The mode of drawing means

0: turn point off
1: turn point on
2: invert point

The program can be converted to any 6502 machine. The only things that need to be changed are where the variables are stored and how to plot the points.

The only problem with the machine language program is that it does no checking to see if the circle goes off screen. And no clipping is done. Therefore, if your circle goes off screen, you will write over other memory.

Program 1: Sines And Cosines

```
100 REM CIRCLE DEMONSTRATION
110 REM PROGRAM #1
140 REM THIS METHOD TAKES APPROXIMAT
    ELY 61 SECONDS
200 DEG
210 GRAPHICS 8
220 COLOR 1
230 SETCOLOR 2,Ø,Ø
240 A=16Ø
250 B=8Ø
260 R=5Ø
300 FOR ALPHA=Ø TO 36Ø
310 X1=INT(R*COS(ALPHA)+Ø.5)
320 Y1=INT(R*SIN(ALPHA)+Ø.5)
330 PLOT A+X1,B+Y1
340 NEXT ALPHA
```

Program 2: Sines And Cosines Reflected

```
100 REM CIRCLE DEMONSTRATION
110 REM PROGRAM #2
140 REM THIS METHOD TAKES APPROXIMAT
    ELY 11 SECONDS
200 DEG
210 GRAPHICS 8
220 COLOR 1
230 SETCOLOR 2,Ø,Ø
240 A=16Ø
250 B=8Ø
260 R=5Ø
270 PLOT A+R,B
300 FOR ALPHA=Ø TO 45
310 X1=INT(R*COS(ALPHA)+Ø.5)
320 Y1=INT(R*SIN(ALPHA)+Ø.5)
330 PLOT A+X1,B+Y1
340 PLOT A-X1,B+Y1
350 PLOT A+X1,B-Y1
360 PLOT A-X1,B-Y1
370 PLOT A+Y1,B+X1
380 PLOT A-Y1,B+X1
390 PLOT A+Y1,B-X1
400 PLOT A-Y1,B-X1
410 NEXT ALPHA
```

Program 3: Square Root

```
100 REM CIRCLE DEMONSTRATION
110 REM PROGRAM #3
140 REM THIS METHOD TAKES APPROXIMAT
    ELY 17 SECONDS
210 GRAPHICS 8
220 COLOR 1
230 SETCOLOR 2,Ø,Ø
240 A=16Ø
250 B=8Ø
260 R=5Ø
270 XØ=-R:YØ=Ø
300 FOR X1=-R TO R
310 Y1=INT(Ø.5+SQR(R*R-X1*X1))
330 PLOT A+XØ,B+YØ:DRAWTO A+X1,B+Y1
335 PLOT A+XØ,B-YØ:DRAWTO A+X1,B-Y1
336 XØ=X1:YØ=Y1
340 NEXT X1
```

Program 4: Square Root Reflected

```
100 REM CIRCLE DEMONSTRATION
110 REM PROGRAM #4
140 REM THIS METHOD TAKES APPROXIMAT
    ELY 5 SECONDS
210 GRAPHICS 8
220 COLOR 1
230 SETCOLOR 2,Ø,Ø
240 A=16Ø
250 B=8Ø
260 R=5Ø
270 XØ=-R:YØ=Ø
280 X1=-R
290 Y1=INT(Ø.5+SQR(R*R-X1*X1))
300 PLOT A+XØ,B+YØ:DRAWTO A+X1,B+Y1
310 PLOT A-XØ,B+YØ:DRAWTO A-X1,B+Y1
320 PLOT A+XØ,B-YØ:DRAWTO A+X1,B-Y1
330 PLOT A-XØ,B-YØ:DRAWTO A-X1,B-Y1
340 PLOT A+YØ,B+XØ:DRAWTO A+Y1,B+X1
350 PLOT A-YØ,B+XØ:DRAWTO A-Y1,B+X1
360 PLOT A+YØ,B-XØ:DRAWTO A+Y1,B-X1
370 PLOT A-YØ,B-XØ:DRAWTO A-Y1,B-X1
380 XØ=X1:YØ=Y1
390 IF -X1>=Y1 THEN X1=X1+1:GOTO 29Ø
```

Program 5: Potential

```
100 REM CIRCLE DEMONSTRATION
110 REM PROGRAM #5
140 REM THIS METHOD TAKES APPROXIMAT
    ELY 3 SECONDS
210 GRAPHICS 8
220 COLOR 1
230 SETCOLOR 2,Ø,Ø
240 A=16Ø
250 B=8Ø
260 R=5Ø
270 PHI=Ø
280 Y1=Ø
290 X1=R
300 PHIY=PHI+Y1+Y1+1
310 PHIXY=PHIY-X1-X1+1
400 PLOT A+X1,B+Y1
410 PLOT A-X1,B+Y1
420 PLOT A+X1,B-Y1
430 PLOT A-X1,B-Y1
440 PLOT A+Y1,B+X1
450 PLOT A-Y1,B+X1
460 PLOT A+Y1,B-X1
470 PLOT A-Y1,B-X1
500 PHI=PHIY
510 Y1=Y1+1
520 IF ABS(PHIXY)<ABS(PHIY) THEN PHI
    =PHIXY:X1=X1-1
530 IF X1>=Y1 THEN 3ØØ
```

Program 6: BASIC Call To Machine Language

```
100 REM CIRCLE DEMONSTRATION
110 REM PROGRAM #6
140 REM THIS METHOD TAKES APPROXIMAT
    ELY Ø.1833 SECONDS
210 GRAPHICS 8
220 COLOR 1
230 SETCOLOR 2,Ø,Ø
240 A=16Ø
250 B=8Ø
260 R=5Ø
270 P=7*16*16*16
300 I=USR(P,A,B,R,1)
```

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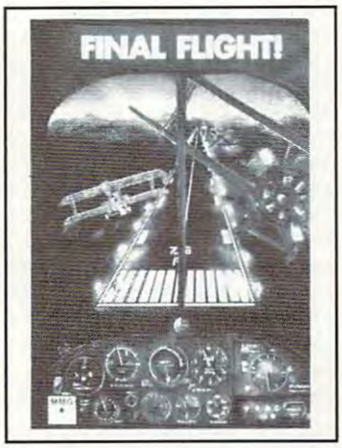

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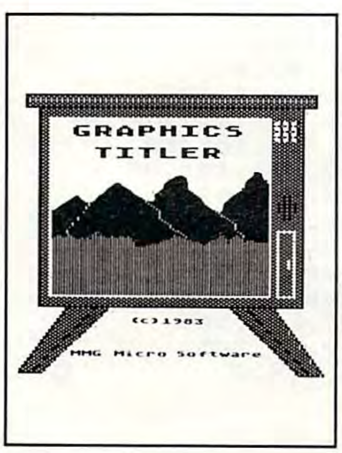

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Program 7:
Machine Language Circle Drawing Subroutine

```
10 REM 28000- IS SUBROUTINE
20 GOSUB 28000
30 END
28000 FOR I=0 TO 758:READ A:POKE 286
      72+I,A:NEXT I
28010 RETURN
28672 DATA 104,104,141,5,6,104
28678 DATA 141,4,6,104,141,7
28684 DATA 6,104,141,6,6,104
28690 DATA 141,9,6,141,12,6
28696 DATA 104,141,8,6,141,11
28702 DATA 6,104,104,141,10,6
28708 DATA 201,3,144,1,96,169
28714 DATA 0,141,13,6,141,14
28720 DATA 6,141,15,6,141,16
28726 DATA 6,24,173,4,6,109
28732 DATA 11,6,141,25,6,173
28738 DATA 5,6,109,12,6,141
28744 DATA 26,6,24,173,4,6
28750 DATA 109,13,6,141,29,6
28756 DATA 173,5,6,109,14,6
28762 DATA 141,30,6,56,173,4
28768 DATA 6,237,11,6,141,27
28774 DATA 6,173,5,6,237,12
28780 DATA 6,141,28,6,56,173
28786 DATA 4,6,237,13,6,141
28792 DATA 31,6,173,5,6,141
28798 DATA 14,6,141,32,6,24
28804 DATA 173,6,6,109,11,6
28810 DATA 141,33,6,173,7,6
28816 DATA 109,12,6,141,34,6
28822 DATA 24,173,6,6,109,13
28828 DATA 6,141,37,6,173,7
28834 DATA 6,109,14,6,141,38
28840 DATA 6,56,173,6,6,237
28846 DATA 11,6,141,35,6,173
28852 DATA 7,6,237,12,6,141
28858 DATA 36,6,56,173,6,6
28864 DATA 237,13,6,141,39,6
28870 DATA 173,7,6,237,14,6
28876 DATA 141,40,6,173,25,6
28882 DATA 141,0,6,173,26,6
28888 DATA 141,1,6,173,37,6
28894 DATA 141,2,6,173,38,6
28900 DATA 141,3,6,32,106,114
28906 DATA 173,27,6,141,0,6
28912 DATA 173,28,6,141,1,6
28918 DATA 32,106,114,173,25,6
28924 DATA 141,0,6,173,26,6
28930 DATA 141,1,6,173,39,6
28936 DATA 141,2,6,173,40,6
28942 DATA 141,3,6,32,106,114
28948 DATA 173,27,6,141,0,6
28954 DATA 173,28,6,141,1,6
28960 DATA 32,106,114,173,29,6
28966 DATA 141,0,6,173,30,6
28972 DATA 141,1,6,173,33,6
28978 DATA 141,2,6,173,34,6
28984 DATA 141,3,6,32,106,114
28990 DATA 173,31,6,141,0,6
28996 DATA 173,32,6,141,1,6
29002 DATA 32,106,114,173,29,6
29008 DATA 141,0,6,173,30,6
29014 DATA 141,1,6,173,35,6
29020 DATA 141,2,6,173,36,6
29026 DATA 141,3,6,32,106,114
29032 DATA 173,31,6,141,0,6
29038 DATA 173,32,6,141,1,6
29044 DATA 32,106,114,173,14,6
29050 DATA 205,12,6,240,3,144
29056 DATA 10,96,173,13,6,205
29062 DATA 11,6,144,1,96,173
29068 DATA 11,6,133,4,173,12
29074 DATA 6,133,5,173,13,6
29080 DATA 133,205,173,14,6,133
29086 DATA 206,6,4,38,5,6
29092 DATA 205,38,206,56,165,205
29098 DATA 109,15,6,141,17,6
29104 DATA 165,206,109,16,6,141
29110 DATA 18,6,24,173,17,6
29116 DATA 229,4,141,19,6,173
29122 DATA 18,6,229,5,141,20
29128 DATA 6,173,18,6,16,27
29134 DATA 73,255,141,22,6,173
29140 DATA 17,6,73,255,24,105
29146 DATA 1,141,21,6,173,22
29152 DATA 6,105,0,141,22,6
29158 DATA 24,144,9,141,22,6
29164 DATA 173,17,6,141,21,6
29170 DATA 173,20,6,16,27,73
29176 DATA 255,141,24,6,173,19
29182 DATA 6,73,255,24,105,1
29188 DATA 141,23,6,173,24,6
29194 DATA 105,0,141,24,6,24
29200 DATA 144,9,141,24,6,173
29206 DATA 19,6,141,23,6,173
29212 DATA 17,6,141,15,6,173
29218 DATA 18,6,141,16,6,24
29224 DATA 173,13,6,105,1,141
29230 DATA 13,6,173,14,6,105
29236 DATA 0,141,14,6,173,22
29242 DATA 6,205,24,6,144,39
29248 DATA 208,8,173,21,6,205
29254 DATA 23,6,144,29,173,19
29260 DATA 6,141,15,6,173,20
29266 DATA 6,141,16,6,56,173
29272 DATA 11,6,233,1,141,11
29278 DATA 6,173,12,6,233,0
29284 DATA 141,12,6,76,55,112
29290 DATA 173,2,6,133,205,169
29296 DATA 0,133,206,6,205,38
29302 DATA 206,6,205,38,206,6
29308 DATA 205,38,206,165,205,133
29314 DATA 4,165,206,133,5,6
29320 DATA 205,38,206,6,205,38
29326 DATA 206,24,165,205,101,4
29332 DATA 133,205,165,206,101,5
29338 DATA 133,206,173,0,6,133
29344 DATA 4,173,1,6,133,5
29350 DATA 70,5,102,4,70,5
29356 DATA 102,4,70,5,102,4
29362 DATA 24,165,205,101,4,133
29368 DATA 205,165,206,101,5,133
29374 DATA 206,24,165,205,101,88
29380 DATA 133,205,165,206,101,89
29386 DATA 133,206,173,0,6,41
29392 DATA 7,170,160,0,173,10
29398 DATA 6,208,10,189,41,6
29404 DATA 73,255,49,205,145,205
29410 DATA 96,201,1,208,8,189
29416 DATA 41,6,17,205,145,205
29422 DATA 96,189,41,6,81,205
29428 DATA 145,205,96,0,0,0
```

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PET Uncompactor

David L. Evans

The PET Compactor program (July 1982) was a popular, very fast way to squeeze a BASIC program into the smallest amount of memory possible. It created "metalines," some far longer than 80 characters, using a new line number only when the program's logic demanded it. Here's the companion utility. Also written entirely in machine language (and requiring Upgrade or 4.0 BASIC, with disk), the Uncompactor stretches a compact BASIC program out into many small lines. This makes modifications and program analysis easier. Often, a compacted program cannot be changed at all without being uncompacted first. The program is provided as a hex dump, with instructions on how to enter it into your PET.

This machine language routine uncompacts fast. In fact, it represents a 3300% increase in speed over an uncompactor written in BASIC.

Unlike my "Compactor" program published last year, it requires *no* changes to run on either Upgrade or 4.0 PET BASIC. It achieves this by making heavy use of the "kernal" (the jump table located at the top of memory in all PET/CBMs). The kernal is used to PRINT, OPEN and CLOSE files, GET and INPUT bytes, and to restore the original environment (default parameters) of the PET.

The routines to GET, INPUT, and RESTORE are all straightforward; all the user does is execute a subroutine call to the desired routine.

For example, to use the routine RESTORE, the user types:

```
JSR $FFCC
```

Both of the routines to GET and INPUT return the value that was input into the accumulator.

The PRINT routine (JSR $FFD2) requires that the accumulator be loaded with the byte that the user wishes to be printed. The routine to set the OUTPUT or INPUT device also requires the user to set up some parameters before calling them. The user must first open the file to be accessed, then load the X-register with the file number, and finally execute a subroutine call to the routine desired.

Example: To print a colon to file number two, do the following (this assumes that file number two has been opened):

```
LDX  #$02
JSR  $FFC9   ; set current output device
LDA  #$3A
JSR  $FFD2   ; print a colon
JSR  $FFCC   ; restore default devices
```

All the routines discussed above are widely used. The routines to OPEN and CLOSE files, however, are not as well-known. Each routine requires that you have, somewhere in memory, a string of characters containing the OPEN/CLOSE command. BASIC is informed where the command string is, by setting locations $77 and $78 to point to it.

Example: To open file number 15,8,15, type the following:

```
LDA  #<COMAND
STA  $77
LDA  #>COMAND
STA  $78
JSR  $FFC0  ;open the file
COMAND .BYTE '15,8,15'
```

Note: My assembler uses "<" to load the LSB of a label and ">" to load the MSB of a label. To CLOSE a file, the same procedure is used.

The program is provided in the form of a hex dump of memory. To enter this into your computer, invoke the built-in monitor by typing SYS 4. Next, display the first block of memory by typing m 0400 047f. Type over the numbers already in memory with the new values in the program, hitting RETURN after each line of eight bytes. Repeat this procedure for the following blocks of memory until all changes have been made. Then save the program to disk by typing:

```
S "UNCOMPACTOR", 08, 0400, 08E7
```

Since the program occupies the normal BASIC program area, and since the first 13 bytes constitute a short "self-calling" routine, the program can be loaded and run as if it were in BASIC.

It is not necessary to initialize the drives used; the program will automatically do it for you. If the output file name exists on the destination diskette, the program will overlay it. Follow the directions printed on the screen and your program will then be uncompacted. When the program is finished, LOAD the new version of your program and type the CLR command. This is necessary to relink the BASIC program. Be sure to reSAVE your CLRed program or else you will lose it.

For those who do not want to type this in, send $3 and a tape or disk along with a SASE mailer to the address below. If you send a disk, I have DOS 2.0 so all disks will be written in DOS 2.0.

I have source code available in CBM assembler format. If you would like a copy of the source code, be sure to make a note of it when you send for a copy of my program.

David L. Evans
2202 Ellis Avenue
Caldwell, ID 83605

PET Machine Language Uncompactor.

```
0400 00 0B 04 FF FF 9E 31 30
0408 33 37 00 00 00 A9 E2 85
0410 01 A9 08 85 02 A0 00 98
0418 91 01 C8 D0 FB E6 02 A6
0420 02 E0 0B D0 F3 A2 BC A0
0428 07 20 E8 06 A2 00 BD D1
0430 08 F0 06 9D F1 08 E8 D0
0438 F5 20 CF FF C9 0D F0 08
0440 9D F1 08 E8 E0 19 D0 F1
0448 A0 00 B9 94 08 F0 07 9D
0450 F1 08 E8 C8 D0 F4 AD F8
0458 08 C9 30 F0 04 C9 31 D0
0460 C4 AD F9 08 C9 3A D0 BD
0468 A2 7E A0 08 20 E8 06 A2
0470 00 BD D9 08 F0 06 9D 15
0478 09 E8 D0 F5 20 CF FF C9
0480 0D F0 08 9D 15 09 E8 E0
0488 1A D0 F1 A0 00 B9 9A 08
0490 F0 07 9D 15 09 E8 C8 D0
0498 F4 AD 1D 09 C9 30 F0 04
04A0 C9 31 D0 C4 AD 1E 09 C9
04A8 3A D0 BD A5 77 8D E2 08
04B0 A5 78 8D E3 08 A9 C9 85
04B8 77 A9 08 85 78 20 C0 FF
04C0 A2 0F 20 C9 FF AD F8 08
04C8 CD 1D 09 F0 10 A9 49 20
04D0 D2 FF AD F8 08 20 D2 FF
04D8 A9 0D 20 D2 FF A9 49 20
04E0 D2 FF AD 1D 09 20 D2 FF
04E8 A9 0D 20 D2 FF 20 CC FF
04F0 20 10 07 A9 F1 85 77 A9
04F8 08 85 78 20 C0 FF 20 10
0500 07 A9 15 85 77 A9 09 85
0508 78 20 C0 FF 20 10 07 A2
0510 AB A0 08 20 E8 06 20 F9
0518 06 A2 06 20 C9 FF AD E4
0520 08 20 D2 FF AD E5 08 20
0528 D2 FF 20 CC FF AD E4 08
0530 D0 11 20 FF 06 A2 06 20
0538 C9 FF AD E5 08 20 D2 FF
0540 20 CC FF A9 01 8D F0 08
0548 D0 46 AD E8 08 8D EA 08
0550 AD E9 08 8D EB 08 AD EE
0558 08 D0 03 4C A5 06 AD EA
0560 08 AE EB 08 20 53 07 A2
0568 06 20 C9 FF A9 01 20 D2
0570 FF 20 D2 FF AD EC 08 20
0578 D2 FF AD ED 08 20 D2 FF
0580 20 CC FF A0 01 20 FF 06
0588 99 6B 09 F0 03 C8 D0 F5
0590 20 F9 06 18 6D E4 08 8D
0598 EE 08 90 03 EE EE 08 F0
05A0 12 20 F9 06 8D E9 08 8D
05A8 ED 08 AD E4 08 8D E8 08
05B0 8D EC 08 AD F0 08 F0 07
05B8 A9 00 8D F0 08 F0 8B A0
05C0 01 B9 6B 09 C9 3A D0 51
05C8 C0 01 D0 03 4C 8B 06 EE
05D0 EA 08 D0 03 EE EB 08 AD
05D8 EA 08 CD E8 08 90 0B AD
05E0 EB 08 CD E9 08 90 03 4C
05E8 8B 06 A2 06 20 C9 FF A9
05F0 00 20 D2 FF A9 01 20 D2
05F8 FF 20 D2 FF AD EA 08 20
0600 D2 FF AD EB 08 20 D2 FF
0608 20 CC FF C8 B9 6B 09 C9
0610 20 F0 F8 C9 3A F0 F4 D0
0618 A8 A9 81 D9 6B 09 B0 4A
0620 A9 9B D9 6B 09 90 43 A9
0628 80 D9 6B 09 F0 23 A9 99
0630 D9 6B 09 90 1C A9 8A D9
0638 6B 09 B0 2E A9 90 D9 6B
0640 09 90 27 A9 8C D9 6B 09
0648 F0 20 A9 8D D9 6B 09 F0
0650 19 A2 06 20 C9 FF B9 6B
0658 09 20 D2 FF B9 6B 09 F0
0660 03 C8 D0 ED 20 CC FF 4C
0668 4A 05 B9 6B 09 C9 22 D0
0670 1A A2 06 20 C9 FF B9 6B
0678 09 20 D2 FF 20 CC FF C8
0680 B9 6B 09 C9 22 F0 04 C9
0688 00 D0 E6 A2 06 20 C9 FF
0690 B9 6B 09 20 D2 FF 20 CC
0698 FF B9 6B 09 F0 04 C8 4C
06A0 C1 05 4C 4A 05 A2 06 20
06A8 C9 FF A9 00 20 D2 FF 20
06B0 D2 FF 20 CC FF A2 A0 A0
06B8 08 20 E8 06 A9 C2 85 77
06C0 A9 08 85 78 20 C3 FF A9
06C8 C4 85 77 A9 08 85 78 20
06D0 C3 FF A9 C6 85 77 A9 08
06D8 85 78 20 C3 FF AD E2 08
06E0 85 77 AD E3 08 85 78 60
06E8 86 01 84 02 A0 00 B1 01
06F0 F0 06 20 D2 FF C8 D0 F6
06F8 60 20 FF 06 8D E4 08 A2
0700 05 20 C6 FF 20 E4 FF 48
0708 20 CC FF 68 8D E5 08 60
0710 A2 0F 20 C6 FF A2 00 20
0718 E4 FF 9D 39 09 C9 0D F0
0720 03 E8 D0 F3 20 CC FF AD
0728 39 09 C9 32 B0 01 60 A9
0730 0D 20 D2 FF 20 D2 FF A2
0738 00 BD 39 09 20 D2 FF C9
0740 0D F0 03 E8 D0 F3 68 68
0748 AD E2 08 85 77 AD E3 08
0750 85 78 60 8D E6 08 8E E7
0758 08 A9 20 20 D2 FF 20 D2
0760 FF 20 D2 FF A0 00 8C EF
0768 08 A2 00 AD E6 08 38 F9
0770 B4 07 8D E6 08 AD E7 08
0778 C8 F9 B4 07 90 08 8D E7
0780 08 E8 88 4C 6B 07 88 AD
0788 E6 08 79 B4 07 8D E6 08
0790 8A D0 09 2C EF 08 30 09
0798 A9 20 D0 07 A2 80 8E EF
07A0 08 09 30 20 D2 FF C8 C8
07A8 C0 08 90 BD AD E6 08 09
07B0 30 4C D2 FF 10 27 E8 03
07B8 64 00 0A 00 93 20 20 20
07C0 20 20 20 4D 41 43 48 49
07C8 4E 45 20 4C 41 4E 47 55
07D0 41 47 45 20 55 4E 43 4F
07D8 4D 50 41 43 54 4F 52 0D
07E0 0D 0D 42 59 3A 20 44 41
07E8 56 49 44 20 45 56 41 4E
07F0 53 0D 0D 0D 45 4E 54 45
07F8 52 20 46 49 4C 45 20 4E
0800 41 4D 45 20 57 49 54 48
0808 20 54 48 45 20 44 52 49
0810 56 45 20 4E 55 4D 42 45
0818 52 0D 0D 50 52 45 43 45
0820 44 49 4E 47 20 49 54 2E
0828 0D 0D 45 58 41 4D 50 4C
0830 45 3A 20 20 20 30 3A 46
0838 49 4C 45 4E 41 4D 45 0D
0840 0D 44 4F 20 54 48 45 20
0848 53 41 4D 45 20 57 49 54
0850 48 20 54 48 45 20 4F 55
0858 54 50 55 54 20 46 49 4C
0860 45 20 4E 41 4D 45 2E 0D
0868 0D 0D 0D 49 4E 50 55 54
0870 20 46 49 4C 45 20 4E 41
0878 4D 45 20 3F 20 00 0D 0D
0880 4F 55 54 50 55 54 20 46
0888 49 4C 45 20 4E 41 4D 45
0890 20 3F 20 00 2C 50 2C 52
0898 22 00 2C 50 2C 57 22 00
08A0 93 12 44 4F 4E 45 0D 0D
08A8 0D 0D 00 93 57 4F 52 4B
08B0 49 4E 47 20 4F 4E 20 4C
08B8 49 4E 45 2E 2E 2E 2E 0D
08C0 0D 00 36 00 35 00 31 35
08C8 00 31 35 2C 38 2C 31 35
08D0 00 35 2C 38 2C 35 2C 22
08D8 00 36 2C 38 2C 36 2C 22
08E0 40 00 00 00 00 00 00 00
```

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Statistical Test Of Commodore And Radio Shack RND

Brian Flynn

This article provides a statistical test of the randomness of your BASIC's random number generator. Versions of the program for TRS-80 Color Computers with Extended Color BASIC and for PET/CBM, VIC, and 64 computers are provided. To use the TRS-80 version with non-Extended BASIC, you must substitute the value of square root of N for SQR(N) in lines 6110 and 6120, since non-Extended Color BASIC has no square root function. (SQR(1000)=31.6228.) Alternatively, the Color BASIC manual lists a square root routine on page 116. The only changes necessary to use the PET/CBM version on the VIC-20 or Commodore 64 are to adapt the PRINT statements to the smaller screen sizes.

As presented, the program takes several hours to sort each subsequence. Thus, several days would be required for a complete program run. Each of the following options significantly reduces the required execution time:

1. *Replace the sort routine (Module 5) with a faster sorting routine. (See "All Sorts of BASIC Sorts,"* **COMPUTE!**, *December 1982, #31.)*
2. *Compile the program before running it. (Of course, to do this you must have a BASIC compiler.)*
3. *Reduce the number of fractions specified in the DATA statement of line 2020.*

The phrase "Kolmogorov-Smirnov" brings to mind the vision of a big white dog, a beautiful princess, and a bearded, virile, vodka-drinking czar. In reality, however, "Kolmogorov-Smirnov" is not this imaginary troika from pre-Bolshevik days, but rather a statistical test, named after two Russian mathematicians, for trying to determine how well values from a sample match values from a specified population.

The test is often used to examine the degree of randomness of sequences of fractions generated by the computer from a uniform distribution. This article explains the Kolmogorov-Smirnov test in more detail, and then uses the test to evaluate the quality of the random number generator in Microsoft's BASIC compiler for the TRS-80 and Commodore computers.

Kolmogorov-Smirnov Test

The command "RND(0)" in TRS-80 BASIC generates a fraction from a uniform distribution between 0 and 1, exclusive. In this distribution, graphed in Figure 1, the probability of drawing a fraction between 0.0 and 0.1, in a one-shot selection, is equal to the probability of drawing a fraction between 0.1 and 0.2, or 0.2 and 0.3, and so on. In each case, the probability is 1/10 since the distribution is divided into ten equal parts.

Now, the Kolmogorov-Smirnov test uses cumulative rather than absolute relative frequency distributions. Referring again to the uniform distribution of Figure 1, note that the probability of drawing a fraction less than or equal to 0.2 is 1/10+1/10, or 0.2. Similarly, the probability of drawing a fraction less than or equal to 0.3 is 1/10+1/10+1/10, or 0.3. In general, the probability of selecting a fraction less than or equal to some number X is simply X, where X ranges from 0 to 1. The distribution based upon these cumulative probabilities is graphed in Figure 2.

The essence of the Kolmogorov-Smirnov test is comparing theoretical and empirical cumulative frequency distributions. An example of the latter type of distribution is based upon the following sequence of ten fractions, rounded to three decimal places, generated by executing "RND(0)" on a Honeywell computer: 0.789, 0.528, 0.871, 0.097, 0.276, 0.434, 0.711, 0.535, 0.776, and 0.918. If the sample sequence is random, then the empirical cumulative frequency distribution, based upon observed values sorted in ascending order, should approximate the theoretical one. These distributions are compared in Table 1 and Figure 3.

These two displays reveal that the observed fractions are a little too high, and that the empirical

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distribution is therefore a little too low. But is it so low that we reject the null hypothesis of a random sequence? The following two test statistics are used to answer this question (Professor Knuth, p. 45):

$$K^+ = \sqrt{n}\,\max\{j/n - F(X_j)\} \text{ and}$$
$$K^- = \sqrt{n}\,\max\{F(X_j) - (j-1)/n\}, \text{ for } j = 1, 2, \ldots, n.$$

The symbol K^+ is the maximum vertical distance between the two curves when the empirical distribution is higher than the theoretical distribution, and K^- is the maximum distance when the empirical distribution is lower. Further, n is the sample size, ten in this case. And $F(X_j)$ is the theoretical cumulative frequency for the j^{th} observation. For example, $F(X_1) = 0.097$ since 9.7% of all values from a uniform distribution are ≤ 0.097. Similarly, $F(X_2) = 0.276$, and so on.

For our data, $K^+ = 0.259$ and $K^- = 0.740$. Referencing Kolmogorov-Smirnov critical values (Professor Knuth, p. 44), both of these statistics fall in the acceptance region for the null hypothesis at the 10% level of significance, using a two-tail test (5% of the distribution's area is under each tail). Hence, we can't label the observed sequence of fractions "nonrandom."

A Practical Application

The quality of the random number generator in Microsoft's BASIC is examined here, using the computer program listed at the end of the article. Specifically, the degree of randomness of the sequence of the first 50,000 fractions generated by RND(0) is investigated. This is done by performing the Kolmogorov-Smirnov test on each successive interval of 1,000 fractions within the total sequence. Hence, 50 values of the K^+ statistic and 50 values of the K^- statistic are tallied.

Test results, summarized in Table 2, reveal that the K^+ and K^- values always fall within the middle 98 percentile portion of the distribution. And they fall within the middle 90 percentile part 92 out of 100 times. These results suggest that the random number generator is a good one.

As an additional check, however, the Kolmogorov-Smirnov test is applied once again, this time to the 50 K^+ values and to the 50 K^- values from before. As Professor Knuth indicates (p. 45), this enables us "... to detect both local and global nonrandom behavior." Test results, using

$$F(X) = 1 - e^{-2X^2}$$

as the cumulative frequency distribution for the K values, are:

	K^+	K^-
Based on 50 K^+'s	0.217	0.650
Based on 50 K^-'s	0.875	0.111

In all four cases, the null hypothesis of a random sequence is not rejected at the 2% level of significance, in a two-tail test. At the 10% level of significance H_o is rejected one out of four times, with 0.111 the guilty value.

The Kolmogorov-Smirnov test is useful in examining the randomness of sequences of fractions generated by RND(0). But remember, no random number generator is perfect. And just because a sequence passes one statistical test does not mean that it will pass a second.

References

Knuth, Donald E. *The Art of Computer Programming*, Vol. 2. Reading: Addison-Wesley Publishing Company, Inc., 1971.

Lapin, Lawrence L. *Statistics for Modern Business Decisions*. New York: Harcourt Brace Jovanovich, Inc., 1973, pp. 422-426.

Table 1: Sample And Theoretical Cumulative Relative Frequencies

Fraction	Sample Cumulative Frequency	Theoretical Cumulative Frequency
0.097	0.1	0.097
0.276	0.2	0.276
0.434	0.3	0.434
0.528	0.4	0.528
0.535	0.5	0.535
0.711	0.6	0.711
0.776	0.7	0.776
0.789	0.8	0.789
0.871	0.9	0.871
0.918	1.0	0.918

Note that the theoretical cumulative frequency always equals the value of the observed fraction. This is because the probability of drawing a fraction less than or equal to, say, 0.276, is 0.276, where the population is the uniform distribution between 0 and 1.

Table 2: Kolmogorov-Smirnov Test Results

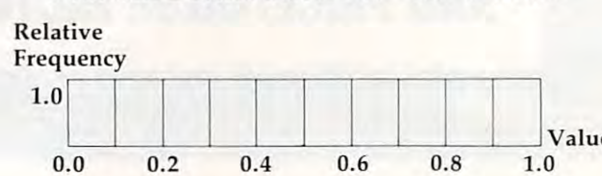
H_o: The sequence is random
H_A: The sequence is nonrandom

Level Of Significance	Critical Values Lower	Critical Values Upper	Number Of Times In 50 Trials That H_0 Is Rejected K^+	Number Of Times In 50 Trials That H_0 Is Rejected K^-
2%	0.066	1.511	0	0
10%	0.156	1.219	4	4
50%	0.375	0.828	26	26

Note: The level of significance is the probability of rejecting H_o when H_o is in fact true.

Figure 1.

Uniform Distribution Between 0 And 1



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Meteor Madness (New) (D)	29.95	21.95
Fast Eddie (D)	34.95	26.95
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Squish 'Um (New) (D)	34.95	26.95
Type Attack (D)	39.95	29.95
Robbers of the Lost Tomb (D/T)	24.95	18.95
Wall Street (D/T)	24.95	18.95
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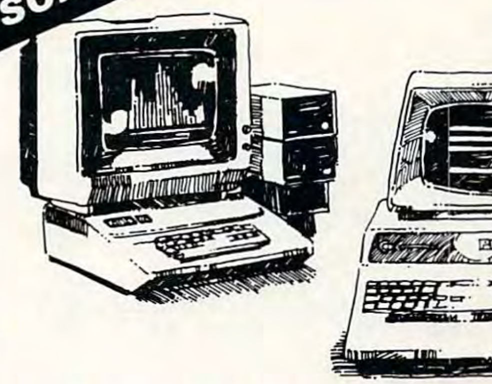

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Figure 2.

Probability Of Drawing A Fraction Less Than Or Equal To X

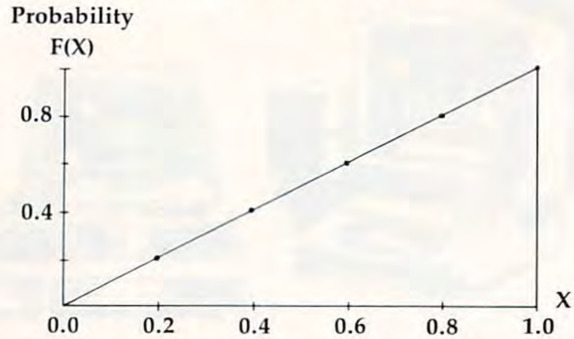
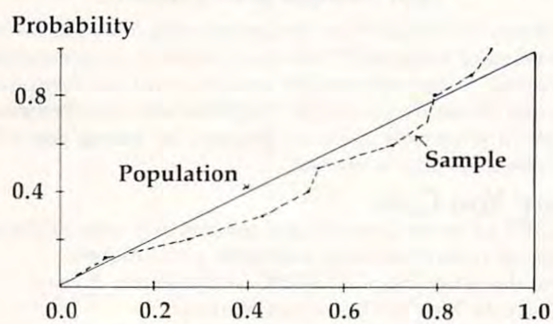


Figure 3.

Comparison Of Theoretical And Sample Cumulative Relative Frequency Distributions



Color Computer Version.

```
40 REM SALIENT SYMBOLS AND ARRAYS
50 REM  MODULE 1
60 REM FIRST LEVEL SUBROUTINES
70 REM  MODULE 2 - INITIALIZE
80 GOSUB 2000
90 REM  MODULE 3 - PERFORM TEST
100 GOSUB 3000
110 REM SECOND LEVEL SUBROUTINES
120 REM  MODULE 4 - GENERATE A SEQUENCE OF FRA
    CTIONS
130 REM  MODULE 5 - SORT FRACTIONS IN ASCENDIN
    G ORDER
140 REM  MODULE 6 - TALLY TEST STATISTICS
150 REM  MODULE 7 - PRINT RESULTS
160 END
1000 REM MODULE 1
1010 REM SALIENT SYMBOLS
1020 REM  KMINUS = PROFESSOR KNUTH'S K- STATIST
    IC
1030 REM  KPLUS = PROFESSOR KNUTH'S K+ STATISTI
    C
1040 REM  N = NUMBER OF FRACTIONS IN A SUBSEQUE
    NCE
1050 REM  T = TOTAL NUMBER OF FRACTIONS
1060 REM ARRAYS
1070 REM  U = VECTOR OF VALUES FROM A UNIFORM D
    ISTRIBUTION
2000 REM MODULE 2
2010 REM  TOTAL NUMBER OF FRACTIONS GENERATED &
     NUMBER IN EACH SUBSEQUENCE
2020 DATA 50000,1000
2030 READ T,N
2040 DIM U(N)
2050 REM HEADING
2060 CLS
2070 PRINT"THIS PROGRAM PERFORMS THE KOLMOGOROV
     -SMIRNOV (KS) TEST OF"
2080 PRINT"RANDOMNESS ON A SEQUENCE OF FRACTION
    S FROM A UNIFORM"
2090 PRINT"DISTRIBUTION BETWEEN 0 AND 1."
2100 PRINT
2110 PRINT"THIS IS DONE BY APPLYING THE KS TEST
     TO SUBSEQUENCES"
2120 PRINT"OF THE TOTAL SEQUENCE:"
2130 PRINT
2140 PRINT" TOTAL NUMBER OF FRACTIONS GENERATED
     = ";T
2150 PRINT"NUMBER IN EACH SUBSEQUENCE = ";N
2160 PRINT
2170 PRINT"CHANGE THE ELEMENTS IN THE DATA STAT
    EMENT OF LINE 2020"
2180 PRINT"FOR DIFFERENT VALUES."
2190 PRINT
2200 PRINT"HIT 'ENTER' TO PROCEED":INPUT Z$
2210 RETURN
3000 REM MODULE 3
3010 CLS
3020 BK$ = "
     "
3030 PRINT TAB(20)"KOLMOGOROV-SMIRNOV TEST"
3040 FOR I=1 TO T STEP N
3050 REM  PRINT SUBSEQUENCE
3060 PRINT @64,BK$
3070 PRINT @64,"FRACTIONS :";I;" TO ";I+N-1
3080 REM  GENERATE SEQUENCE OF FRACTIONS
3090 PRINT @192,"** GENERATING FRACTIONS ...
    "
3100 GOSUB 4000
3110 REM  SORT FRACTIONS
3120 PRINT @192,"** SORTING FRACTIONS ...
    "
3130 GOSUB 5000
3140 REM  TALLY KS STATISTICS
3150 PRINT @192,"** TALLYING TEST STATISTICS ..
    ."
3160 GOSUB 6000
3170 REM  PRINT RESULTS
3180 GOSUB 7000
3190 NEXT I
3200 RETURN
4000 REM MODULE 4
4010 FOR J = 1 TO N
4020 U(J) = RND(0)
4030 NEXT J
4040 RETURN
5000 REM MODULE 5
5010 REM  SUBSTITUTE "QUICK SORT" HERE FOR FAST
    ER PROGRAM EXECUTION
5020 FOR J=1 TO N-1
5030 FOR L=1 TO N-J
5040 IF U(L+1)<U(L) THEN HOLD=U(L+1):U(L+1)=U(L
    ):U(L)=HOLD
5050 NEXT L,J
5060 RETURN
6000 REM MODULE 6
6010 REM  PROFESSOR KNUTH'S K+ AND K- STATISTICS
6020 KPLUS=0
6030 KMINUS=0
6040 FOR J=1 TO N
6050 QPLUS=J/N - U(J)
6060 QMINUS=U(J) - (J-1)/N
6070 IF QPLUS>KPLUS THEN KPLUS=QPLUS
6080 IF QMINUS>KMINUS THEN KMINUS=QMINUS
6090 NEXT J
6100 REM  APPLY PROFESSOR KNUTH'S MULTIPLICATIV
    E TERM
6110 KPLUS=SQR(N)*KPLUS
6120 KMINUS=SQR(N)*KMINUS
6130 RETURN
7000 REM MODULE 7
7010 PRINT @320,BK$
7020 PRINT @384,BK$
7030 PRINT @320,"K+ = ";KPLUS
7040 PRINT @384,"K- = ";KMINUS
7050 RETURN
```

Commodore Version.

```
40 REM SALIENT SYMBOLS AND ARRAYS
50 REM  MODULE 1
60 REM FIRST LEVEL SUBROUTINES
70 REM  MODULE 2 - INITIALIZE
80 GOSUB 2000
90 REM  MODULE 3 - PERFORM TEST
100 GOSUB 3000
110 REM SECOND LEVEL SUBROUTINES
120 REM  MODULE 4 - GENERATE A SEQUENCE OF FRA
    CTIONS
130 REM  MODULE 5 - SORT FRACTIONS IN ASCENDIN
    G ORDER
140 REM  MODULE 6 - TALLY TEST STATISTICS
150 REM  MODULE 7 - PRINT RESULTS
160 END
1000 REM MODULE 1
1010 REM SALIENT SYMBOLS
1020 REM  KMINUS = PROFESSOR KNUTH'S K- STATIST
    IC
1030 REM  KPLUS = PROFESSOR KNUTH'S K+ STATISTI
    C
1040 REM  N = NUMBER OF FRACTIONS IN A SUBSEQUE
    NCE
1050 REM  T = TOTAL NUMBER OF FRACTIONS
1060 REM ARRAYS
1070 REM  U = VECTOR OF VALUES FROM A UNIFORM D
    ISTRIBUTION
2000 REM MODULE 2
2010 REM  TOTAL NUMBER OF FRACTIONS GENERATED &
     NUMBER IN EACH SUBSEQUENCE
2020 DATA 50000,1000
2030 READ T,N
2040 DIM U(N)
2050 REM HEADING
2060 PRINT"{CLEAR}"
2070 PRINT"THIS PROGRAM PERFORMS THE KOLMOGOROV
    -"
2080 PRINT"SMIRNOV (KS) TEST OF RANDOMNESS ON A
    "
2090 PRINT"SEQUENCE OF FRACTIONS FROM A UNIFORM
    "
2100 PRINT"DISTRIBUTION BETWEEN 0 AND 1.":PRINT
2110 PRINT"THIS IS DONE BY APPLYING THE KS TEST
     TO"
2120 PRINT"SUBSEQUENCES OF THE TOTAL SEQUENCE:"
2130 PRINT
2140 PRINT"TOTAL NUMBER OF FRACTIONS = ";T
2150 PRINT"NUMBER IN EACH SUBSEQUENCE = ";N
2160 PRINT
2170 PRINT"CHANGE THE ELEMENTS IN THE DATA STAT
    E-"
2180 PRINT"MENTS OF LINE 2020 FOR DIFFERENT VAL
    UES."
2190 PRINT
2200 PRINT"HIT 'RETURN' TO PROCEED"
2210 GET Z$:IF Z$<>CHR$(13) THEN 2210
2220 RETURN
3000 REM MODULE 3
3010 PRINT"{CLEAR}"
3020 BK$ = "
    "
3030 PRINT TAB(8)"KOLMOGOROV-SMIRNOV TEST"
3040 FOR I=1 TO T STEP N
3050 REM  PRINT SUBSEQUENCE
3060 PRINT"{04 DOWN}";BK$
3070 PRINT"{02 UP}FRACTIONS :";I;"TO";I+N-1
3080 REM  GENERATE SEQUENCE OF FRACTIONS
3090 PRINT"{04 DOWN}** GENERATING FRACTIONS ...
    "
3100 GOSUB 4000
3110 REM  SORT FRACTIONS
3120 PRINT"{UP}** SORTING FRACTIONS ...        "
3130 GOSUB 5000
3140 REM  TALLY KS STATISTICS
3150 PRINT"{UP}** TALLYING TEST STATISTICS ..."
3160 GOSUB 6000
3170 REM  PRINT RESULTS
3180 GOSUB 7000
3190 PRINT"{HOME}{DOWN}"
3200 NEXT I
3210 RETURN
4000 REM MODULE 4
4010 FOR J = 1 TO N
4020 U(J) = RND(0)
4030 NEXT J
4040 RETURN
5000 REM MODULE 2
5010 REM  SUBSTITUTE "QUICK SORT" HERE FOR FAST
    ER PROGRAM EXECUTION
5020 FOR J=1 TO N-1
5030 FOR L=1 TO N-J
5040 IF U(L+1)<U(L) THEN HOLD=U(L+1):U(L+1)=U(L
    ):U(L)=HOLD
5050 NEXT L,J
5060 RETURN
6000 REM MODULE 6
6010 REM  PROFESSOR KNUTH'S K+ AND K- STATISTIC
    S
6020 KPLUS=0
6030 KMINUS=0
6040 FOR J=1 TO N
6050 QPLUS=J/N - U(J)
6060 QMINUS=U(J) - (J-1)/N
6070 IF QPLUS>KPLUS THEN KPLUS=QPLUS
6080 IF QMINUS>KMINUS THEN KMINUS=QMINUS
6090 NEXT J
6100 REM  APPLY PROFESSOR KNUTH'S MULTIPLICATIV
    E TERM
6110 KPLUS=SQR(N)*KPLUS
6120 KMINUS=SQR(N)*KMINUS
6130 RETURN
7000 REM MODULE 7
7010 PRINT"{04 DOWN}";BK$
7020 PRINT"{02 UP}K+ = ";KPLUS
7030 PRINT"{DOWN}";B$
7040 PRINT"{02 UP}K- = ";KMINUS
7050 RETURN
```

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How The VIC/64 Serial Bus Works

Jim Butterfield, Associate Editor

The Serial bus connects VIC or Commodore 64 to its major peripherals, especially disk and tape. The workings of this interface have been a source of bafflement to most of us. We know that it's somehow related to the IEEE-488 bus which is used on PET and CBM computers. But it has fewer wires, and it's slower. For anyone interested in interfacing details, this article will clear up the mystery.

Ground Rules

To understand the workings of this bus, you must work through a few concepts. Later, we'll get technical for those who want it.

The bus, like the IEEE, has two modes of operation: Select mode, in which the computer calls all devices and asks for a specific device to remain connected after the call ("Jones, would you stay in my office after the meeting?"); and Data mode, in which actual information is transmitted ("Jones, I've decided to give you a raise"). Select mode is invoked by the use of a special control line called "Attention," or ATN.

By using Select mode, you can call in any device you choose, but you may need to do more before you transmit data. You might have several disk files in progress – writing some and reading others – and when you select the disk, device 8, you'll still need to specify which "part" of the disk you want to reach: subchannel 3, subchannel 15, or whatever. To do this, we use a "secondary address" which usually signals a subsystem within a specific device. That goes in as part of the command during Select mode. Finally, we may need to send other control information: the name of the file we wish to open, for example. That's not data; it's device setup information, so we also send it in Select mode.

But the main part is: you select a device, and then you send to it or receive from it. Finally, you shut it off. All devices are connected, but only the one you have selected will listen or talk.

Some Technical Ground Rules

If you're not into volts and signals and things, the rest of this article may not do much for you. I want to talk about technical aspects of the bus.

First, all the data flows over two wires; they are called the Clock line and the Data line. There are other wires used for control purposes, but the data uses only the two main ones.

All wires connect to all devices. The wires don't go "one way"; any device can put a ground on a signal line, and all other devices will see it. Indeed, that's the secret of how it works: each wire serves as a common signal bus.

When no device puts a ground on a signal line, the voltage rises to almost five volts. We call this the "false" logic condition of the wire. If any device grounds the line, the voltage drops to zero; we call this the "true" condition of the line. Note that if two devices signal "true" on a line (by grounding it), the effect is exactly the same as if only one has done so: the voltage is zero and that's that. We can summarize this as an important set of logic rules:

– A line will become "true" if one or more devices signal true;

– A line will become "false" only if all devices signal false.

Remember that we have several lines, but the important ones for information transmission are the Clock line and the Data line. Let's watch them work.

Transmission: Step Zero

Let's look at the sequence when a character is about to be transmitted. At this time, both the Clock line and the Data line are being held down to the true state. With a test instrument, you can't tell who's doing it, but I'll tell you: the talker is holding the Clock line true, and the listener is holding the Data line true. There could be more than one listener, in which case all of the listeners are holding the Data line true. Each of the signals might be viewed as saying, "I'm here!"

Step 1: Ready To Send

Sooner or later, the talker will want to talk, and

send a character. When it's ready to go, it releases the Clock line to false. This signal change might be translated as "I'm ready to send a character." The listener must detect this and respond, but it doesn't have to do so immediately.

The listener will respond to the talker's "ready to send" signal whenever it likes; it can wait a long time. If it's a printer chugging out a line of print, or a disk drive with a formatting job in progress, it might hold back for quite a while; there's no time limit.

Step 2: Ready For Data

When the listener is ready to listen, it releases the Data line to false. Suppose there is more than one listener. The Data line will go false only when all listeners have released it – in other words, when all listeners are ready to accept data.

What happens next is variable. Either the talker will pull the Clock line back to true in less than 200 microseconds – usually within 60 microseconds – or it will do nothing. The listener should be watching, and if 200 microseconds pass without the Clock line going to true, it has a special task to perform: note EOI.

Intermission: EOI

If the Ready for Data signal isn't acknowledged by the talker within 200 microseconds, the listener knows that the talker is trying to signal EOI. EOI, which formally stands for "End of Indicator," means "this character will be the last one." If it's a sequential disk file, don't ask for more: there will be no more. If it's a relative record, that's the end of the record. The character itself will still be coming, but the listener should note: here comes the last character.

So if the listener sees the 200 microsecond time-out, it must signal "OK, I noticed the EOI" back to the talker. It does this by pulling the Data line true for at least 60 microseconds, and then releasing it.

The talker will then revert to transmitting the character in the usual way; within 60 microseconds it will pull the Clock line true, and transmission will continue.

At this point, the Clock line is true whether or not we have gone through the EOI sequence; we're back to a common transmission sequence.

Step 3: Sending The Bits

The talker has eight bits to send. They will go out without handshake; in other words, the listener had better be there to catch them, since the talker won't wait to hear from the listener. At this point, the talker controls both lines, Clock and Data. At the beginning of the sequence, it is holding the Clock true, while the Data line is released to false. The Data line will change soon, since we'll send the data over it.

The eight bits will go out from the character one at a time, with the least significant bit going first. For example, if the character is the ASCII question mark, which is written in binary as 00011111, the ones will go out first, followed by the zeros.

Now, for each bit, we set the Data line true or false according to whether the bit is one or zero. As soon as that's set, the Clock line is released to false, signalling "data ready." The talker will typically have a bit in place and be signalling ready in 70 microseconds or less.

Once the talker has signalled "data ready," it will hold the two lines steady for at least 20 microseconds to allow the listener to read it. This timing needs to be increased to 60 microseconds if the Commodore 64 is listening, since the 64's video chip may interrupt the processor for 42 microseconds at a time, and without the extra wait the 64 might completely miss a bit.

The listener plays a passive role here; it sends nothing, and just watches. As soon as it sees the Clock line false, it grabs the bit from the Data line and puts it away. It then waits for the Clock line to go true, in order to prepare for the next bit.

When the talker figures the data has been held for a sufficient length of time, it pulls the Clock line true and releases the Data line to false. Then it starts to prepare the next bit.

Step 4: Frame Handshake

After the eighth bit has been sent, it's the listener's turn to acknowledge. At this moment, the Clock line is true and the Data line is false. The listener must acknowledge receiving the byte OK by pulling the Data line to true.

The talker is now watching the Data line. If the listener doesn't pull the Data line true within one millisecond – one thousand microseconds – it will know that something's wrong and may alarm appropriately.

Step 5: Start Over

We're finished, and back where we started. The talker is holding the Clock line true, and the listener is holding the Data line true. We're ready for step 1; we may send another character – unless EOI has happened.

If EOI was sent or received in this last transmission, both talker and listener "let go." After a suitable pause, the Clock and Data lines are released to false and transmission stops.

Attention!

This is all very well for a transmission that's under way, but how do we set up talker and listener? We use an extra line that overrides everything else, called the ATN, or Attention line.

Normally, the computer is the only device that will pull ATN true. When it does so, all other

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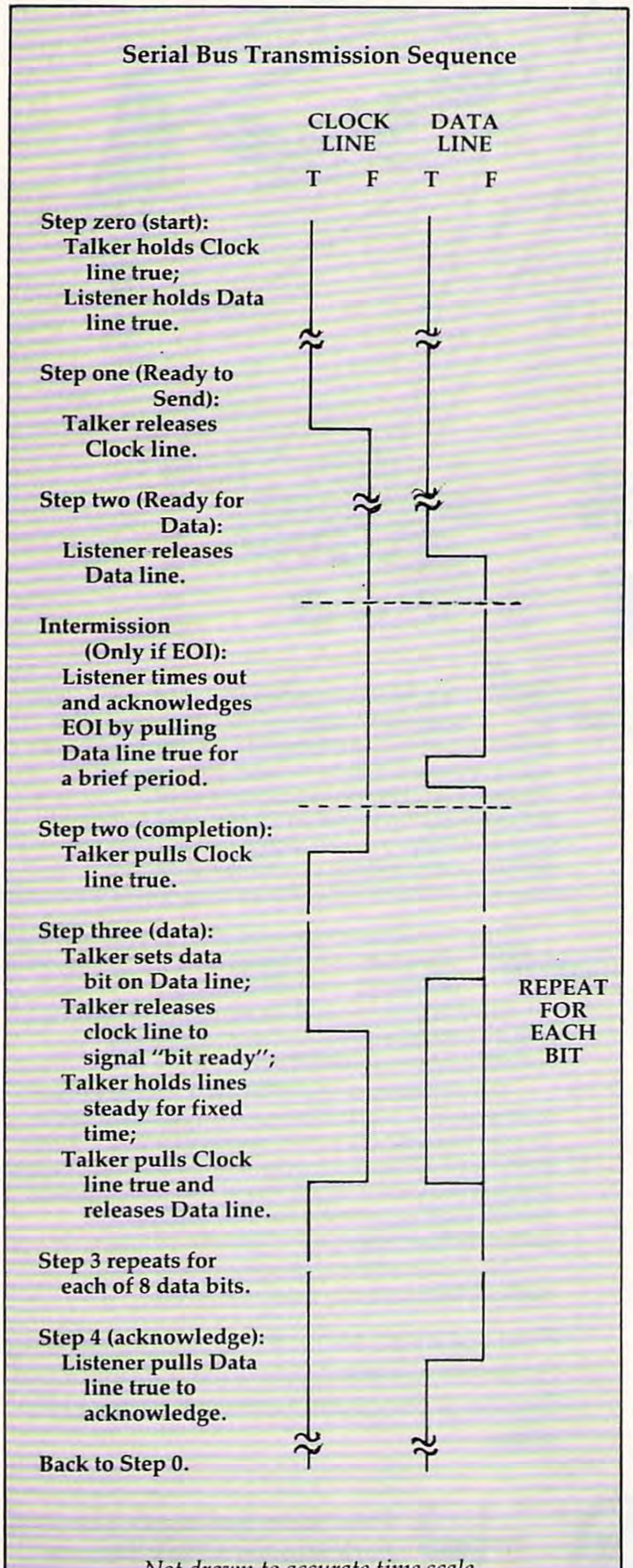
devices drop what they are doing and become listeners.

Signals sent by the computer during an ATN period look like ordinary characters – eight bits with the usual handshake – but they are not data.



Not drawn to accurate time scale.

They are "Talk," "Listen," "Untalk," and "Unlisten" commands telling a specific device that it will become (or cease to be) a talker or listener. The commands go to all devices, and all devices acknowledge them, but only the ones with the suitable device numbers will switch into talk and listen mode. These commands are sometimes followed by a secondary address, and after ATN is released, perhaps by a file name.

An example might help give an idea of the nature of the communications that take place. To open for writing a sequential disk file called "XX," the following sequence would be sent with ATN on: DEVICE-8-LISTEN; SECONDARY-ADDRESS-2-OPEN. When ATN switches off, the computer will be waiting as a talker, holding the Clock line true; and the disk will be the listener, holding the Data line true. That's good, because the computer has more to send, and it will transmit: X; X; comma; S; comma; W – the W will be accompanied with an EOI signal. Shortly thereafter, the computer will switch ATN back on and send DEVICE-8-UNLISTEN.

The file is now open; later, the computer will want to send data there. It will transmit, with ATN on, DEVICE-8-LISTEN; SECONDARY-ADDRESS-2-DATA. Then the computer releases the ATN line and sends its data; only the disk will receive the data, and the disk will know to put it onto the file called XX. The last character sent by the computer will also signal EOI.

After the computer has sent enough data for the moment, it will pull ATN on again and send DEVICE-8-UNLISTEN. Many bursts of data may go to the file; eventually, the computer will close the file by sending (with ATN on, of course) DEVICE-8-LISTEN; SECONDARY-ADDRESS-2-CLOSE.

ATN overrides everything in progress. A disk file might have lots of characters to give to the computer, but the computer wants only a little data. It accepts the characters it wants, then switches on ATN and commands the disk to Untalk. The disk has not sent EOI, but it will disconnect as commanded. Later, when it's asked to Talk again, it will send more characters.

ATN Sequences

When ATN is pulled true, everybody stops what they are doing. The processor will quickly pull the Clock line true (it's going to send soon), so it may be hard to notice that all other devices release the Clock line. At the same time, the processor releases the Data line to false, but all other devices are getting ready to listen and will each pull Data to true. They had better do this within one millisecond (1000 microseconds), since the processor is watching and may sound an alarm ("device not available") if it doesn't see this take place.

Under normal circumstances, transmission now takes place as previously described. The computer is sending commands rather than data, but the characters are exchanged with exactly the same timing and handshakes as before. All devices receive the commands, but only the specified device acts upon it. This results in a curious situation: you can send a command to a nonexistent device (try "OPEN 6,6") – and the computer will not know that there is a problem, since it receives valid handshakes from the other devices. The computer will notice a problem when you try to send or receive data from the nonexistent device, since the unselected devices will have dropped off when ATN ceased, leaving you with nobody to talk to.

Turnaround

An unusual sequence takes place following ATN if the computer wishes the remote device to become a talker. This will usually take place only after a Talk command has been sent. Immediately after ATN is released, the selected device will be behaving like a listener. After all, it's been listening during the ATN cycle, and the computer has been a talker. At this instant, we have "wrong way" logic; the device is holding down the Data line, and the computer is holding the Clock line. We must turn this around.

Here's the sequence: the computer quickly realizes what's going on, and pulls the Data line to true (it's already there), as well as releasing the Clock line to false. The device waits for this: when it sees the Clock line go true, it releases the Data line (which stays true anyway since the computer is now holding it down) and then pulls down the Clock line.

We're now in our starting position, with the talker (that's the device) holding the Clock true, and the listener (the computer) holding the Data line true. The computer watches for this state; only when it has gone through the cycle correctly will it be ready to receive data. And data will be signalled, of course, with the usual sequence: the talker releases the Clock line to signal that it's ready to send.

The logic sequences make sense. They are hard to watch with a voltmeter or oscilloscope since you can't tell which device is pulling the line down to true.

The principles involved are very similar to those on the PET/CBM IEEE-488 bus – the same Talk and Listen commands go out, with secondary addresses and similar features. There are fewer "handshake" lines than on IEEE, and the speed is slower; but the principle is the same.

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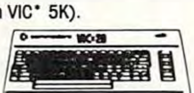

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INSIGHT: Atari

Bill Wilkinson

A mini-series on relocatable machine language begins in this month's column, plus a tip on a new product – an intelligent cable. Next month, the last part of the BAIT interpreter and more on relocatable machine language.

I have been working on a new project for **COMPUTE! Books**. By the time you read this, *COMPUTE!'s Atari BASIC Sourcebook* should be wending its way to your dealers' shelves and into your hands. Like *Inside Atari DOS*, the *Sourcebook* is a complete source listing of – what else? – Atari BASIC, along with a comprehensive explanation of how and why it all works.

Enough advertising. This month we will begin a mini-series on self-relocatable machine language. But before we begin all that, time out for some ruminations.

Machine Language Be Not Hard

Before we start investigating self-relocatable machine code on the 6502, I'd like to get up on my soapbox for a while and do a little preaching.

This month's sermon was inspired by a machine language program published in another magazine. The program seemed to me the epitome of poor programming techniques. And lest it seem that I am taking a cheap shot, let me hasten to add that the program works and works well. I am carping about the printed form of the program, not the results thereof.

In the tradition of any good preacher, then, let me give you some suggestions on how to write good, readable, maintainable machine language:

1. Always use plenty of comments (they cost nothing in the assembled code, unlike BASIC).

2. Never use absolute addresses (except in equates).

3. Never use absolute numeric constants (again, except in equates, though we might forgive an occasional constant 0 or 1).

4. Always use plenty of comments.

5. Always use long, meaningful names for labels. (Which makes more sense, ICCOM or IOCB.COMMAND ?).

6. Never branch to a location relative to the location counter (that is, never use "* + xx" or "*-xx").

7. Never use a comment that simply echoes the machine language code.

8. Always use plenty of comments.

9. Never change the location counter needlessly (that is, most programs should contain only one "* = ", except for the use of "* = * + xx" to reserve space).

10. If possible, always define a label before its first use.

11. Always thoroughly document the entry and exit values for a subroutine, taking special care to note what happens to the CPU registers.

12. Always use plenty of comments.

Those of you with some OSS software will see that I have taken a small pot shot at our own manuals in commandment 5. Well, I never said we were perfect. (Great, maybe, but not perfect.)

And those of you with Atari's Macro Assembler may object to using long labels since, even though AMAC allows long labels, it ignores all but the first six characters. Sorry, but I still think this rule should be followed. You just have to be more inventive to insure that labels are unique in the first six characters. (For example, IOCB.AUX1 and IOCB.AUX2 look the same to AMAC, so use IOCB.1AUX and IOCB.2AUX .)

Anyway, rather than go through each of those commandments one by one, let's look at an example subroutine coded with both worst and best techniques.

Example 1: Worst Technique

```
; EXAMPLE 1 : print A register
  *= $1F00
  LDX #11
  STX $342    ; put 11 in location $342
  LDX #0
  STX $348
  STX $349
  JMP $E456   ; go to $E456
```

Example 2: Best Technique

```
;
; Example 2: Output the character in the A-register
;            to file channel (IOCB) number zero
;            (assumed to be the screen).
;
```

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```
; Entry: A-register contains the character
; Exit: Status of all registers unknown
;
  *= LOWMEMORY
PRINTCHARACTER
  LDX #COMMAND.PUTBINARY
  STX IOCB.COMMAND ; command for CIO
  LDX #0   ; use a zero buffer length
  STX IOCB.LOLENGTH   ;tells CIO to output
  STX IOCB.HILENGTH   ;contents of A register
; next line commented out...not needed since X
  already =0
;  LDX #0   ; specify IOCB zero
   JSR CIO   ; let CIO do the real work
; Could check for errors here
   RTS        ; all done
```

Enough said? I refuse to decipher programs like Example 1. Of course, Example 2 wouldn't be very useful either unless equates for the various labels were supplied (as in IOCB.COMMAND= $342), but at least most readers could understand its intent.

Absolutely Not

Regular readers will no doubt recall the many occasions on which I have ranted about staying out of Page 6 or about putting code at LOMEM or about writing code that is not specific to a particular hardware/software configuration. But, to be fair, sometimes it is hard to follow all of the rules, especially when adapting a program from a book or magazine.

Often, the real secret to writing adaptable code is in learning to write self-relocatable code. The techniques we will begin discussing this month are designed specifically for use with the 6502 microprocessor. While there will be several references to Atari internal structure, most of what is presented here is appropriate to Apple and Commodore machines as well.

And I will answer one more question before we start on the hard stuff: *Why* should we want to write self-relocatable code? Sorry, we don't have room for that answer this month. Wait until next month. (It's a good answer, honest!)

Actually, there is just one rule to remember in writing self-relocatable code: *avoid references to absolute memory locations.*

Unfortunately, this is often a very hard rule to follow. Fortunately, there are many places where we can make an exception to this rule.

For starters, look at the subroutine in Examples 1 and 2 above. Is it self-relocatable? Your first impulse might be to say *no,* since it references $342, $348, $349, and $E456, which are all absolute locations. And even if you do it right and use the equated labels of Example 2, they are still absolute, no matter what they look like.

But. Within the context of any given machine, there are always certain locations which *never* change. In particular, hardware locations, locations in ROM, and locations in the RAM (or values used and defined by ROM subroutines) cannot possibly change. An exception to this is when you plug in a new set of ROMs, and you can ask the software vendors about the fun and games the Atari 1200XL's new ROMs are giving them.

In the example given, $E456 (CIO) is in the Atari's OS ROM space. It is a guaranteed entry point to the OS command implementation code. It won't change (even in the new 1200, etc.).

And locations $340 through $34F (as well as $350 through $3BF) are in the IOCB space defined by Atari for use with CIO. Again, they won't and cannot change.

Finally, the command used (11) and the zero buffer length are values defined by the OS ROMs to have certain meanings. And if Atari changes these meanings, we are *all* in trouble, because Atari BASIC, PILOT, and more won't work then.

Implicit Relocatability

The result of all this? No matter where you assemble that example (that is, no matter where the "*=" places the code), the resultant machine object code will be precisely the same! Presto. That example is self-relocatable.

Surprisingly, a lot of the subroutines used with Atari BASIC follow the mold shown here: they simply set up some values in the Atari-specified memory locations and call an Atari-specified OS routine. They are implicitly self-relocatable.

So what is *not* relocatable? Generally, the prime culprits are:

1. References to RAM locations defined within the user's own code (for example, LDA, STA, INC, etc.).

2. Jumps (JMPs) to locations in the user's own code.

3. Calls (JSRs) to locations in the user's own code.

Let's make up an example just to illustrate potential problems.

```
        *= $600
SAVEX *= *+1
MESSAGE .BYTE 'This is the message',0
;
; this is the same code as the examples above
;
PRINTCHARACTER
        LDX #COMMAND.PUTBINARY
        STX IOCB.COMMAND   ; command for CIO
        LDX #0   ; use a zero buffer length
        STX IOCB.LOLENGTH   ; tells CIO to output
        STX IOCB.HILENGTH   ; contents of A register
        JMP CIO   ; let CIO do the real work
;
; call here to print contents of 'MESSAGE'
; Entry conditions: none
; Exit conditions: none, no registers saved
;
```

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```
PRINTMESSAGE
        LDX #0
        STX SAVEX   ; initialize message pointer
MSGLOOP
        LDX SAVEX   ; get current message pointer
        LDA MESSAGE,X   ; get next character of msg
        BEQ QUIT   ; but quit if it's last char
        JSR PRINTCHARACTER   ; else print it
        INC SAVEX   ; point to next character
        JMP MSGLOOP   ; and do another character
;
QUIT
        RTS         ; we are done
```

Do you see the problem areas? If we move this routine somewhere else in memory, the addresses of MESSAGE, PRINTCHARACTER, MSGLOOP, and SAVEX all change, and the object code associated with them changes also. This routine is definitely *not* self-relocatable.

But let's tackle each of the problem labels one at a time and see how we can change the references to each to make the code self-relocatable.

MSGLOOP is the easiest label to "fix." For example, if we change the line JMP MSGLOOP to BNE MSGLOOP, the label MSGLOOP is no longer a problem (since *all* branch instructions are always, by nature, self-relocatable).

And we could save the X-register on the stack (via TXA and PHA) and later retrieve and increment it similarly (via PLA, TAX, and INX), thus eliminating the need for SAVEX.

The PRINTCHARACTER routine could easily be eliminated in its entirety by placing its code in-line in the middle of the PRINTMESSAGE routine. This is a good solution only if PRINTCHARACTER is not called by any other routine. It may also be an adequate solution if the routine being placed in-line is fairly small (as is PRINTCHARACTER) so that you can keep two or more copies around, if necessary.

But what do we do about MESSAGE, which is too big to put in a register? Or what would we do if PRINTCHARACTER was a long routine? And, most importantly, what do we do with a hunk of self-relocatable code once we have managed to produce it?

Next month we'll tackle those questions and others.

A Handy Product?

Do you do much work on *both* Apple II and Atari computers? If so, you could probably use a handy-dandy little device which we recently acquired.

Allen Prowell of Fresno, California, built us what amounts to an intelligent cable between our Apple and our Atari. It plugs into the joystick port on the Atari and into the game port on the Apple. It transfers ASCII files in either direction (doing "light conversion" on return characters, etc.). *Very fast.* It is much more convenient and reliable than using RS-232, and it moves over 1000 characters a second, including disk accesses.

As I said, this is a specialized product, but if you need it, call Allen (209) 227-4917. Using our C/65 and MAC/65 on both Atari and Apple, we have converted an 8K program in as little as two hours, including the transfers, assemblies, etc.

Coming Attractions

I think next month's column will be fairly long, what with the last part of BAIT and Part 2 of self-relocatable machine language. If I have room, though, I will introduce you to a new Atari graphics mode. Also, coming soon, information on some strange and wonderful new products for the Atari. ©

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Jim Butterfield, Associate Editor

Part III

Numeric Output

There's a quick method of generating decimal output on the 6502. It's a notable departure from conventional methods, and it would be worthwhile to lay down a few general ideas.

Shift Transfer

Suppose we have two bytes, OLD and NEW. OLD contains a value, and NEW contains zero. We want to transfer the contents of OLD to NEW, and set OLD to zero. That's not hard by conventional coding (a couple of Load and Store commands), but we're going to look at another method.

Suppose that we shift each bit out of OLD, and then shift it into NEW. Using a left shift, we would code: ASL OLD (arithmetic shift left), which puts the extra bit into the carry; and then ROL NEW, which slides the carry bit into the new byte. If we repeat this eight times, OLD will have moved to NEW, bit by bit. It seems like a slow way of doing it, but it does indeed achieve what we want.

The same method, of course, would move a two-byte OLD to NEW, or as many bytes as we need. Each bit shift would consist of one ASL followed by several ROL commands until the job is done.

A New Way To Rotate

The ROL (Rotate Left) command is compact and handy. It takes the contents of the Carry flag and moves it into the low-order bit position of the operand; all other bits move over to make room, and the high-order bit falls out into the Carry. Now let's do the same thing without using the ROL command.

The ROL command might be considered the same as multiplying by two plus adding a carry, if necessary. We often use the left Shift and Rotate commands for multiplication. But there's another way to multiply: we can use repeated addition.

We can do exactly the same as ROL NEW by coding: LDA NEW: ADC NEW: STA NEW. The original number is doubled, which gives the left shift, and the carry is automatically added in. A new carry condition is generated. All we seem to have done is use three instructions where one would have done.

The Gimmick

But here's the gimmick: we can make the ADC instruction add in a different manner by switching to *decimal* mode. In decimal mode, addition automatically produces BCD numbers. And BCD numbers can be printed as if they were hexadecimal, which greatly simplifies the output calculation.

Let's work this out in principle. First, a warning: on many machines, decimal mode is poisonous to the operating system and to the interrupt routines. Remember to restore binary mode when you're finished; and if your machine uses interrupt, lock it out for the duration of your calculation.

Let's look at simple coding to change a one-byte OLD to NEW:

```
LDA  #$00
STA  NEW       (clear NEW)
LDX  #$07      (eight bits)
ASL  OLD       (grab a bit)
LDA  NEW       (slip it..)
ADC  NEW       (..into..)
STA  NEW       (...NEW)
DEX            (count down)
BPL  BIT       (next bit)
     ...
```

If we are in binary mode, the above routine will copy OLD to NEW unchanged. But if we switch to decimal mode, OLD will be converted to BCD as it is moved to NEW.

A warning here: the result might not fit. A one-byte binary number might need to be converted to three decimal digits (for example, 250). In this case, we'd need to have two bytes available in NEW to hold the result, since BCD holds only two decimal digits per byte. Be sure your coding provides for sufficient space for the answer.

An Example

Let's write the outline of a routine to convert a series of 16-bit numbers to decimal and output

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*See your dealer for exact model number. Rebate program ends August 31, 1983 them. We'll write the code in compact form so as to emphasize the logic flow.

Set up Y to reach several numbers:

LDY #0

Copy a number into the work area:

A: LDA TABLE,Y:STA WORK:LDA TABLE+1,Y: STA WORK1

Move Y to reach the next number, clear output area:

INY:INY:LDA #0:STA OUT1:STA OUT2:STA OUT3: STA ZSUP

Get ready to move 16 bits from WORK to OUT:

LDX #15

Move bit out of WORK:

B: ASL WORK:ROL WORK1

Switch to decimal mode:

SEI:SED

Move bit (decimally) into OUT:

LDA OUT1:ADC OUT1:STA OUT1
LDA OUT2:ADC OUT2:STA OUT2
LDA OUT3:ADC OUT3:STA OUT3

Clear decimal mode:

CLD:CLI

Repeat for next bit:

DEX:BPL B

Prepare to output three bytes (six digits):

LDX #2

Get bytes, high order first, for output:

C: LDA OUT1,Y:PHA

Output high order digit:

PHA:LSR:LSR:LSR:LSR:JSR PUT:PLA

Output low order digit:

AND #$0F:JSR PUT

Go for next byte:

DEX:BPL C

Print RETURN:

LDA #$0D:JSR PRINT

Go back for another number:

CPY #10:BCC A

Quit:

RTS

Zero suppress output subroutine:

PUT: CMP ZSUP:BNE D

Fill with space:

LDA #$20:BNE E

Convert numeric, kill zero suppression:

D: ORA #$30:STA ZSUP

Print and return:

E: JMP $FFD2

Let's put the above into a PET/CBM/VIC/C64 environment to see it work:

```
100 DATA 160,0, 185,80,3, 141,64,3
110 DATA 185,81,3, 141,65,3, 200,200
120 DATA 169,0, 141,66,3, 141,67,3, 141,68,3
130 DATA 141,69,3, 162,15, 14,64,3, 46,6
    5,3, 120, 248
140 DATA 173,66,3, 109,66,3, 141,66,3, 1
    73,67,3
150 DATA 109,67,3, 141,67,3, 173,68,3
160 DATA 109,68,3, 141,68,3, 216, 88, 20
    2, 16,216
170 DATA 162,2, 189,66,3, 72, 74, 74, 74, 74
180 DATA 32,184,3, 104, 41,15, 32,184,3,
     202, 16,236, 169,13, 32,210,255
190 DATA 192,10, 144,155, 96, 205,69,3,
    208,4, 169,32
195 DATA 208,5, 9,48, 141,69,3, 76,210,255
200 FOR J=848 TO 968:READ X
210 T=T+X:POKE J,X
220 NEXT J
230 IF T<>10738 THEN STOP
300 SYS 848
```

The numbers that are printed won't have any special meaning, but you'll see that conversion is taking place, and that zero suppression works nicely.

Converting binary numbers to BCD in preparation for output isn't really a gimmick. It's a sensible way to do an otherwise difficult job. ©

COMPUTE!'s
Machine Language For Beginners

Author: Richard Mansfield
Price: $12.95
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One of the most exciting moments in computing is when a beginner writes his or her first program which actually works... usually after hours of effort. A new world opens up.

But as beginners grow into intermediate programmers and become more fluent in BASIC, they realize the language's limitations – slow speed, and the lack of total control over the inner operations of the computer. They often develop an admiration for the fast, smoothly running machine language programs that mark commercial software. Unfortunately, too many people view machine language as mysterious and forbidding, and they are reluctant to tackle it themselves.

COMPUTE! Books' latest release, *Machine Language For Beginners*, by Richard Mansfield, introduces newcomers to the challenges of machine language with a unique approach. Aimed at people who understand BASIC, *Machine Language For Beginners* uses BASIC to explain how machine language works. A whole section of the book explains machine language in terms of equivalent BASIC commands. If you know how to do it in BASIC, you can see how it's done in machine language.

Machine Language For Beginners is a general tutorial for all users of computers with 6502 microprocessors – with examples for the Commodore 64, VIC-20, Atari 400/800/1200XL, Apple II, and PET/CBM. The numerous machine language programs will work on all these computers.

As a bonus, *Machine Language For Beginners* includes something that all fledgling machine language programmers will need to get started – an assembler. The "Simple Assembler," written in BASIC for the various computers, takes the tedium out of entering and assembling short machine language programs. The book even explains how to use the built-in machine language monitors on several of the computers. And it includes a disassembler program and several monitor extensions.

This book fills the need for a solid, but understandable, guide for personal computing enthusiasts. Mansfield is Senior Editor of **COMPUTE!**. His monthly column, "The Beginner's Page," has been one of **COMPUTE!**'s most popular features.

In the **COMPUTE!** tradition, *Machine Language For Beginners* has been written and edited to be straightforward, clear, and easily understood. It is spiral-bound to lie flat to make it easier to type in programs.

Table of Contents

Available at computer dealers and bookstores nationwide. To order directly call TOLL FREE 800-334-0868. In North Carolina call 919-275-9809. Or send check or money order to **COMPUTE! Books**, P.O. Box 5406, Greensboro, NC 27403.

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C. Regena

Planning Color Sets

In a previous column we looked at defining characters for graphics. Let's expand on that idea and discuss in more detail how to plan the color sets for high-resolution graphics.

To define colors for your graphics, use the CALL COLOR statement. The form is CALL COLOR(s,f,b) where s is the set number, f is the foreground color, and b is the background color. Each of the numbers can be from 1 to 16. Each graphics character you define can have two colors (a foreground color and a background color) chosen from the list of 16 colors.

The Color Sets

There are 16 color sets. Each color set contains eight character numbers (ASCII codes). The table shows which ASCII character codes are in which color set. You may find it handy to mark off these sets on the "Character Codes" table on the BASIC Reference Card that came with your computer. Just make a mark after every eighth number, then number the sets so you can tell at a glance which character is in which set – and which other characters are in the same set.

Color Sets

Set	Character Codes	Set	Character Codes
1	32-39	9	96-103
2	40-47	10	104-111
3	48-55	11	112-119
4	56-63	12	120-127
5	64-71	13	128-135
6	72-79	14	136-143
7	80-87	15	144-151
8	88-95	16	152-159

Now try this short program to see how the CALL COLOR statement works:

```
100 PRINT"HELLO THERE!"
110 PRINT"THIS IS A SAMPLE."
120 CALL COLOR(5,7,1)
130 GOTO 130
```

RUN the program. Lines 100 and 110 just print some words on the screen. By the way, we didn't use a CALL CLEAR statement, so the program will also still be on the screen. The screen turns green when the program starts to run. Line 120 says to change all characters in set number 5 to a red foreground (color 7) and a transparent background (color 1). Line 130 holds the colors on the screen until you press FCTN 4 to CLEAR or stop the program (SHIFT C on the TI-99/4 console). You will notice when you RUN the program that the screen turns green, and then all the letters in Set 5 (@,A,B,C,D,E,F,G) turn red. Color 1 for the transparent background means that the background for the character will be the screen color.

Stop the program by pressing CLEAR. Change line 120 to

```
120 CALL COLOR(5,6,1)
```

The letters turn blue. Go ahead and try different colors for the second number in parentheses.

Now experiment with background color. Add these lines to your program:

```
130 FOR DELAY=1 TO 100
140 NEXT DELAY
150 CALL COLOR(6,7,16)
160 FOR DELAY=1 TO 100
170 NEXT DELAY
180 CALL COLOR(6,16,7)
190 GOTO 130
```

Lines 130-140 and 160-170 are delay loops. RUN the program. Line 120 changes the letters in Set 5 to whatever color you specified. Line 150 changes the letters in Set 6 (H,I,J,K,L,M,N,O) to a red (7) foreground and a white (16) background. Each character will look like a red letter on a white square. After the delay loop, line 180 changes the letters in Set 6 to a white foreground and a red background – now white letters on red squares. Line 190 branches to the delay loop in line 130, so the letters in Set 6 blink red on white then white on red.

Screen Changes

Notice that as soon as you use a CALL COLOR statement, *all* characters in that set change color – those already on the screen and any that you may later print or draw on the screen. Careful planning is necessary so you know exactly which characters you are defining to be certain colors.

If you would like to change the screen color, use CALL SCREEN(c), where c is a color number from 1 to 16. For example, add line 90 and run your program:

```
90 CALL SCREEN(12)
```

Keep in mind that anywhere you have used the color number 1, for transparent, it really means the screen color.

Now try another special effect. Add line 125:

```
125 CALL COLOR(1,2,8)
```

This changes all characters in Set 1 to black on cyan (instead of black on transparent). RUN the program. The "space" is Character 32 in Set 1, and all spaces have been turned to cyan. The screen is light yellow from line 90, so you get a border around a cyan rectangle with various colors of letters from the rest of the program.

The default value of all character sets is black on transparent, so the letters on the screen are black on the screen color of yellow. If you would like a complete cyan rectangle with black letters on the cyan background, the character sets would need to be changed to black on cyan.

Keep in mind that it does make a difference in your programming whether you print first then define the colors, or define the colors and then print. Plan your program so that the computer will perform the actions in exactly the order you want.

Here is another sample program. Type NEW (enter), and then try this program. Watch carefully.

```
1ØØ CALL CLEAR
11Ø CALL VCHAR(1Ø,5,42,9)
12Ø CALL VCHAR(1Ø,1Ø,42,9)
13Ø CALL HCHAR(14,6,42,4)
14Ø CALL VCHAR(1Ø,17,42,9)
15Ø CALL VCHAR(1Ø,24,33,6)
16Ø CALL VCHAR(18,24,33)
17Ø CALL COLOR(2,7,1)
18Ø GOTO 18Ø
```

The computer is quite fast, but you can see that the screen clears, the characters are drawn in black, and then some of the characters turn red. If you prefer to have the asterisks printed in red from the start, the CALL COLOR statement must come before the CALL VCHAR and CALL HCHAR statements. Delete line 170 and add

```
105 CALL COLOR(2,7,1)
```

RUN the program and you can see the difference.

Invisible Characters

Another thing you can try is to draw your characters invisibly and then make them appear all at once. This is quite effective if you have a lot of CALL HCHAR and CALL VCHAR statements drawing an intricate picture. For this program, make the following changes:

```
1Ø5 CALL COLOR(2,1,1)
1Ø6 CALL COLOR(1,1,1)
17Ø CALL COLOR(2,7,1)
175 CALL COLOR(1,2,1)
```

First the characters in Sets 2 and 1 are made invisible by setting both foreground and background to transparent. Next the characters are drawn with CALL HCHAR and CALL VCHAR statements. You won't be able to see this process. Last, line 170 colors the asterisks red, and line 175 colors the exclamation points black so the greeting appears all at once.

When defining your own graphics characters, you may use any character number. If you want to keep the alphabet intact, you will probably use character numbers beyond 95. Group your characters so that all characters of the same color will be in the same set.

Remember that there are eight characters per set. If you are using many different colors or need to conserve memory, you will also need to plan the number of characters you can design in each set. For example, if you have a dog that uses nine characters, could you redraw him in eight characters so only one CALL COLOR statement would be needed?

Refer to the table to determine which characters are in which set. For example, if you are designing character number 134, it will be in Set 13, which contains characters 128-135. Your CALL COLOR statement will use set number 13.

If you are not using the small letters in character codes 97-122 (available on the TI-99/4A console, but not on the TI-99/4), use those numbers to define your graphics characters, then PRINT the characters rather than using HCHAR and VCHAR to draw them on the screen. PRINT TAB(10);"hikn" will be much faster than four separate CALL HCHAR statements to put up characters 104, 105, 107, and 110. By the way, your listing will say "hikn" with the small letters, but when your program is run those letters will be substituted by the graphics characters as you defined them. If you want to use the PRINT method on characters numbered higher than 126, you may use a statement such as PRINT CHR$(132)&CHR$(133)&CHR$(137).

Teeth Wisdom

The following program illustrates the use of color sets in an educational program. "Teeth Wisdom" draws the teeth and their names on the screen in high resolution graphics. After the user knows the names, he or she presses ENTER and the labels clear. The names will be reprinted in a random order. For a quiz, certain teeth will "blink" and the user must press the correct answer. The order will be random.

The teeth are drawn white on a light red background, and the gums are light red on a transparent background. Although all the teeth are white, they are defined in different color sets so that only certain teeth will blink during the quiz. The central incisors use characters 96-100; the lateral incisors, 104-107; the cuspids, 112-117; the bicuspids, 120-127; and the molars 128-134. The gums use characters from 136 to 157.

Since so many graphics characters are defined, DATA statements rather than individual CALL CHAR statements are used. The DATA in lines 240 to 330 are character definitions. Be careful to type these lines exactly as shown. The round symbols are zeros and not the letter O. When there are two or more commas in a row, it means that a character is defined as a null string. At the end of a data list such as line 250, the "" (double quotes) marks are necessary to indicate a null string, but in a series such as in line 260, the quote marks may be omitted between commas. These null strings correspond to unused character numbers.

Lines 180-230 let the character number C vary from 94 to 157 and READ in a string then define character C with graphics definition C$. The CALL COLOR statements blink the asterisks on the title screen while the characters are being defined. Lines 340-390 define the colors for the teeth and gums.

Lines 590-690 PRINT the graphics on the screen, which is faster than using individual CALL HCHAR or CALL VCHAR statements for this many special characters. Within the quotation marks are the lowercase letters – release the ALPHA LOCK key to type these symbols in. Line 610 uses the symbol found on the face of the "C" key and is typed by pressing FCTN and C. Other symbols requiring the FCTN key are in lines 640 and 650.

For The TI-99/4 Console

If you have the TI-99/4 console, you will not be able to type in these lines. You can use the method found in line 600 to print the characters, listing each character number. *Note:* If a program like this has been typed in on the TI-99/4A console, it *will* work correctly on the TI-99/4 console (read it in from cassette or diskette).

In the quiz, lines 900 and 910 blink the particular teeth while the computer waits for a response. A random number (I) is chosen, and the corresponding color set is I+8 for the CALL COLOR statements.

Program Structure

Lines	
100	Title.
110-170	Clear screen; print title screen.
180-230	Define graphics characters 94 through 157 by READing the definitions from DATA; blink asterisks on screen green and white.
240-330	DATA containing graphics definitions.
340-360	Define color sets 9 through 13 as white on light red for teeth.
370-390	Define color sets for light red on transparent for graphics surrounding teeth.
400-510	Clear screen; print instructions; define strings as groups of characters for later printing.
520-560	READ in names of five groups of teeth as N$ array and set the W$ array elements equal to the N$ array elements.
570	Prints message to press ENTER and waits for response.
580-690	Clear screen; print teeth with labels.
700	Prints message to press ENTER and waits for response.
710-760	Clear message and clear labels.
770	Prints quiz title.
780-850	Randomly print names of teeth on screen from the W$ array of five names. A(I) will be the correct corresponding answer.
860-1060	Perform quiz.
870-880	Randomly choose teeth.
890-920	Blink teeth blue and white while waiting for response.
930-940	If number 1-5 is pressed, show which number was pressed, otherwise return to line 890.
950-990	If answer is incorrect, sound "uh-oh" and return for another response.
1000-1030	If answer is correct, play arpeggio.
1040	Clears answer chosen.
1050-1060	Set A element to zero so that tooth will not be chosen again; return to next problem.
1070-1100	Print option to try again; wait for response; branch appropriately.
1110-1140	If user wants to try again, set W$ array elements equal to names of teeth, branch to beginning of exercise.
1150	Stop.
1160-1190	Subroutine to print "PRESS <ENTER>" and wait for response.
1200-1210	Clear screen and END.

Teeth Wisdom

```
100 REM  TEETH FOR TI
110 CALL CLEAR
120 PRINT TAB(4);"****************
    **"
130 PRINT TAB(4);"*";TAB(22);"*"
140 PRINT TAB(4);"*  TEETH  WISDOM
    *"
150 PRINT TAB(4);"*";TAB(22);"*"
160 PRINT TAB(4);"****************
    **":::::::
170 PRINT :::
180 FOR C=94 TO 157
190 CALL COLOR(2,13,1)
200 READ C$
210 CALL CHAR(C,C$)
```