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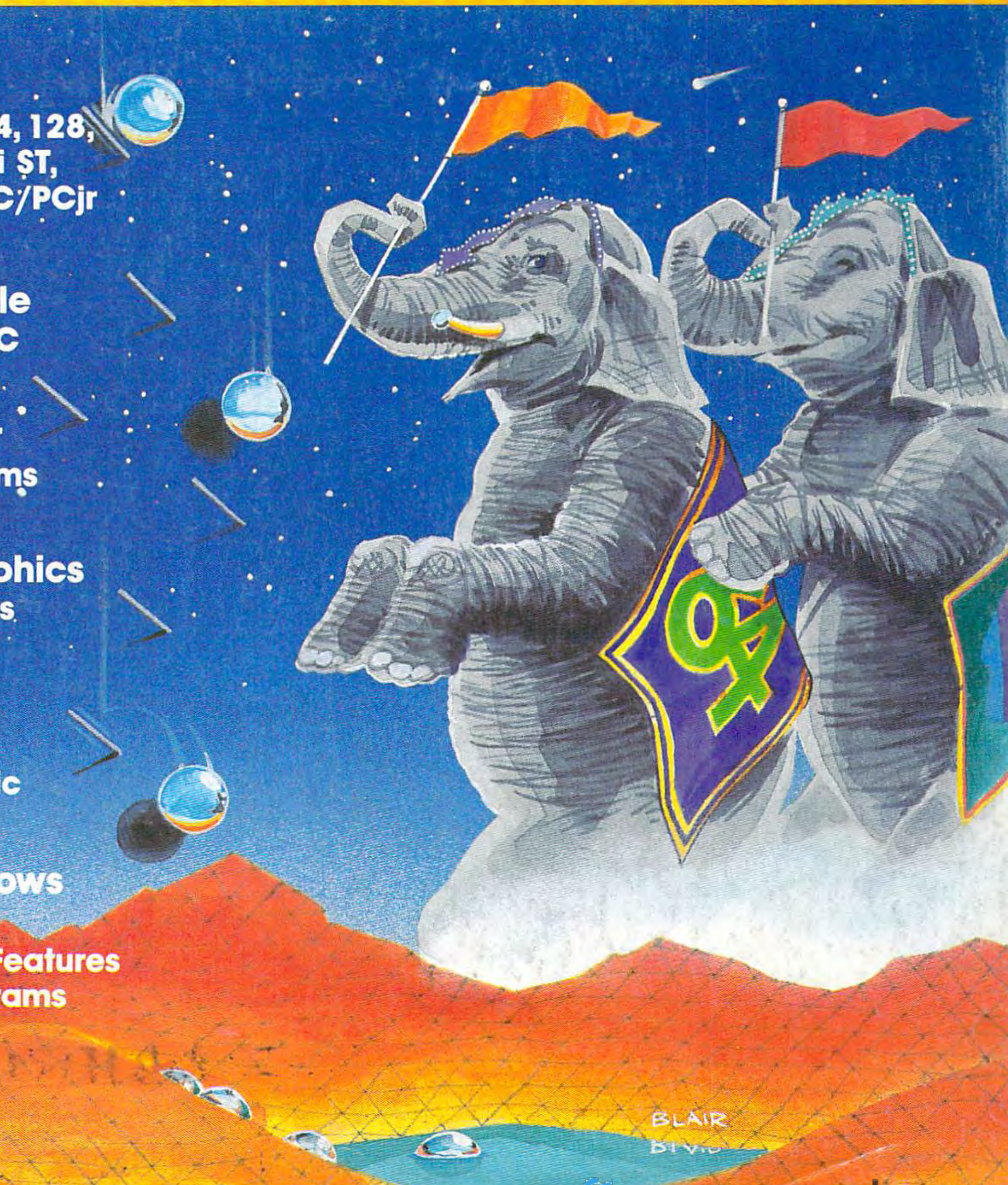

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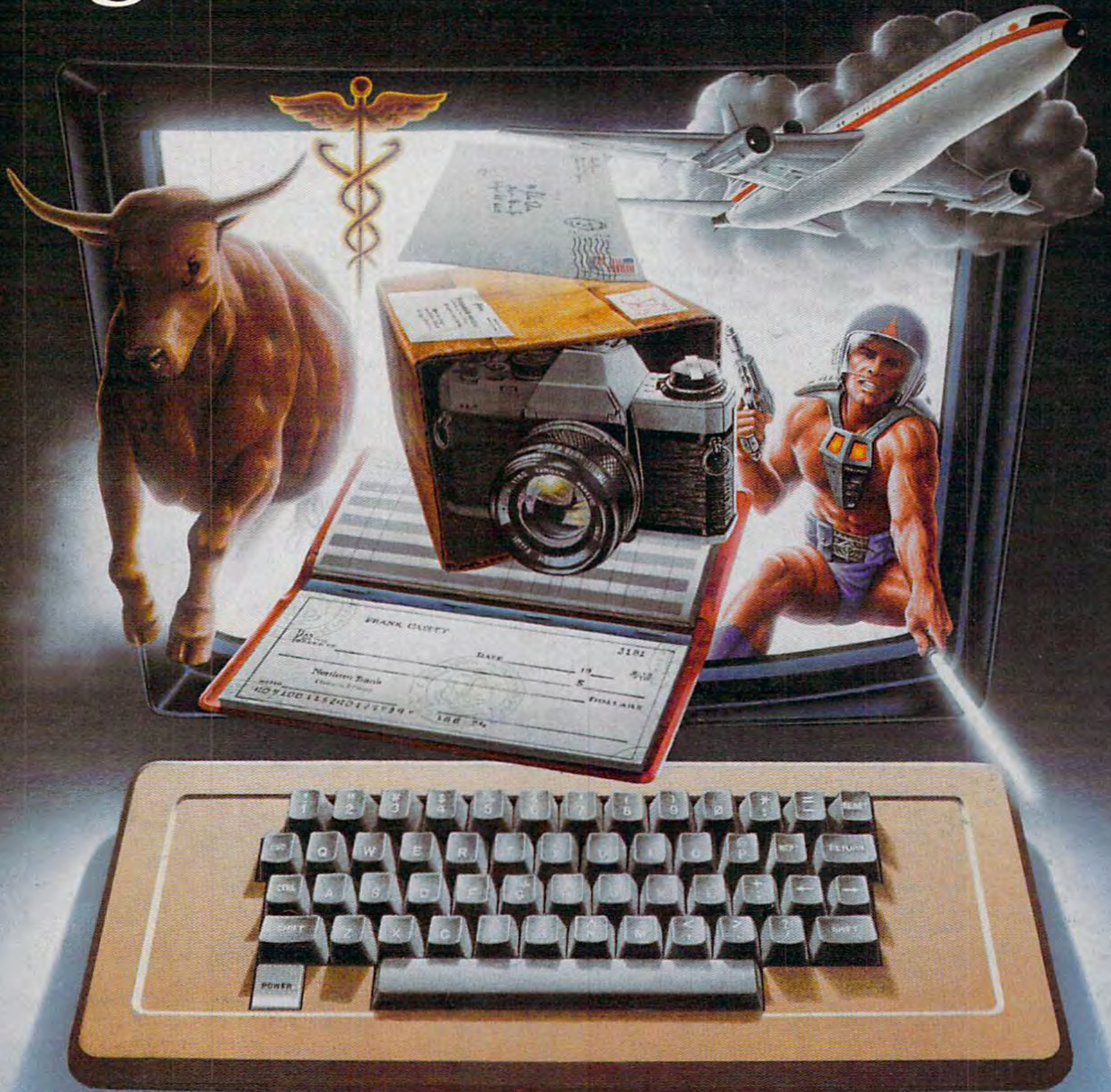

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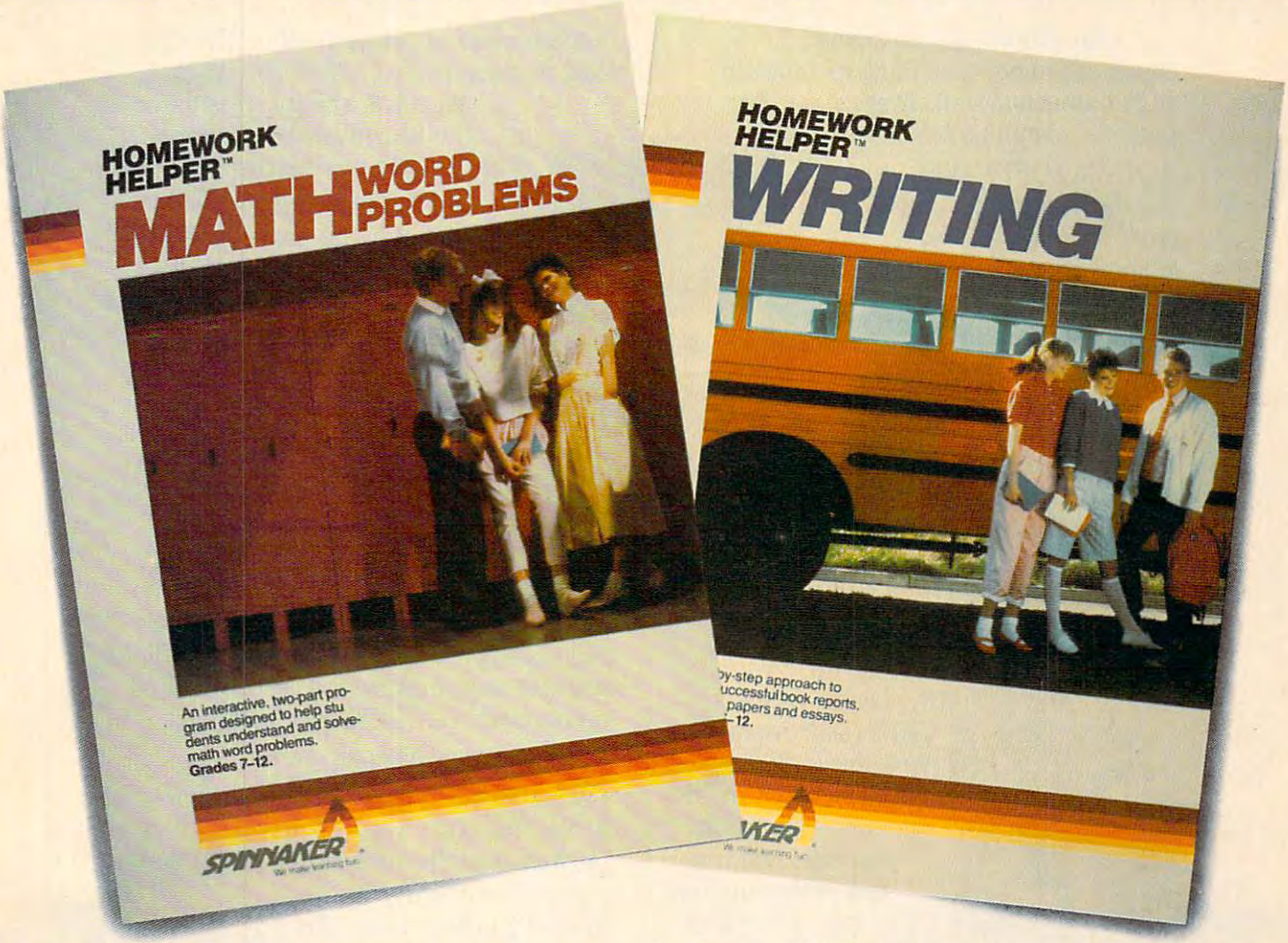
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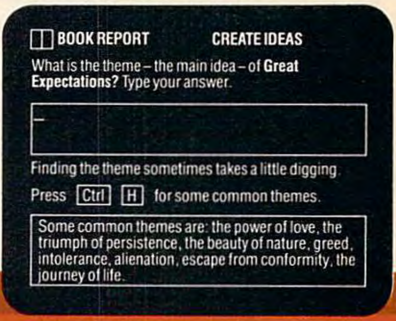

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What is the theme – the main idea – of **Great Expectations?** Type your answer.

Finding the theme sometimes takes a little digging.

Press Ctrl H for some common themes.

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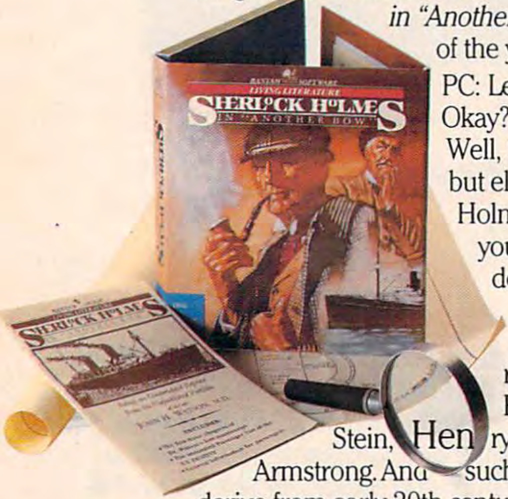
PERSONAL COMPUTER: It's about time someone asked the real expert. What turns me off is boring software. Boring, uninvolving, predictable software. And cold rooms. Why is it always so cold in here?

B: *Games* and *Ahoy* magazines called *Sherlock Holmes in "Another Bow"* one of the year's best.



PC: Let me decide. Okay? (Disk inserted.) Well, this is anything but elementary. You're Holmes. Watson's at your side. And you determine your own fate in case after case. And look, you run into the likes of Picasso, Gertrude Stein, Henry Ford, Louis Armstrong. And such graphics! These derive from early 20th century photographs. I don't have a clue how you did it, but you have a winner. Next case.

B: *The Fourth Protocol*, from Frederick Forsyth's gigantic best-selling book. *Games* called it "nerve-tingling." Here you go. (Slides disk in.)

PC: You mean circuit-tingling. If I knew I had to save the world, I would have gotten more sleep. All kidding aside, this involves *nuclear* weapons. A British traitor. The KGB. And the subversion of NATO. This is a challenge. Will it help if I read the book? (Loud explosion on screen.) Oh no! Does that mean I lost?

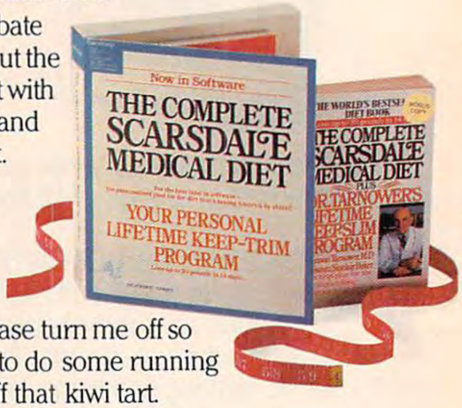
B: No, but losing's the whole point of the next one. *The Complete Scarsdale Medical Diet.* You know the bestseller.

PC: Why, do I look heavy? Never mind, let's have a taste. (Disk is inserted.) This is some menu. It helps you assess your goals. Monitor your progress. Mix 'n match meals from all five Scarsdale diets. Even prepares your shopping list. It'll tell you how much exercise you need to work off certain foods. Let's see about kiwi tart…

B: We've got one other program.

PC: No more. I'm exhausted.

B: No…this is a rebate program. Just fill out the coupon and mail it with proof of purchase and you get $5.00 back.



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PC: Thank you. That's a nice offer.

B: So, did we turn you on?

PC: Yup. Now, please turn me off so I can rest. I've got to do some running later on to work off that kiwi tart.

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AP Apple, **Mac** Macintosh, **AT** Atari, **ST,** Atari ST, **V** VIC-20, **64** Commodore 64, **+4** Commodore Plus/4, **16** Commodore 16, **128** Commodore 128, **P** PET/CBM, **TI** Texas Instruments, **PC** IBM PC, **PCjr** IBM PCjr, **AM** Amiga. *General interest.

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Editor's Notes

Now that the hubbub is dying down after the introduction of Atari's ST and Commodore's Amiga, those long-awaited, powerhouse, new-generation computers, perhaps it's a good time to reflect on their relative merits. Although not much software is yet available to show them off to best advantage—a few adventure games, utilities, and applications programs so far—some conclusions can already be drawn.

We've been writing and editing Amiga and ST books and articles here for some months, and our staff is already segregating into camps. We've had camps, of course, for years: Apple enthusiasts, Commodore fans, Atari aficionados, IBM devotees, and assorted other, smaller, clusters of allegiance. It all makes for some spirited exchanges on the relative merits of the competing technologies and, we like to think, energizes our writing and programming.

For example, one of the major responsibilities of our programming staff is transporting programs between machines. We'll transport an arcade game with excellent graphics from its original home to several new computers with varying screen, color, sprite, character, and sound capabilities. This sort of thing throws the differences between computers into high relief.

The Amiga and the ST are quite similar in many respects: Each has a 68000 chip; 512K RAM (although the Amiga is advertised as having only 256K RAM, since the rest is reserved for storing the disk-based operating system); 3½-inch disk drive; mouse; windows; pull-down menus; RS-232 port; parallel printer port; and high-resolution color graphics.

The most striking difference, perhaps, is the price: with color monitor and disk drive, the Amiga costs $1,800, $800 more than the ST. For this extra money, you get multiprocessing, which allows you to run more than one program at a time. The Amiga also offers a more complex sound system with four voices in stereo to the ST's three in mono. The Amiga has 640 × 400 and 640 × 200 resolution modes with 16 simultaneous colors, a 320 × 200 mode with 32 colors, and a total palette of 4,096 colors. The ST has a 640 × 400 monochrome mode, a 640 × 200 mode with 4 simultaneous colors, a 320 × 200 mode with 16 colors, and a total of 512 colors.

Thus, some of the specs would favor the Amiga if, for example, you need extraordinary degrees of color or resolution. Some argue that differences between color number 3,067 and 3,068 are extremely difficult to detect and that this palette represents overkill; others disagree. The Amiga has specialized chips dedicated to memory moves, fills, and other graphics and sound techniques. This frees up the 68000 to do other things while graphics are being manipulated (an important consideration on a computer with a bitmapped, graphics-oriented display). On the other hand, the ST allows the 68000 to run somewhat faster than does the Amiga.

An ST disk holds 360K, the Amiga 880K (although double-sided ST drives with 720K are an option). The Amiga has built-in speech synthesis, but the ST has a built-in MIDI interface for controlling external synthesizers and drum machines. The ST has a built-in hard disk interface; the Amiga requires an additional interface.

Many of the differences between the machines can be eliminated, however, by upgrading, adding peripherals, cards, or options. For example, Commodore will offer a plug-in MIDI interface, and, doubtless, speech synthesis will be made available for the ST. Commodore has announced and demonstrated IBM compatibility via a software emulator, opening up a huge software base. Of course, ST developers are likely to be working on this, too.

While not claiming that the COMPUTE! staff represents a microcosm of the computer marketplace, we have heard effective defenses of both computers. One of our ST partisans says that the disk I/O is faster; software is in greater supply; the operating system and hardware have been around longer and are therefore more fully tested; the machine is easier to understand; there's more speed except for graphics-oriented computing; the keyboard is excellent; the debugger is better; nobody needs multitasking (who could stay in control while simultaneously supervising a spreadsheet and calling a bulletin board?); anything you want that the ST doesn't have you can add; and so forth.

An Amiga owner insists that his computer can expect a great deal of software very soon (the ST was released earlier, and much of its current software comes from Europe where the Amiga has yet to be introduced); the Amiga is hardly an untested technology—it's been in development for three years; the difference in the clock speeds is rendered irrelevant because of the layers of systems, software, languages, and applications above a clock; such things as area fill are built into the Amiga hardware which further counters any clock differences; adding on things not built into the machine results in a pile of extra cords and extra expense; built-in speech means that all programs can use that feature without worrying about compatibility; multitasking is quite useful—having more than one program resident in RAM avoids disk-swapping or rebooting and also allows unrelated software to act as if it were an integrated package.

Rising to the occasion, the ST proponent counters that provisions for multitasking are possible in the ST as well. And so it goes.

At user groups, in magazines, and on telecommunications services around the country, advocates urge one another to get realistic and accept the fact that machine A is obviously better than B. Any comparison of them is contrapuntal; any argument designed to demonstrate the superiority of one can be met by an equally convincing counterargument. It's not surprising that this debate has vitality. After all, the COMPUTE! staff has been working closely with many different machines for years and, with rare exceptions, our Atari camp has never been able to convert the Commodore camp and vice versa, not to mention the solidity of Apple, IBM, and other allegiances. It appears that the ST and Amiga have raised new flags and are likely to perpetuate the friendly face-off that's been an energizing force in personal computing for a decade.

Richard Mansfield

Senior Editor

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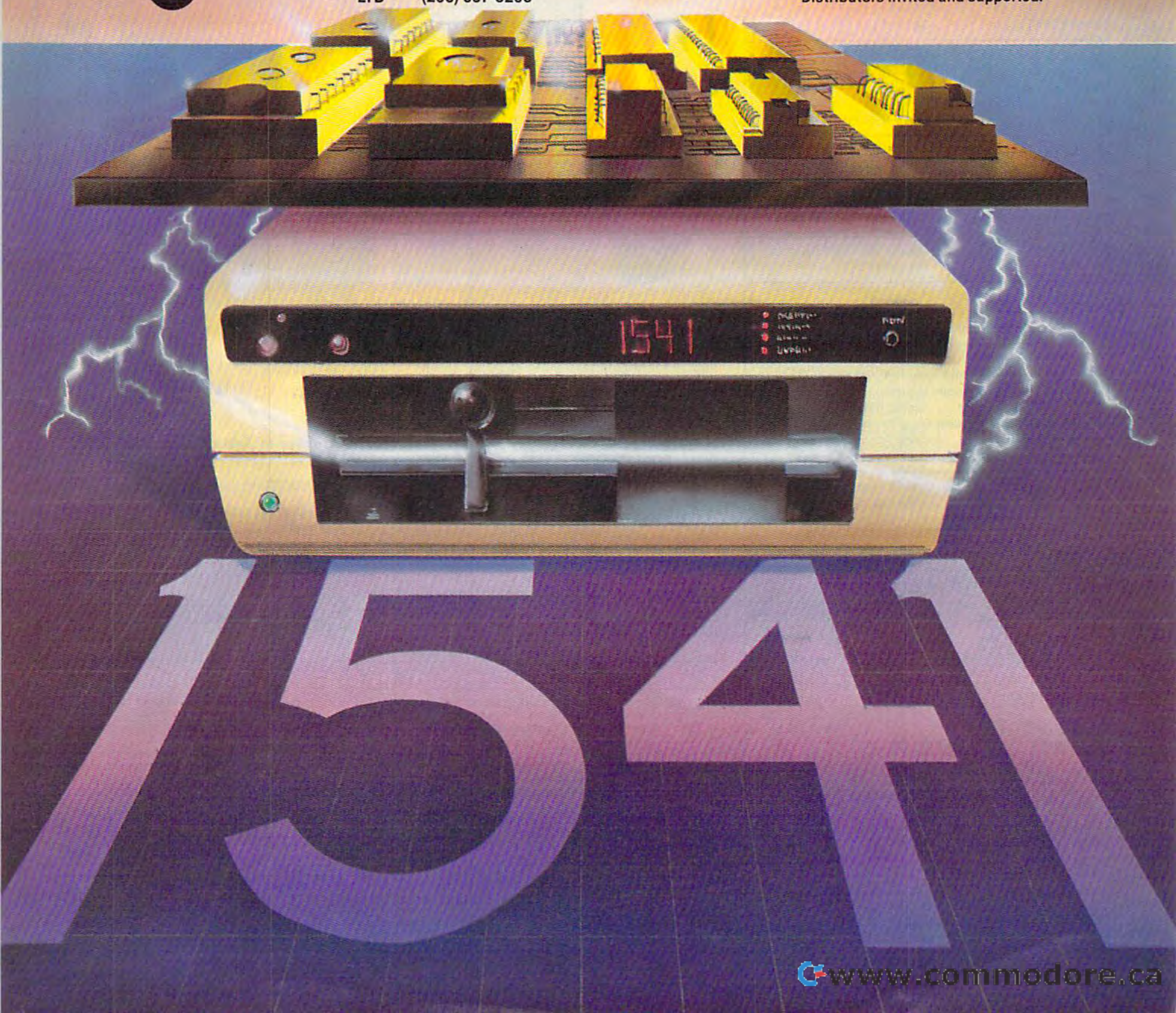

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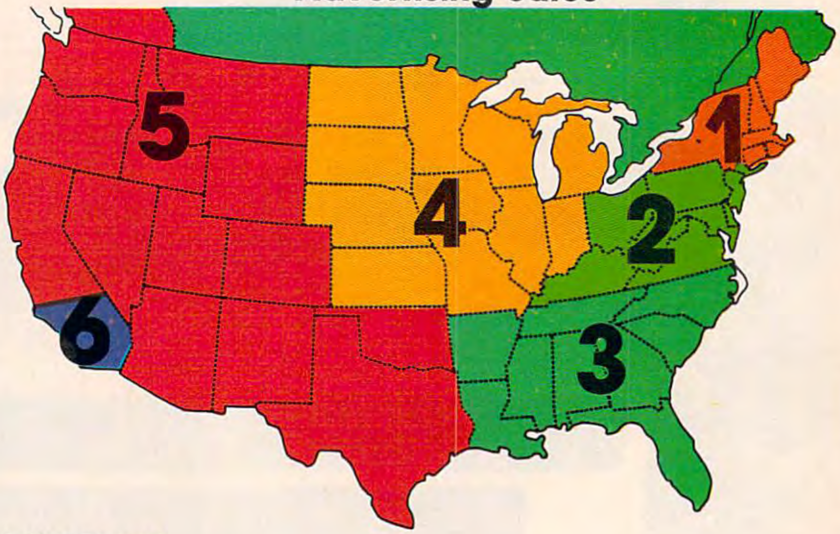

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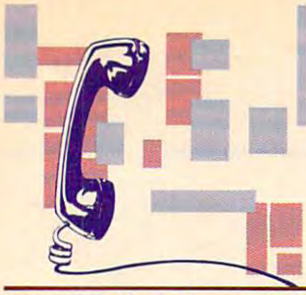

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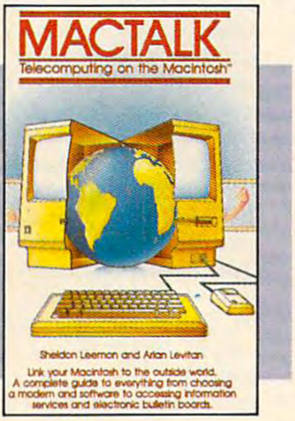
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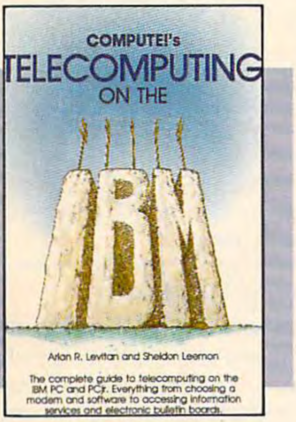
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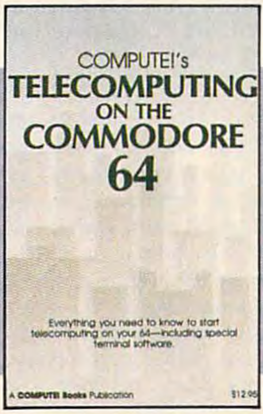
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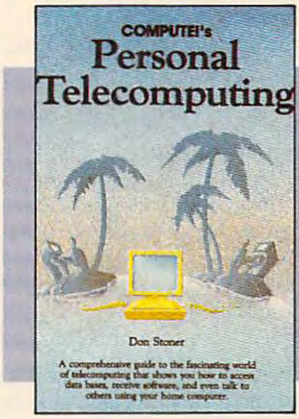
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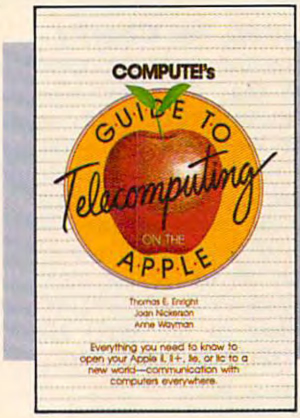
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A Few Helpful REMarks

I suppose this isn't a new idea, but whenever I type in a program printed in COMPUTE!, I add one or two REM lines near the beginning to indicate the program's name, the date, and the page number where it appeared. That way, if I forget some command and can't get the program to work correctly, I can always find the COMPUTE! article which accompanied that program and reread the instructions.

John Hibbs

After a few weeks or months have elapsed, it's easy to forget exactly how a program works, even if it's one you wrote yourself. In most cases, you can't harm a program by adding a couple of REMs. However, you should be careful not to disturb existing lines unless you know exactly what the program is doing. Also, this technique is limited to BASIC programs. Some machine language programs such as Commodore 64 SpeedScript *begin with a line of BASIC (usually something like 0 SYS2061) so that you can load and run the program as if it were BASIC. If you try to add a REM to such a program, it probably won't work at all.*

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Digitized Amiga Sound

In the September 1985 issue of COMPUTE!, you mentioned that the Amiga computer will be able to digitize music. If I were to plug the output from a stereo system or a radio into the Amiga, could it record the music and play it back exactly like the original? How many different voices does the Amiga computer have?

Robert Patterson

The answer to your first question is a qualified yes. The Amiga can play back digitized sound, but you can't plug your stereo output directly into an Amiga and expect to record music without additional hardware and a program to control it. The output from conventional sound equipment is an analog *signal, whereas the Amiga, like other computers, deals only with* digital *information (binary 1's and 0's). Before doing anything else, you'll need to pass the analog signal through an analog-to-digital (A-to-D) converter to put it in a form the computer can use. That sounds more forbidding than it really is: The components for A-to-D converters are cheap and readily available, and it probably won't be long before you see reasonably priced plug-in digitizers for the Amiga.*

Assuming you can convert the incoming signal to digital form, the computer must then sample the signal at a rapid rate—usually thousands of times per second. At each sampling interval, it stores a numeric value which represents the sound input at that point in time. The more frequently you sample the sound, the higher the quality of reproduction—and the more memory is required. The Amiga's 68000 microprocessor runs fast enough to sample incoming signals at an extremely high rate—rivaling the quality of compact disc sound—but even 512K of RAM isn't enough to record significant amounts of high-quality music. Remember that a compact disc can store only up to 75 minutes of music with its capacity of 550 megabytes (563,200K). At that sampling rate, a 512K Amiga could barely record four seconds of music. Of course, by lowering the sampling rate (and accepting somewhat lower quality), that duration can be extended.

At the end of the digital sampling process, the computer has thousands of sample values stored in memory, which can be saved to disk for future use or output directly through a sound channel. To output the digitized sound, you simply reverse the process, reading the stored data from memory, converting it from digital to analog form, and sending the resulting signal to a conventional amplifier at the same rate it was sampled. The Amiga already contains circuitry that can perform the D-to-A conversion at the output end of the process, so sending digitized sound out doesn't require any extra hardware at all.

To answer your second question, the Amiga has four independently programmable sound channels (voices). However, it's difficult to compare them to sound channels on other computers because they're considerably more flexible than tone generators. Most computers are limited to producing one or several basic waveforms, but the Amiga lets you define your own waveforms. And since one channel can modulate (affect) another, it's possible to create extremely sophisticated sounds. Any single channel can simulate a complex waveform, so individual channels can make sounds which would require several channels on other computers. Two of the four channels are assigned to each of the Amiga's stereo outputs, so realistic stereo effects are fairly easy to achieve. The Amiga version of "Switchbox," found elsewhere in this issue, creates stereo effects by switching sounds back and forth between the two stereo outputs.

Moving The New Proofreader's Checksum

When I use the "Automatic Proofreader" with my Commodore 64, the checksum is displayed too high on my screen to be visible. Is there any way to modify the program so it prints the checksum lower on the screen?

Melvin Baral

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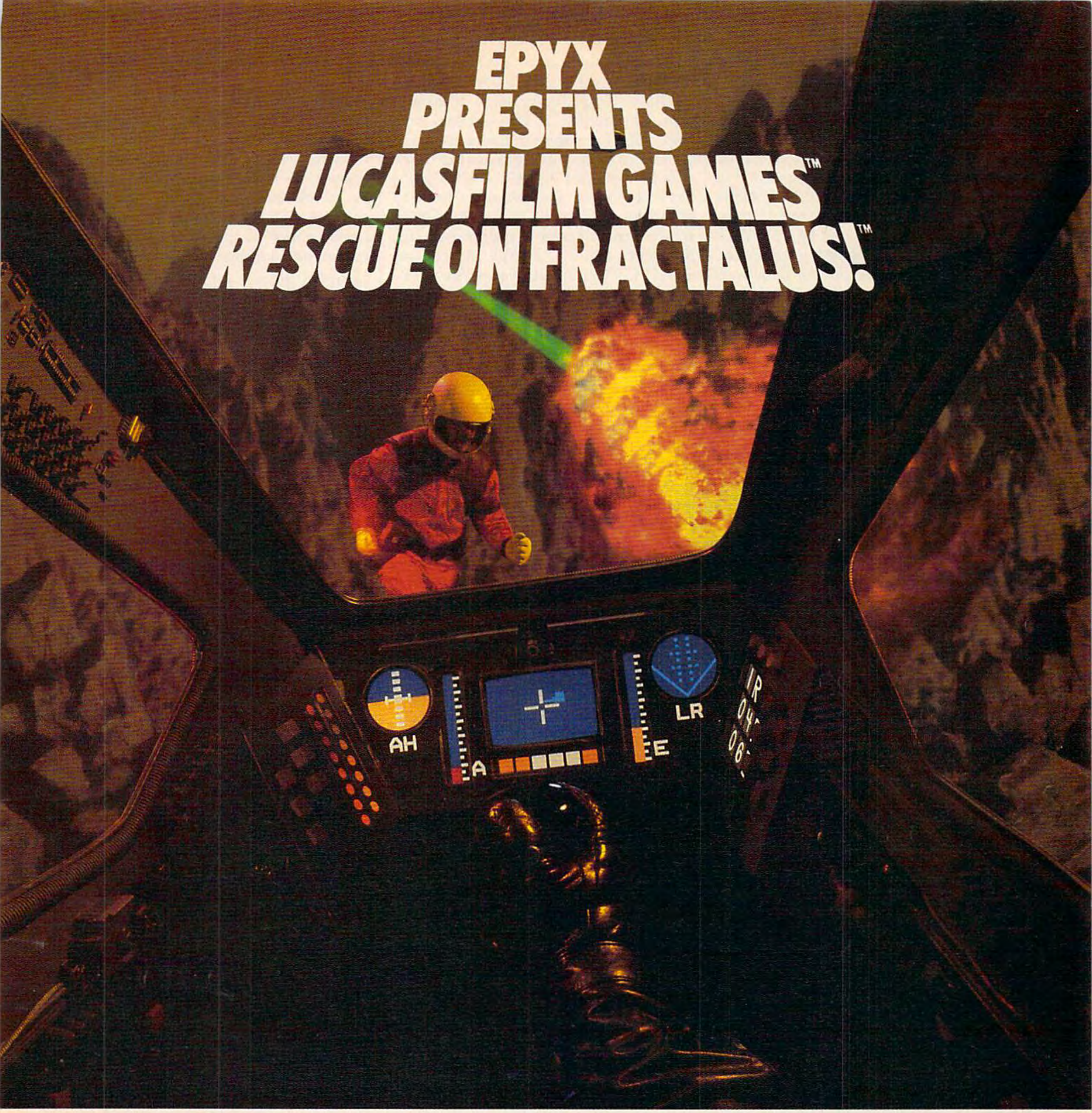

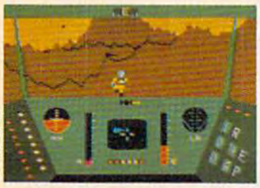

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The problem you mention is typical of TV sets or monitors that suffer from severe overscan (they can't display all of the picture on the screen). If you can't adjust the picture to include the top screen line, you'll have to modify the program. In this issue, we're introducing the "New Automatic Proofreader" for Commodore computers, which works on the 64, 128, VIC-20, Plus/4, and 16. Though it's designed to print the checksum in the upper-left corner of the screen, the new Proofreader can be made to print it elsewhere. First, follow the instructions in the article for typing and saving the new Proofreader. Then reload it and make the following changes:

- *In line 80, change 20570 to 20551.*
- *In line 110, change 22054 to 22035.*
- *In line 190, change 19 to 0.*

Now resave the program, using a different filename so you can tell it apart from the original version. The modified Proofreader prints the checksum just below the last line entered, rather than at the top of the screen. You can either type the next line number over the checksum, or move the cursor down to the next blank line and then start typing. Since this modification makes the Proofreader less convenient for listing and rechecking a group of existing program lines, you probably won't want to make this change unless it's absolutely necessary.

Checking Apple DOS From BASIC

How can an Apple II BASIC program check to see which operating system is running?

P. Nyman

There are quite a few differences between DOS 3.3 and ProDOS, but with a little care, a BASIC program can run under either operating system. You can tell which system is active by PEEKing memory location 48640. This is the start of the BASIC System Global Page in ProDOS, and contains operating system variables which a BASIC programmer might want to read or change. Since the page begins with a machine language JMP (jump) instruction, this first byte has a value of 76 under ProDOS. When you use DOS 3.3, the same byte contains 208. Here's a simple routine that does what you want:

```
10 IF PEEK(48640)=76 THEN PRINT
   "PRODOS INSTALLED":GOTO 30
20 PRINT "DOS 3.3 INSTALLED"
30 REM PROGRAM CONTINUES HERE
```

Atari Compiler Problem

I own an Atari 800XL and frequently use Datasoft's *BASIC Compiler* to compile my own BASIC programs. I recently tried to compile a public domain terminal program called "Amodem 7.1," with unsatisfactory results. The compiler won't accept statements that GOTO or GOSUB a variable or expression. The author of the terminal program used the common memory-saving technique of defining often-used numbers as variables (C1=1, and so on). I have converted the variables back to numbers, but the GOTO and GOSUB statements still refer to expressions (for instance, GOTO 3*100 instead of GOTO C3*C100). Can you write a routine that will take me the rest of way, or lead me on the right track?

Dennis Brenner

*Since we don't have the terminal program in question, we can't give a specific answer. However, it's not very practical to write a routine that will solve your problem automatically. You'll need to analyze each of the problem statements to determine whether it always branches to the same destination, or branches to different destinations depending on the controlling variable's value. To explain, say that you find the statement GOTO C3*C100 and discover that C3=3 and C100=100. If it's clear that the values of C3 and C100 never change, you can replace the statement with GOTO 300. However, the primary reason for using a variable expression with GOTO or GOSUB is to permit the program to branch to a variety of destinations depending on the variable's value.*

*For example, say that you find the same statement (GOTO C3*C100) and discover that C3 may have the values 1, 2, or 3 when this statement executes. Program flow will branch to line 100, 200, or 300, depending on the value of C3. In this case, you can't replace the expression with a constant, since that would limit the branch to only one destination. The best alternative is to substitute ON-GOTO and ON-GOSUB. For instance, the statement ON C3 GOTO 100, 200, 300 branches to line 100 when C3=1, line 200 when C3=2, and so on. To make this work, you must determine all the possible values that the controlling variable (C3 in this case) might have, and compute all the destinations that might be generated by that expression. Once that's done, you'll know which line numbers to put at the end of the ON-GOTO or ON-GOSUB statement.*

Most BASIC compilers accept only a subset of all the commands in BASIC, so it's possible that yours might not handle ON-GOTO or ON-GOSUB, either. If that's the case, you could replace the original statement with a string of IF-THEN-GOTO statements (IF C3=1 THEN GOTO 100, IF C3=2 THEN GOTO 200, etc.). This construction is less efficient, but should work with almost any compiler. Tradeoffs of this sort are inevitable when compiling programs that weren't designed to be compiled.

Saving IBM PC Screens

I'm writing a BASICA painting program for the IBM PC that does all the drawing with PUT commands. But I need to know how to save a picture to disk so my work isn't lost when I turn the computer off. I know you can store an entire screen in an array with a GET command like this:

```
10 DIM V(4001)
20 GET (0,0)-(639,199),V
```

How can I save the contents of this array to disk?

David Short

*It's a simple operation in BASICA. The VARPTR function can tell you the memory location where any array is stored, and BSAVE can save the contents of any block of memory, including arrays or other variables. Since each element of the array occupies four bytes, you must save 16004 (4*4001) bytes of memory. Use VARPTR(V(0)) to find the location of the first element in the array. This statement saves the array V in a file called PICTURE:*

```
30 BSAVE "PICTURE",VARPTR(V(0))
,16004
```

Here's a complementary program to load the same picture from disk and display it on the screen. Don't forget to DIMension the array before performing this operation.

```
10 DIM V(4001)
20 BLOAD "PICTURE",VARPTR(V(0))
30 PUT (0,0),V,PSET
```

Embedded BASIC Words

I usually pay little or no attention to spacing when typing BASIC programs, but when using "MLX II" to type in a program from the December 1985 issue of COMPUTE!, I ran into a puzzling problem. Everything worked fine until I tried to load data and received the message SYNTAX ERROR IN LINE 830. I rechecked the line and found that everything was correct, except that I hadn't used the same spacing shown in the magazine listing. When I corrected the spacing, the program worked perfectly. After a little further investigation, I discovered that the space causing the problem was between ST and AND. Why does that space make such a difference?

Jim David

Here's what that portion of line 830 looks like:

```
IF ST AND(I<>B)THEN F=2
```

Both AND and ST are reserved words *in Commodore BASIC, meaning that BASIC lets you use them for only one purpose. ST (STatus) is a reserved variable that indicates the status of input/output operations like loading or saving to disk. AND*

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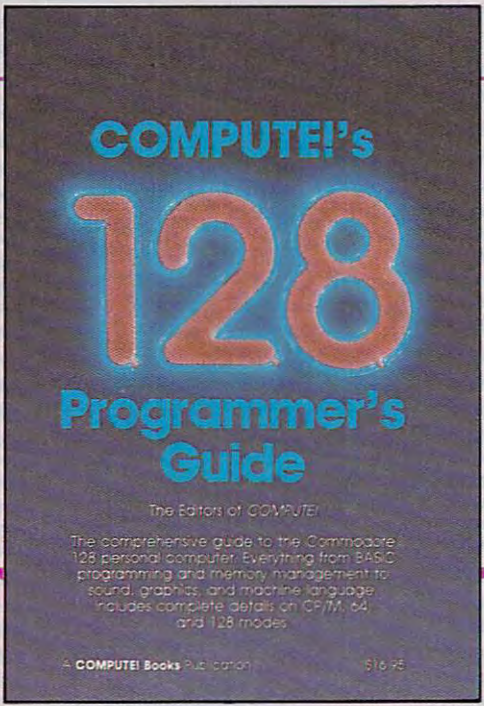
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is a logical operator which in this case connects the value of ST with the value of the expression (I<>B).

Typing STAND(I<>B) instead of ST AND(I<>B) makes the computer see a third reserved word in the line—the numeric function TAN (TANgent). Since TAN, like other functions, must be followed by something inside parentheses, the computer responds with a syntax error message when it finds the letter D instead of a left parenthesis. That's a nutshell explanation for the error. But you may still wonder why the computer sees TAN inside the word STAND. After all, the words ST and AND seem to be there as well.

The short program below shows exactly why TAN appears. Don't worry about the fact that line 10 looks strange. We're not going to execute that line—it's only there to let us examine how BASIC handles these reserved words.

```
10 :ST:TAN:AND::STAND::
20 PRINT CHR$(14);CHR$(147)
30 FOR J=0 TO 19:POKE 1024+J,
   PEEK(2049+J):POKE 55296+J,1:NEXT
```

After typing the program, enter GOTO 20 and press RETURN (don't start the program with RUN). Line 30 PEEKs the first 20 bytes of BASIC program space and displays their contents on the screen, showing you how the computer stores line 10 in memory. As you'll see, the reserved variable ST is stored as the ASCII characters S and T, exactly what you typed in. This is the way all variable names are stored. However, both TAN and AND are changed into one-byte tokens, which appear here as reverse video characters. Most BASIC words are tokenized—compressed into a single numeric value—to save space and make BASIC run faster. Between the double colons we placed in the line as markers, you can see how the computer handles the character sequence S-T-A-N-D. When it tokenizes a BASIC line, the computer reads from left to right, just as you do. The initial S in STAND is left unchanged, since it isn't part of a keyword that can be tokenized. Next, the computer finds the characters T-A-N, which it replaces with the one-character token for TAN. That leaves the character D, which is also left unchanged.

After TAN is tokenized, the computer can't possibly see ST or AND (T and AN are missing), so the line can't work as intended. In this case, it was coincidental that the combination of two reserved words made a third reserved word. However, the same thing would happen if you omitted a space between ST and the logical operator OR. When the computer scans the characters S-T-O-R, it changes the embedded keyword TO into a token. For similar reasons you should be careful not to use variable names like TOP, NOTE, or FORK, which also contain embedded BASIC words (TO, NOT, and FOR).

Arabian Atari Revisited

In the December 1985 "Readers' Feedback" you printed a letter from Nour Abdullah Al-Rasheed asking how to make the cursor on his Atari computer move from right to left. He may want to consider a hardware solution. The images displayed by a television set or monitor are placed on the screen by vertical and horizontal deflection circuits. An experienced electronics technician who's familiar with video displays should be able to examine the schematic for that device and determine which wires control horizontal deflection. By rewiring that circuit, the technician could bring about the desired change. This modification should probably be considered permanent; and it may require some adjustment of normally untouched internal controls to get a satisfactory picture. While it might be possible to install a switch that would let you flip back and forth between display modes, the technician would have to use special insulating spacers and take pains to protect the operator from the very high voltages involved.

Jim Taylor

Thanks to you and the other readers who suggested this solution. As you point out, the circuitry involved carries extremely high voltages that can cause very serious injury, so this type of modification must be performed by a fully qualified technician. *Unless you fit that category, don't even consider poking around inside your TV or monitor. You may cancel any warranty which is in effect, and run a serious risk of injuring yourself as well as the device.*

Refurbishing Tip

I really appreciate the article "Refurbish Your 64" from the December issue of COMPUTE!. Here is an additional convenience feature. If you change line 3470 to read as follows, you won't have to enter the direct mode statements (POKE 55,0:POKE 56,160:POKE 643,160:POKE 644,160:NEW) after the program is run.

```
3470 READ A0:IF A0=99999 THEN
   POKE253,253:SYS49194:POKE643,0
   :POKE644,160:NEW
```

Albert Alarie

Thanks for the tip.

TI Music

I have seen TI-99/4A programs that create music with DATA statements. Please show me how this is done.

Tim Huemmer

Though the DATA statements play a part in the process, the TI actually makes sound with CALL SOUND. Here's the simplest form of the statement:

```
CALL SOUND(d,f,v)
```

The first value in parentheses (d) sets the duration for the sound. The second value (f) sets the frequency, and the third (v) sets the volume. CALL SOUND lets you produce as many as four tones at once, so with a statement like CALL SOUND (d,f1,v1,f2,v2,f3,v3) it's possible to create a three-note chord. In this case, f1, f2, and f3 represent the frequencies of the three notes, and v1, v2, and v3 represent their respective volumes. Of course, in a program you'd substitute real numbers or variables inside the parameters.

Where do DATA statements come into the picture? In most cases, it's simplest to read the music data from DATA statements and assign it to variables inside parentheses in CALL SOUND. This saves program space and makes the music data easier to understand and modify. Here's a short example of how it's done:

```
100 V=5
110 FOR I=1 TO 5
120 READ D,F1,F2,F3
130 CALL SOUND(D,F1,V,F2,V,F3,V)
140 NEXT I
150 DATA 1500,262,330,390
160 DATA 250,262,349,440
170 DATA 1500,262,349,415
180 DATA 250,277,349,415
190 DATA 1500,277,370,466
200 DATA 250,262,392,466
```

This program plays five three-note chords. Line 100 assigns the value 5 to the variable V. Since the CALL SOUND statement uses V to set the volume for every note, it stays the same throughout the program. Line 120 READs in new DATA items for each chord, setting the duration with the variable D and the three note frequencies with variables F1, F2, and F3. The frequency values for the notes are found in the appendix in the TI User's Reference Guide. *You can read more about TI sound in* COMPUTE!'s Programmer's Reference Guide to the TI-99/4A *by C. Regena. Several of her monthly columns in* COMPUTE! *have also covered this topic.*

Commodore B128 Users' Group

I was glad to see that Jim Butterfield's dynamic keyboard articles (COMPUTE!, October–December 1985) included some references to the Commodore B128 (called the B700 in Europe). As you may know, the international B128 user group is sending out 13,000 newsletter/membership applications to B128 owners in North America and B700 users in Europe. The group currently has 1,500 members, and membership is rapidly increasing. Our disk library is also off to a good start, and offers a variety of public domain

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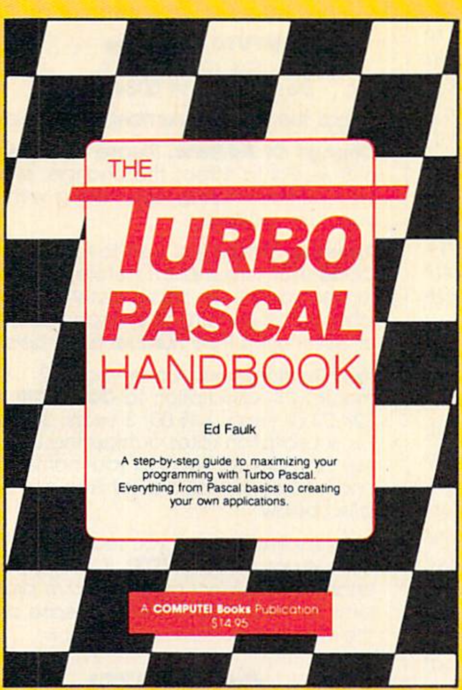
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Thanks to reader John A. Francis for supplying this information.

Booting PCjr In 80 Columns

I own an IBM PCjr, as do many of my coworkers. We would all like to know if there is any way to make the PCjr boot DOS 2.1 in an 80-column format instead of 40 columns. Presently, to get DOS in 80 columns, I execute the program "Rebound" which was published in COMPUTE!. I then press Fn-Break, and the DOS prompt appears in 80 columns. Can you show me a simpler way?

Martin Gappa

No tricks are needed to get 80 columns on the PCjr, since DOS has a command specifically for that purpose. Just type MODE 80 at the DOS prompt with the DOS disk in the drive. To get back to 40 columns, type MODE 40. Additional parameters let you shift the display left or right to center it on the screen. MODE 80,L shifts the display two characters to the left, and MODE 80,R shifts to the right. A third parameter, T, displays a test pattern on the screen for precise alignment. For example, MODE 80,R,T shifts the display to the right and prints the digits 0–9 eight times across the screen. Then you're asked if you can see the leftmost 0. If you can't, press N and the display shifts again followed by the same prompt. Press Y to return to the DOS prompt.

You can make the computer automatically switch to 80 columns when it's turned on by using a batch file. To create the batch file, insert one of your disks with system files on it and enter the command COPY CON AUTOEXEC.BAT. Then type MODE 80 and press the F6 function key (Fn-6) followed by Enter. When the drive stops spinning, display the directory: You should see the file AUTOEXEC.BAT. This file is automatically executed when you turn on the computer. For more information about batch files, see "All About IBM Batch Files" in the September and October 1985 issues of COMPUTE!. *Since MODE is an external DOS command, you must also have the file MODE.COM on the same disk. To add this feature to all your boot disks, use the COPY command to copy both AUTOEXEC.BAT and MODE .COM to each disk.* ©

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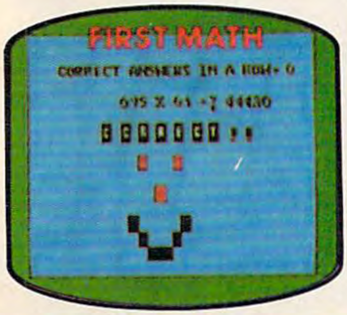

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THE FUTURE OF MASS STORAGE

Selby Bateman,
Features Editor

Dramatic changes are occurring in the ways we store computer information. Technological advances and lower production costs are affecting both magnetic and optical data storage media. Traditional 5¼-inch floppy disks are giving way to 3½-inch microfloppies. Hard disk drives are rapidly becoming cost effective for average users. And low-power lasers are making optical storage technology the medium of the future. Here's a look at how far and how fast data storage technology has come, and where it's headed next.

Just when we think we're getting used to the pace of change, technology surprises us again. Consider the following important changes to the ways we store computer data:

• Apple Computer introduces its UniDisk 3.5, a 3½-inch disk drive for the Apple IIe and the Apple IIc computers that can store up to 800K (kilobytes) of information, more than five times the amount of the standard Apple 5¼-inch drives.

• New 3½-inch drives are included as standard storage systems for Atari's 520ST and Commodore's Amiga, joining Apple's Macintosh which was introduced with the drive in 1984. Industry sources believe IBM will also begin using the faster, more powerful 3½-inch drives sometime in 1986.

• Blue Chip Electronics says it plans to offer a 3½-inch disk drive for the Commodore 64, tentatively priced at about $100. Commodore insiders admit that they already have the technology to offer a 3½-inch drive and a 10-megabyte hard disk drive for the 64 and 128 (although no plans to market these peripherals have yet been announced). Atari also has been considering a 3½-inch disk drive for its line of eight-bit computers.

• Haba Systems is marketing a low-priced ($699) 10-megabyte (10,240-kilobyte) hard disk drive for the Atari ST. Prices for 10- and 20-megabyte hard disks fall as low as $400 for some computers. Hard disks on a card are announced for the IBM PC.

• Toshiba, Hitachi, Philips, and several other companies announce CD-ROM (Compact Disc-Read Only Memory) players that can store entire encyclopedias or massive software libraries on just a portion of a 4¾-inch optical laser disc.

• Maxell Corporation shows a new 2½-inch microfloppy disk drive that it plans to sell to manufacturers for use in laptop computers. The company also announces a 5¼-inch *eraseable, reusable* optical laser disc, which is to be marketed by 1987, and a new high-density *perpendicular* magnetic recording disk that packs up to 100K of data per inch.

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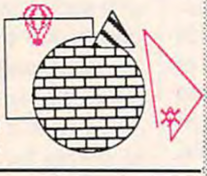

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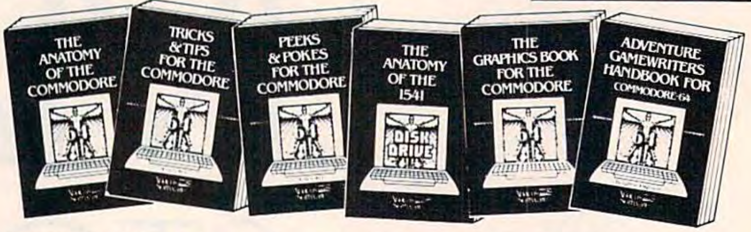
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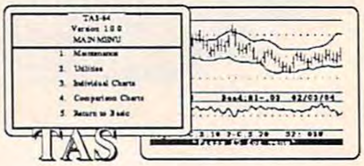

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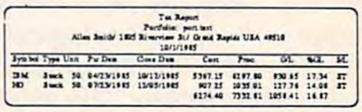

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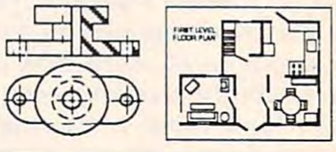

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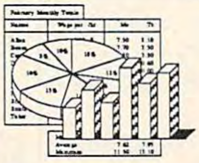

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3/86

• Sony announces a *writeable* optical laser disc storage system for computer use in business, science, and major archival applications capable of storing up to 3.2 *gigabytes* (3,276 megabytes, or 3,354,624 bytes) per disc.

Virtually every week, another advance in data storage technology surfaces within the computer industry. What's going to happen to all of the 5¼-inch floppy disks we're using now? Listen to Maxell's Ted Ozawa, vice president of the computer products division: "While we expect floppy disks to continue as a major industry factor for at least the next ten years, new technologies offering more portability or more storage capacity are being developed more quickly than previously anticipated."

Apple Computer's UniDisk 3.5 is a double-sided floppy disk drive that stores 800K of data, one of a growing number of 3½-inch drives for popular microcomputers.

Ozawa's comments are being echoed throughout the computer industry as breakthroughs in storage technology are coupled with swiftly falling prices. Even casual computer users are beginning to think in terms of megabytes—and, with CD-ROMs, gigabytes.

The computer industry is rapidly advancing in two related areas of technology. The most immediate and visible changes are the advances in magnetic technology, ushering in low-cost, high-capacity disks and drives for the mass market. At the same time, a second technology is gaining speed, less visible but more important in the long run: laser discs designed for audio and video players are being tailored to computer data storage.

To understand the economies of scale involved with recent data storage improvements, consider that a typical 5¼-inch double-density IBM floppy disk holds approximately 360K of information. (By comparison, a Commodore 64 disk holds about 170K.) A double-sided 3½-inch disk contains approximately 800–880K of data. And an optical laser disc typically holds 550 megabytes, or the equivalent of almost 1,500 floppy disks (more than 3,500 Commodore 64 disks; more than 4,000 Apple II disks).

Such capacities are a far cry from the data storage devices used by many of the early microcomputer owners.A few years ago, modified audio cassette recorders were common storage devices on personal computers. They were inexpensive and usually reliable. Purchasers of Commodore VIC-20s, for example, and later Commodore 64 buyers, generally used Commodore Datassette recorders as a way to get started in computing for a fraction of the cost of a disk drive.

As with so much in the microcomputer field, magnetic tape storage was a descendant from mainframe computer systems. A cassette tape is a *sequential* access device. That is, tape moves sequentially across a recording head. In order to get to a program at the end of the tape, all of the preceding tape has to pass by the head first. The result is a frustratingly slow access time. More recent magnetic tape storage devices have used improved technology—data compaction, shorter loop tapes, and faster speeds—to remain competitive, at least as backup systems for hard disk drives.

With the advent of circular magnetic disks, also descendants of mainframe systems, many computer users decided to switch to the new medium. Although more expensive, *random* access storage offered significantly greater speed. A moveable read/write head could find information anywhere on the spinning disk almost instantaneously. The first floppy disks were either 8 inches (from IBM) or 5¼-inches (from Shugart) in diameter. But the emerging micro industry quickly agreed on the smaller 5¼-inch disks that predominate today.

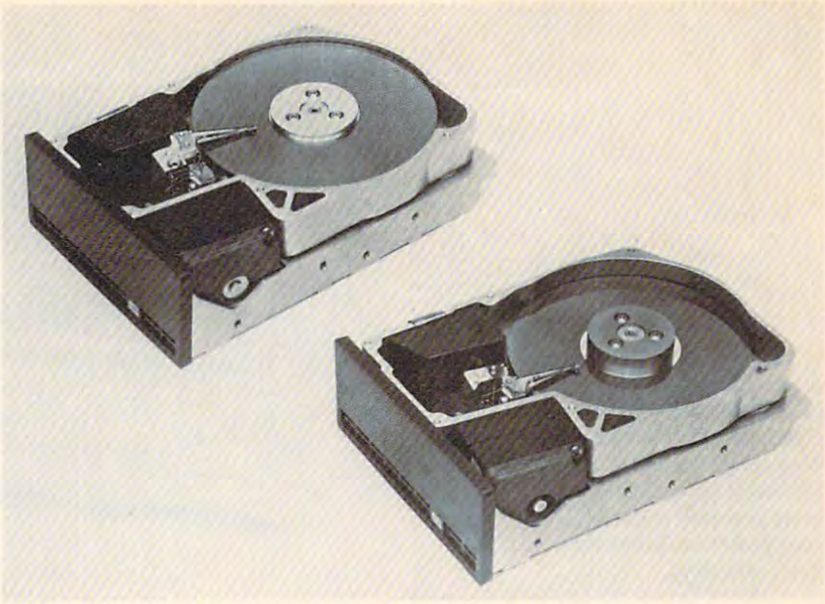
During the past three years, an even smaller-sized magnetic disk, the 3½-inch format, has gained popularity. With its faster access speeds, 800K double-sided, double-density format, and sturdy plastic shell, the 3½-inch disk has definite advantages over the 5¼-inch standard. But when first introduced, so-called microfloppies came in at least three different sizes. Sony sold the 3½-inch disk, Dysan offered its 3¼-inch style, and Hitachi announced a 3-inch model. How did the 3½-inch disk become today's de facto standard?

"The thing that happened was that Sony was very aggressive in promoting its format, not only to media [disk] makers but to drive makers," says David Berry, product manager for Maxell, a division of Hitachi. First Hewlett Packard and then Apple Computer adopted Sony's 3½-inch format, which created a snowball effect toward the Sony size. Hitachi still markets its 3-inch model, primarily in Japan and Europe, notes Berry. In fact, Maxell just introduced an even smaller, 2½-inch disk, that it hopes to sell in selected market niches. "But," admits Berry, "we definitely think the 3½-inch will be the dominant force."

Maxell's new ultra-micro 2½-inch floppy disk holds 500K of unformatted data and is planned for use in laptop computers and other selected markets.

Regardless of their size, the physics of one floppy disk is similar to that of any other. An outer sleeve (vinyl for 5¼-inch; hard plastic for 3½-inch) protects a circular disk that rotates on a disk drive's spin-

Looking similar to a standard 3½-inch microfloppy, Maxell's new perpendicular recording disk stands magnetic particles on end to pack up to 100K of data per inch, about ten times the amount of a normal microfloppy.



Stripped-away views of two new 3½-inch Winchester-style 30- and 20-megabyte hard-disk drives from Peripheral Technology, Inc. Unlike floppies, these hard disks are nonremovable media.

ning hub at hundreds of revolutions per minute. There is a ferrous-oxide coating on one or both sides of the disk. The drive's read/write head (or heads, if the drive is double-sided) can read and alter the arrangement of magnetic particles .Information is recorded on the disk in concentric rings, or tracks, that are divided into arc-shaped sectors. Drive and disk manufacturers are continually improving this technology to allow increasing amounts of data to be accessed at faster speeds. The newest floppy disks are capable of megabytes of storage, such as the IBM AT's 1.2-megabyte floppy or Maxell's recently developed 10-megabyte metal-formula floppy disk, which contains 41.7K storage space per *track* and 120 tracks per side.

The next quantum leap in magnetic computer storage media is coming soon in the form of *perpendicular* recording technology. Magnetic floppy disks have heretofore used a standard metal oxide coating in which the particles lie horizontally on the disk surface. Perpendicular, or vertical, recording is analogous to the principle that more people can occupy a given space standing shoulder-to-shoulder than lying down side-by-side, explains Maxell's Ozawa.

Picture the magnetic particles "like a thickly clustered crowd of people standing in a field," he says. Maxell has developed a perpendicular high-density disk that allows 100K of data per inch, almost a tenfold storage increase over current recording densities. The company has worked with Hitachi to develop a metal-ferrite recording head that provides better head surface contact to read the densely packed particles. Other companies, chiefly Sony, Toshiba, and Matsushita, have issued technical papers and developed prototypes. But don't expect to see the perpendicular disk on store shelves for awhile. Perpendicular recording has been on the drawing boards for several years, but still hasn't proven to be as cost effective or as easily produced as traditional magnetic media, says Maxell's David Berry.

"There continues to be a lot of work by the media and drive people; however, the progress has been much slower than anticipated," he says. "It's a new technology, and the big thing today is the cost of storing per byte on any sort of media. It's a price-performance question right now as to whether it can be made cost effective. We feel that, down the road, it will be *the* media and drive of the future."

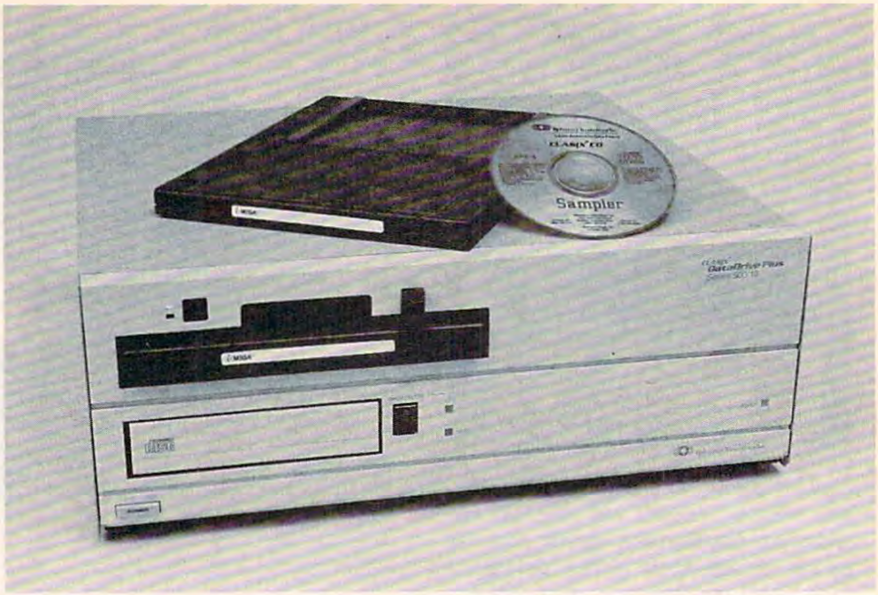
James Porter, head of the market research company, Disk/Trend, Inc., agrees that there's plenty of work ahead before perpendicular recording is durable and cost efficient enough to work.

On another front, computer users are finding that Winchester-style hard disk drives are increasing in performance as they drop in price. Lower prices and ease of use—especially important with today's increasingly integrated, memory-hungry applications—are making hard disks attractive even to casual computer users.

A hard disk spins within a drive, much like a floppy, but at faster speeds (3,600 rpm, for example). However, hard disks have traditionally been nonremoveable, and their recording heads don't actually touch the disk—instead, they float just above the surface. In the past, hard disks also cost thousands of dollars, were quite sensitive to dust and smoke, and were prey to "head crashes" that could ruin the whole disk.

Improvements in technology are now bringing prices down, sometimes well below a thousand dollars. In addition, new 3½-inch hard drives are being introduced along with the standard 8-inch and 5¼-inch models. These new systems are less prone to head crashes, have fewer problems with dust and smoke, and pack as much data into their systems as the older models.

Prices for hard disks in the 10- or 20-megabyte capacities range from $400 to $1,500 depending on access time, capacity, and other fea-



A new hybrid data storage device for IBM PCs and compatibles, the Clasix DataDrive Plus Series from Reference Technology combines a 550-megabyte CD-ROM optical disc player in the same box with a 10- or 20-megabyte Iomega Bernoulli Box removable magnetic cartridge.

tures. Some 300,000 of the 3½-inch hard drives were shipped in 1985, while about three million 5¼-inch hard drives (under 30 megabytes) shipped worldwide during the same period. The numbers for 3½-inch hard disks should increase appreciably during 1986, notes Porter.

Related to hard disk drives is a relatively new product, the Bernoulli Box from Iomega Corp. The Bernoulli Box actually *floats* its disk on a cushion of air within the drive, and also allows the disk to be removed—hence, it offers the portability of a floppy with the storage capacity of a hard disk. The floating disk also cuts down on the potential for destructive head crashes and the problems of dust and smoke.

Some computer experts believe that by the year 2000, the days of magnetic computer data storage may be only an historical footnote. Major advances in the use of low-power lasers in audio and video players are being quickly applied to computer technology. One of the hottest consumer electronics items in recent years is the audio compact disc (CD). And later this year, computer users will get a chance to see what CD laser technology can do when linked with a computer—virtually *any* computer—as a CD-ROM storage device.

The basic principle of CD ROMs is similar to the audio CD. A low-power laser beam reads microscopic pits that have been burned into the disc itself. These pits—representing a series of ones and zeros—contain the data that in a magnetic medium would be formed by the arrangement of magnetic particles. The 4.7-inch CD-ROM discs contain a whopping 550 megabytes of data per disc. The first applications are likely to be encyclopedias, such as the nine-million-word *Academic American Encyclopedia,* a 21-volume reference work that fits on just a quarter of one CD-ROM disc.

The biggest problem with CD-ROM technology at this point is that the devices are read-only. Unlike the magnetic particles on a floppy or hard disk, once the pits are burned into the surface of a CD, they can't be altered. But that limitation is already being challenged in the labs.

Sony recently announced a *writeable* 12-inch optical disc system that can hold up to 3.2 gigabytes of information. The disc is composed of two metallic elements sealed in a polycarbonate plastic. The laser beam writes information on the disc by turning the elements into an alloy which has different reflective properties. "This direct-seal method is more reliable and less costly than melt-type or bubble formation methods, which form gases during the writing process," says Robert Mesnik, Sony Information Products product manager. "The direct-seal method has a simple structure with no air spaces which can cause degradation of information over time."

This is a form of WORM (Write-Once, Read-Mainly) storage technology which offers high-density storage options for a variety of markets. The next step, however, is to create an optical technology that allows a laser to repeatedly write information on the same disc. Although not yet fully developed, an eraseable, reuseable 5¼-inch optical disc has been announced by Maxell for distribution in 1987. But for now, CD-ROMs will remain read-only reference and archival storage devices.

One of the first CD-ROM models debuting in 1986 is Toshiba's XM-1000 drive, which will be able to access digital computer data and also play music—that is, it will be both an audio accessory and a computer peripheral. The unit will have a storage capacity of 600–680 megabytes and may enter the retail market at close to $1,000. Sony will also market its CDU-1 CD-ROM player in 1986.

Five years ago, few computerists could have predicted how fast and how far data storage devices would come by the mid-1980s. Just as microcomputers themselves continue to grow in capability and diminish in price, so too will their storage devices expand to accommodate bigger memories, more complex integrated software, and as-yet unheard of applications. ©

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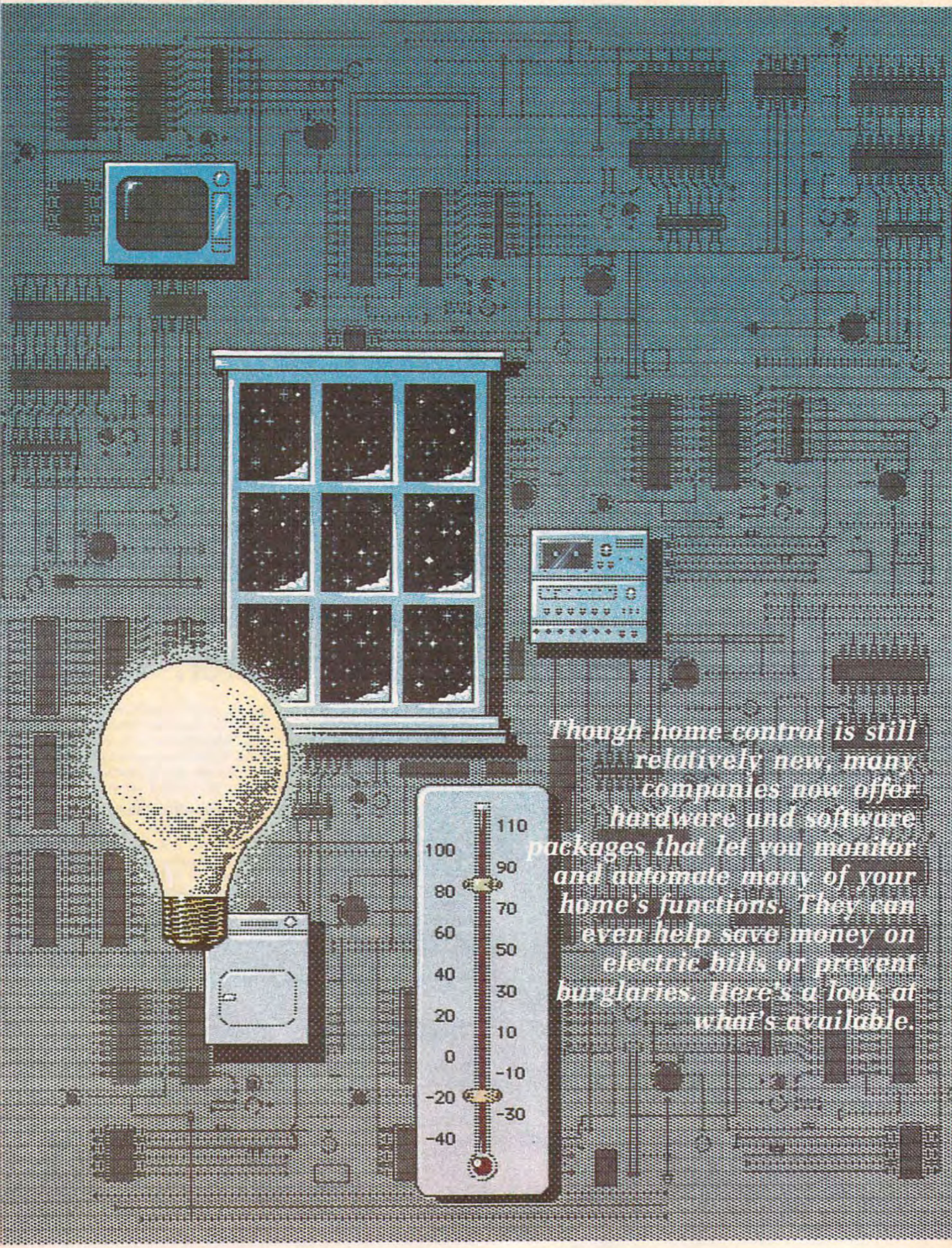


Though home control is still relatively new, many companies now offer hardware and software packages that let you monitor and automate many of your home's functions. They can even help save money on electric bills or prevent burglaries. Here's a look at what's available.

The COMPUTERIZED HOME

Kathy Yakal, Assistant Features Editor

Perhaps you already have some "smart" appliances in your home—a coffeepot that comes on automatically at a preset time every morning; a clothes dryer that senses what kind of fabric is being dried and acts accordingly; lights that turn on at dusk and off at dawn to discourage burglars when you're out of town; or a microwave oven that does everything but get in the car and drive to the grocery store.

The next step, it would seem, is to have all of these individual appliances controlled by a central unit, allowing you to talk to them through one keyboard, and which might even let them communicate with each other. The efforts of several manufacturers toward standardization is bringing this science-fiction scenario closer to home.

Many different home control units are now available. Some work through a personal computer and others are stand-alone units. They range in price from a few hundred dollars to a few thousand, and vary in the degree of technical expertise required to install them. Some are simple systems that work through existing household wiring via inexpensive plug-in modules. Others require some knowledge of programming and skill with a soldering iron, but are suitable for more sophisticated applications. Despite these different features, the three most common functions of these systems are appliance control, energy management, and home security.

Home control can be a full-time job for a computer, especially if you're using it to manage energy consumption. So unless you bought your computer specifically for home control, you're limited to buying a stand-alone unit or a second computer, either of which can be major investments.

Several home-control systems have been designed for the reasonably priced Commodore computers. You can still pick up a discontinued VIC-20 for under $100 at some stores, and a Commodore 64 for under $150. Dedicating such an inexpensive machine to one major function has proven very appealing to both manufacturers and consumers.

For instance, the X-10 Powerhouse is a very easy-to-use, inexpensive home control system that runs on the Commodore 64. The package consists of an interface box that plugs into the computer and software that runs the system. Up to eight different appliances can be set to turn on or off at specified times. The appliances must be plugged into modules available directly from X-10 USA for $16.95 each, or similar modules found at many electronics or hardware stores. (BSR modules are the most common.)

No programming knowledge is necessary to use the X-10's software. The opening screen shows nine icons representing different rooms in a house. After choosing a room, you "install" your own icons to show where appliances in your own house are. Then you simply set up a schedule for turning things off and on. The only time the system ties up the computer is when you're initially setting up or changing the schedule, so you can continue to use your computer as you normally would.

The X-10 Powerhouse is also available for the Apple IIe and IIc, Macintosh, and IBM PC series. The Macintosh version lets you draw your own house plans with *MacDraw* and *MacPaint* instead of using the boilerplate menu. All versions retail for $150. And if you want to do more than simply control appliances, additional modules and controllers include a burglar alarm interface, a thermostat setback controller, a telephone responder (which lets you control your home from any phone), and a heavy-duty 220-volt appliance module.

Many of the modules that work with the X-10 are also compatible with a home control system called HomeMinder, from General Electric. The HomeMinder software also displays graphic icons to help you set up the system. But unlike the X-10, the HomeMinder is a stand-alone unit that plugs into any color TV. Suggested retail price is $499. GE also sells a 25-inch color TV with the home control unit built-in for $1,200.

Savergy, Inc., markets two home control units compatible with the Commodore 64 and VIC-20. The PowerPort, which sells for $99.95, can control up to eight small appliances. The CIM 112, selling for $479, can handle larger appliances such as washing machines and water heaters.

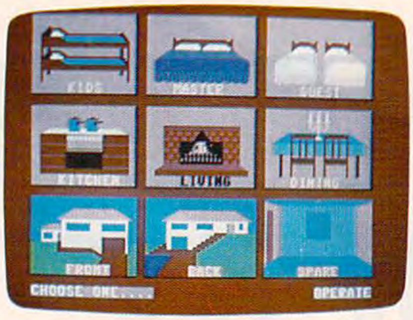
Genesis Computer Corporation also has a line of inexpensive home control units for the Commodore 64 and VIC-20. The VIController ($69.95) uses BSR-type modules to automate lights and small appliances. COMsense ($69.95), used in tandem with the VIController, lets you set up a home security system by hooking up the computer to switches on doors and windows. It can also be programmed to sense things like temperature or moisture levels in the air or ground, which would signal the VIController to turn on the lawn sprinkler or turn off the heat.

The COMclock ($69.95) is a battery backup for the system. It automatically reboots the software used by the VIController if there is a power interruption. Super Schedule Plus is a software package that integrates the operation of all three products. (COMsense and COMclock are compatible with Savergy's products.)

The Energy Manager, from Powerline Software, does not actually control appliances, but is a software package that helps keep track of and analyze energy use in homes and small office buildings. It runs on the Commodore 64 and retails for $59.95.

To justify the expense of adding a controller to your collection of home electronics, there has to be some reward. If it's primarily a home security system, or even just a unit that turns lights on and off, the rewards are obvious: security and convenience.

Another tangible reward can come in the form of monetary savings, if you buy a system geared toward economizing your energy usage. John Helwig, of Jance Associates, Inc., has designed an inexpensive, easy-to-install system that can save substantial amounts of energy, especially if you have an all-electric home.



"The utility companies are in a bind," says Helwig. "They sell electric, and the electric they sell comes from the plants they build. Of course, they want to get away from the idea of building more plants. They want to sell you more electric, but they want to sell it to you at off-peak hours, because it is actually cheaper for them.

"During the day, when everyone wants power, they have to run their most inefficient plants. They only run their most efficient plants at night. So although they want to sell more power—like any company, they want to sell more of their product—they want to sell it in off-peak hours. So the kick in it for them is, very simply, if they can get their customers to use electric at night, it's to their advantage."

Helwig's energy management system, *REDUCE* (Reduction of Electrical Demand Using Computer Equipment), takes advantage of the time-of-day rates offered by many utility companies. (By lowering the hourly rates in evenings and on weekends, time-of-day rates encourage people to limit their heaviest electric use to off-peak hours.) *REDUCE* shuts things down during peak hours to make the most of these lower rates. In Helwig's own home, the system cut his electric bill by 40 percent last year.

Helwig's system so impressed Pennsylvania Power & Light that the utility company is test-marketing it with a group of consumers who have a wide variety of house sizes and lifestyles (and no computer background). The testing is designed to see how much money *REDUCE* can save, and whether it creates any inconveniences.

Compatible with the Commodore 64, *REDUCE* costs $250. In addition, Jance offers a Security Control System—a home security system with some home control features—for $195 (wired version) and $349 (wireless). It works on the 64 and VIC-20.

All home control systems have one thing in common. They must take analog information—anything read according to a scale, like degrees, volts, and pounds—and convert it into the digital information that computers can understand.

One such converter is the ADC-1 Data Acquisition and Control System ($449), from Remote Measurement Systems. It can be used with any RS-232-compatible computer, including the Commodore 64.

One application for an analog-to-digital converter is thermostat control. If the temperature outside drops considerably, a house takes longer to warm up. The ADC-1, using a smart thermostat program, wouldn't let it cool down as much, so it costs less to reheat it. Or if the ADC-1 is connected to security sensors and it detects a back window vibrating, it might wait to see if the window vibrates again. If it senses another vibration, or if the window breaks, the unit might turn on a sequence of room lights to make it appear that someone is walking in that direction to investigate.

The ADC-1 is currently being used for a tremendous variety of purposes in homes and business across the country. Amana, a major appliance manufacturer, has reduced the time required to test room air conditioners from 20 minutes to 2, using an ADC-1 and Commodore 64. A southern California architect uses the system to manage the components of a custom-designed solar heating system. And an arboretum on Bainbridge Island, Washington, uses it to keep track of meteorological measurements.

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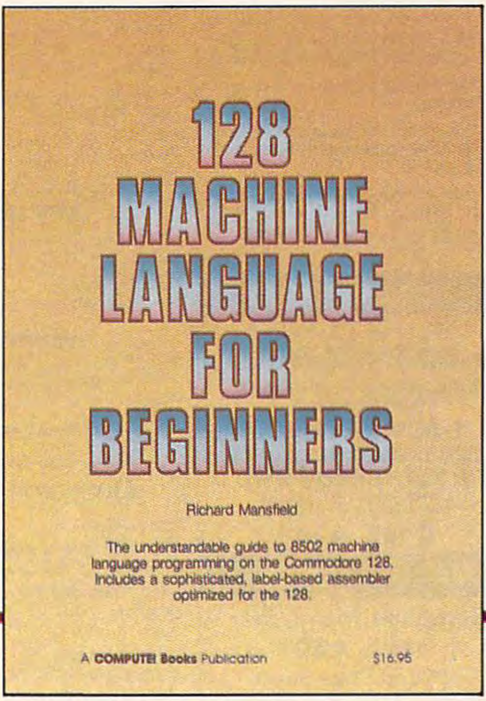

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The low cost of Commodore home computers prompted designers at Proteus Electronics, Inc., to develop the Simple Interface Data Acquisition System (ADAC) for the Commodore 64, 128, and VIC-20. The system consists of an interface ($34.95) and an analog data acquisition conditioner ($64.95). The system can digitize up to 16 channels of analog signals, making it appropriate for functions such as heating, cooling, solar control, voltage measurements, robotics, and weather station monitoring. An Apple version should be available by the time you read this for about $150.

For a home control unit to appeal to many people who don't own personal computers, ease of installation and use is crucial. Manufacturers realize that, and continue to work toward that goal.

Voice recognition may be one method of operation that could appeal to people not enamored of keyboards. Magician Gus Searcy and West German programmer Franz Kavan have developed a home control system that uses voice recognition. Marketed by Mastervoice, the system is called Sidney, the Butler in a Box. Working through existing household wiring, Sidney can dim and brighten lights, answer the phone, act as a security guard, and turn household appliances off and on—all at the sound of its master's voice. A standalone unit, Sidney retails for $1,195.

It's been predicted that eventually we'll all have some kind of universal controller in our homes, a unit that ties together all of our electronic appliances, entertainment equipment, and telephones. Fortunately, we can get a taste of the future right now with the easy-to-use products already available.

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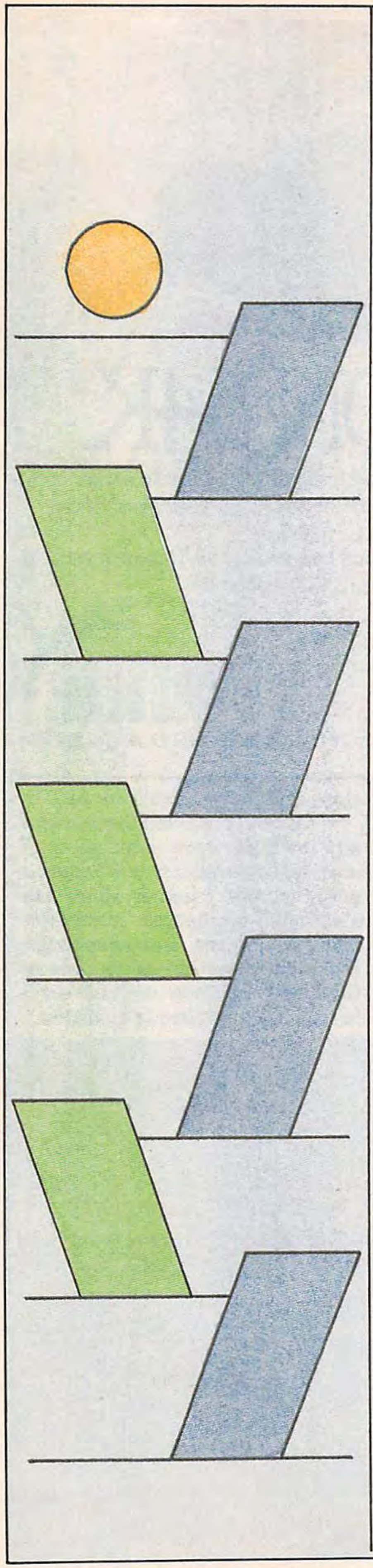


Switchbox

Todd Heimarck, Assistant Editor

Here's a challenging game of strategy that looks easy at first, but takes time to master and permits many variations. The original program is written for the Commodore 128. We've added new versions for the Commodore 64, Apple II, eight-bit Atari computers, IBM PC/PCjr and Atari 520ST, as well as an Amiga version with speech and stereophonic sound effects.

Playing "Switchbox" is like putting dominos in place for a chain reaction—either you're setting them in position or you're knocking them over. Winning requires skill and a sense of when to go for points and when to lay back and wait for a better board. The goal is simple: You try to score more points than your opponent by dropping balls into a box full of two-way switches. Each switch has a trigger and a platform. If the ball lands on an empty platform, it stops dead. But if it hits a trigger, it reverses the switch and continues. In many cases dropping a single ball creates a cascading effect—one ball sets another in motion, which sets others in motion, etc., all the way down.

Type in the program listing for your computer, and save a copy before you run it. If you're using a Commodore 128, enter the 128 version in 128 mode (not 64 mode). The Atari version runs on any eight-bit Atari computer with at least 16K of memory. The Apple II game works on any Apple II machine, under either ProDOS or DOS 3.3. The IBM PC/PCjr version requires BASICA (PC) or cartridge BASIC (PCjr), and a color/graphics adapter on the PC.

The Amiga version of Switchbox requires 512K of memory and Amiga BASIC by Microsoft (not ABasiC, the version supplied with a few very early Amigas). If you have only ABasiC, contact your dealer about getting an upgrade to Amiga BASIC. Before running the program, make sure that the Amiga's display is set for 80 columns of text (if it isn't, the numbers printed on the screen won't match the rest of the display). If you've previously changed the display to 60 columns, open the Preferences icon and change it back to 80, then close Preferences, activate BASIC and run the program as usual.

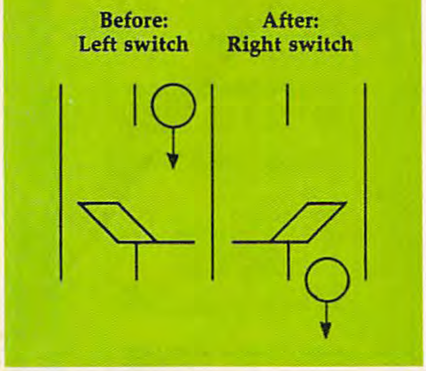
Since the Amiga program doesn't use line numbers, we've placed small arrows in the listing to show you where each line ends. Don't try to type in the arrows: There's no such character in the Amiga's character set. Wherever you see an arrow in the listing, press Return (or move the cursor off that program line) to enter the line. It's important to include the colon (:) that appears after program labels (*Nextround:*, *Setup:*, and so on). If you accidentally omit the colon, you'll make it impossible for the computer to use that label correctly.

Before typing in the 520ST version you must turn off the buffered graphics by clicking on Buf Graphics in the Run menu. You can be in either medium or low resolution mode when typing in the program; but before running it, you must be in low resolution mode. This can be done by selecting Set Preferences from the Options menu on the desktop and clicking on Low.

A Box Of Switches

Switchbox is a tale of twos: Each switch has two parts, two positions, two states, two paths in, and two paths out. The two parts are the platform and the trigger. A switch can lean to the left (platform left, trigger right) or to the right (platform right, trigger left):

Figure 1. Trigger States



The trigger is weak, and always allows balls to pass. But the platform is strong enough to hold a single ball. So the platform either holds a ball—it's full—or it does not and is empty. When a ball sits on a platform, the switch is said to be loaded, or full.

Figure 2. Loaded Trigger

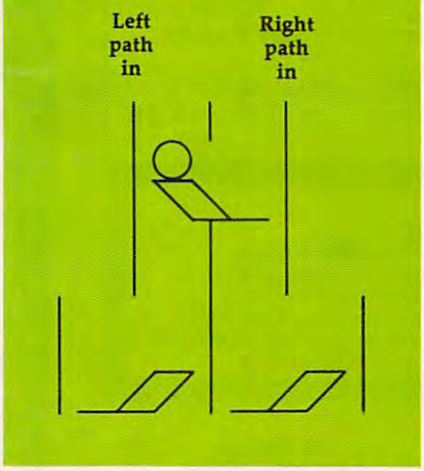


Figure 2 shows a full switch over two empty switches. The platform holds a ball and leans to the left. The trigger extends to the right. Note that the switch on top has two pathways leading in, the left path and the right, and that the right path leading out is the left path into one of the switches below. The left path of the top switch leads into the right path of the other, the switch below and to the left. If you drop a ball down the righthand path, it hits the trigger and flips that switch to the right. Then it continues down, hits the lefthand trigger below and flips that switch as well.

In the meantime, the ball on the platform is set in motion (when the switch is flipped) and then hits the trigger. The top switch is reset to point to the left. The second ball then drops a level to the platform below, where it stops. The playing field is composed of five levels, with four switches in the first level and eight in the bottom level. At the beginning of the game, there are no balls on the field—all platforms are empty—and the position of each switch is chosen randomly.

Moving Down The Path

Players alternate dropping balls into one of eight entry points. These balls (and others) may or may not make it all the way through the switchbox, to one of the 16 exit paths. Balls fall straight down (with one exception), so a ball's movement is always predictable. When it hits an empty switch, one of two things can happen. If it lands on the empty platform, it stops dead in its tracks. But if it lands on a trigger, it falls through to the next level below.

Moving balls always make it through loaded switches. Triggers allow balls to continue, and move the switch to the other position. If it's loaded, the dead ball on the platform is put into motion and it hits the trigger that just moved over. This makes the switch go back to its original position, but with an empty platform. So when a ball hits the trigger of a loaded switch, its motion continues unabated. The switch moves, the ball on the platform begins to fall and it hits the newly placed trigger. The newly emptied switch moves back again, and the two balls drop to the next level.

There's one more possibility: a ball dropping onto a platform that already holds a ball. A platform can't hold any more than one ball, so when this happens one of the balls slides over to the trigger. So the ball does not move straight down—it slides over to the next pathway. This is the exception to the rule that balls drop in a straight line. Of course, when the ball hits the trigger, the switch changes position, causing the other ball to drop and hit the trigger.

The Chain Reaction

At the game's start, all platforms are empty, so four of eight entry paths are blocked. Remember that your turn ends when a ball hits an empty platform and stops. As the switches fill up, the chances increase that a ball will descend through several levels. The goal is to score points by getting balls to pass all the way through the maze of the switchbox. The best way to collect a lot of points is to cause a chain reaction.

A ball that hits a loaded switch from either side continues on its way. And the previously inert ball on the platform starts moving. One enters, two exit. If both of those balls encounter full platforms, four drop from the switches. The pathways are staggered, so the effects can spread outward, with more and more balls cascading toward the bottom.

Rather than taking an easy point or two, it's often worthwhile to build up layers of loaded switches. Watch out for leaving yourself vulnerable, though. Because players take turns, you'll want to leave positions where your opponent's move gives you a chance to create a chain reaction. The best strategy is to play defensively. Look ahead a move or two, and watch for an opening that allows you to score several points at once.

Four Quarters

A game of Switchbox always lasts four rounds. In the first (equality), each exit counts for two points. Your goal is to score ten points. The second quarter has more points available, as well as a higher goal. If you look at the exits, you'll see that the further away from the middle, the higher the point value. The numbers increase in a "Fibonacci" sequence: 1, 2, 3, 5, 8, and so on. Each number is the sum of the previous two (1+2 is 3, 2+3 is 5, 3+5 is 8, etc.). The target score in round two is 40.

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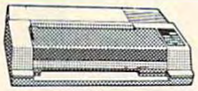

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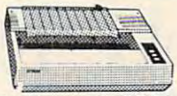

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Writing An Amiga Game

Philip I. Nelson, Assistant Editor

Writing "Switchbox," our first game translation for the Amiga, posed a number of interesting programming challenges and proved to be an excellent way to become familiar with Microsoft's Amiga BASIC. To show off just a few ot the machine's special features, the Amiga version of Switchbox includes fast graphics, stereo sound effects, and voice synthesis.

The first thing you'll notice about the Amiga program is that it has no line numbers. Instead, meaningful labels like *Setup:*, *Putball:* and *Nextround:* mark subroutines and major program divisions. To improve the program's readability, meaningful variable names like *Points, Round, Column* and *Row* have also been used in a number of cases. If you're familiar with Commodore 128 or 64 BASIC, you may find it interesting to compare one of those versions with this one. Though some routines have been repositioned, and the graphics techniques are very different, this program follows essentially the same logic as the original.

Window Management

Before creating any graphics, you must make some basic decisions about the screen itself. The four PALETTE statements in the *Setup:* routine specify colors for the new screen. If these are omitted, the Amiga uses the same colors that appear when you activate BASIC. The following statement creates a window for the game screen:

```
WINDOW 2,"Switchbox",,0
```

The first parameter (2), creates a new output window specifically for this program's output. If you don't create a new window, all output goes to window 1, which is normally titled with the name of the current program. You could follow this statement with WINDOW OUTPUT 2, to direct all output to window 2. But that's done automatically when you open the window. When you close the window with WINDOW CLOSE 2 (see the *Gohome:* routine), output reverts to window 1 again.

The second parameter in a WINDOW statement is a string that contains the window's title.

The third WINDOW parameter, which is optional, specifies the window's size. Windows can be smaller than the actual screen. In this case, we needed a full-screen window, so we simply left out this parameter. The window automatically expands to the full size of the screen.

The fourth WINDOW parameter also is optional. It specifies the window's type—that is, the window's characteristics. Though it's often desirable to resize a window and move it around the screen, those features aren't needed for a game. To disable them, we specify a window type of 0. This creates a window that can't be resized or moved around with the Title Bar; can't be moved from the front to back of other windows with a Back Gadget; and can't be closed with a Close Gadget. However, Amiga BASIC's normal menus are all left active, so the player can still stop the program by choosing the Stop option from the Run menu.

In any program that includes speech, it's a good idea to include a short SAY statement at the very beginning of the program before opening any custom windows. When the Amiga encounters the first SAY statement, it tries to load the narrator device program from disk (the Amiga's speech synthesizer is implemented in software, not hardware). If it can't find the narrator on the currently mounted disk, it displays a requester box prompting you to insert the correct volume. If this happens *after* you've opened a new window, the requester box may appear on the original output window, which is now invisible. This can be very confusing to a new user, who may think that the system has crashed, when in fact it's just waiting for a response.

Hi-Res Graphics

The 128 version of Switchbox draws the playfield and animates the moving figures with traditional Commodore methods—PRINTing graphic characters on the text screen or POKEing them directly into screen memory. Since the 128's text screen is divided into 25 rows of 40 characters, it's a fairly simple matter to keep everything neatly aligned. Not so on the Amiga, which in this case presents a high-resolution graphics screen 640 pixels wide and 200 pixels high. While it's possible to put characters on this screen with

In round three the numbers are a bit lower. They increase arithmetically (1, 2, 3, 4, up to 8 in the corners). A goal of 20 points brings you to round four, where you can score big. Here the numbers are squares: 1, 4, 9, 16, 25, all the way to 64 at the edges. In rounds two through four, it's sometimes prudent to leave a middle path open for your opponent to score a few points, in order to gather a high score on the big numbers to the left and right.

Each round lasts until one player has reached the goal. At that point the other player has one last turn before the round ends. It's possible to win the round on this last-chance play; watch out for barely topping the goal and leaving a chain reaction open for the other player. An arrow points to the scoreboard of the player whose turn it is. On the other side of the screen, you'll see a number where the arrow should be. That's the goal for the current round (the Amiga version displays the goal on both sides of the screen, below the scoreboards).

Bonus points are awarded at the conclusion of each round. Four

Atari Explodes

Atari's new computer serious threat to Macintosh. Will the Amiga survive?

The Atari 520 ST is a serious challenge to the Apple Macintosh and will open up a major fight in the personal computer market.

By Joseph Sugarman

Imagine this. If I could offer you a Macintosh computer—(a computer that sells for over $2000)—for one third the price, you might wonder.

But what if I offered you a better computer with none of the disadvantages of the Mac and what if I added new features which improved its speed and performance? That's exactly what Atari has done in an effort to grab the ball from Apple and really explode into the personal computer market.

HEADING EFFORT

Heading the effort at Atari is Jack Tramiel—the same man who built Commodore into a billion dollar corporation, sold more computers than any other man in the world and believes in giving the consumer incredible value without sacrificing quality. The new Atari is a perfect example.

First, let's compare the new Atari ST to the Macintosh and the Commodore Amiga. Sorry IBM, we can't compare the ST to your PC because yours is almost five years old, much slower, and, in my judgement, over priced.

Price The cheapest you can get the Macintosh with 512K of memory is $1800 with a one-button mouse, a disk drive and a monochrome monitor. The Amiga sells for $1995 with a two-button mouse, a disk drive and a color monitor. The Atari ST sells for $699 with a two-button mouse, a disk drive and a monochrome monitor and for $200 more, a color monitor. Read on.

Monitor With the Mac you can only use its 9" monochrome monitor and with the Amiga you can only use its 12" color monitor. With the ST you have a choice of either a 12" monochrome or high-resolution color monitor or your own TV set.

Resolution The number of pixels or tiny dots on a screen determine the sharpness of a computer monitor. The Mac has 175,104 pixels and has one of the sharpest screens in the industry. The Atari ST has 256,000 pixels or almost a third more than the Mac. And the Atari color monitor compared to the Amiga in its non interlace mode is 128,000 pixels or exactly the same.

Power All the computers have a 512K memory with a 68000 CPU operating with a 32-bit internal architecture. But Atari uses four advanced custom chips which cause the CPU to run faster and more efficiently giving it some tremendous advantages. For example, it has a faster clock speed of 8Mhz compared to the Mac's 7.83 and the Amiga's 7.16. And the speed of the unit is hardly affected by the memory requirements of the monitor which in the Amiga can eat up much as 70% of the unit's cycle time or speed.

Keyboard This is the part I love. The Mac has a small 59-key keyboard and a mouse. That's all. The 95-key Atari has both a mouse, cursor keys, a numeric keypad and ten function keys. The keyboard looks fantastic and is easy to type on. Although the 89-key Amiga has almost all the features of the Atari keyboard, it looks like a toy in comparison. (Sorry Commodore, but that's my opinion.)

Disk Drive The Mac's 3½" disk drives run at variable speeds—slowing down as they run. The Atari 3½" drives run faster at a constant speed—and quieter than any other unit.

Features The Atari ST comes equipped with the same printer and modem ports as the IBM PC—a parallel and RS232C serial port. The Mac comes only with a tiny non-standard serial and modem port. The ST has a hard disk interface capable of receiving 10 million bits per second. There are two joy stick ports and a 128K cartridge port for smaller programs or games. It has 512 colors (for the color monitor), it has a unique MIDI interface into which you can plug your music synthesizer and record or play back your music.

Software Right now, the Mac has more than the Atari ST and the Amiga combined. The Atari is a new system but the track record of Atari's Jack Tramiel and the potential of the new unit is causing a flood of new software titles. In fact, I'll predict that eventually the Atari will have more software than the Mac. There are now hundreds of titles, from word processing to spread sheet programs, from graphics and games to data base management—all with those easy drop-down menus and windows. There's plenty from which to select now and plenty more to come.

If you think I'm enthusiastic over the ST, listen to what the press is saying. *Byte Magazine* just called it the "Computer of the year for 1986." *Creative Computing* exclaimed, "Without question, the most advanced, most powerful micro computer your money can buy." and finally, the Atari ST is the best selling computer in Europe and acclaimed, "The computer of the year," by the European personal computer press.

I am going to make the ST so easy to test in your home or office that it would be a shame if you did not take advantage of my offer. First, I will offer the computer itself for only $299. You will need, in addition, either one or two disk drives and either an Atari monochrome or color monitor or your own TV. If you order with your credit card during our introduction I will ship your order and only bill you for the postage and 1/3 the purchase price. I will also add a few software packages free including "Logo"—a beginners programming language, a disk for programming in BASIC and Neochrome—a graphics paint program.

COMPARE THE TWO

After you receive the Atari ST, put it next to your Mac or Amiga or even IBM. See how extremely sharp the graphics appear, discover what a perfect word processor it is, how great the keyboard feels and finally how much faster and quieter it runs.

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LOCATE and PRINT, the Amiga's character set includes no graphics characters. So 128-style graphic techniques are useless unless you want a game screen that consists of X's, O's, and slash characters. Instead, everything must be drawn with hi-res commands like LINE, PUT, CIRCLE, and PAINT (see the routine labeled *Setup:*).

Repeated shapes are stored in an array with GET and then placed in several locations with PUT commands. PUT is used extensively in this game to create the moving balls, switches, and arrows, as well as to draw parts of the switchbox itself. Though it's one of Amiga BASIC's slower graphics commands, PUT is more than adequate for a game of this type and much faster than the same commands in other BASICs. Thanks to the Amiga's fast 68000 microprocessor and custom graphics chips, this version runs much faster than the original, even though no particular attempt was made to optimize the program's speed.

PUT has several different modes which determine what happens when you PUT a shape into an area that already contains graphics data. The Amiga uses XOR (exclusive or) mode for PUT unless you specify otherwise. This mode is particularly useful for animation, since if you PUT the same shape twice into the same location with XOR, it erases itself without disturbing whatever was there before. Here's a typical use of PUT with XOR:

```
PUT (140,5),Larrow:PUT (440,5),Rarrow
```

These statements, found in the *Taketurn:* routine, are performed on each new turn to make the player's arrows flip back and forth. If you're not familiar with XOR mode, this code looks confusing, since it PUTs both arrows on the screen no matter whose turn it is. But we began the game by PUTting the left arrow in place when the screen was drawn. Thus, when the first turn is taken, the left arrow erases itself, and the right one appears. On the second turn the right arrow erases itself, and the left one appears, and so on. This shortcut eliminates the need for a separate routine to keep track of the arrows' display status.

Speech And Stereo Sound

Speech and stereo sound effects may seem flashy, but the Amiga makes them quite easy to program. Amiga BASIC's SAY TRANSLATE$ command translates any English text into quite understandable speech. And it's easy to flip sound effects from one stereo output to another by changing the final value in a SOUND statement.

If your monitor has only one speaker, you'll probably want to defeat the stereo feature so that both players' sound effects can be heard through one output. This is easy to do. The Amiga has four sound channels, numbered 0–3: Channels 0 and 3 always go to the left speaker, and channels 1 and 2 go to the right. There are five SOUND statements in the program (in the routines labeled *Switch:*, *Putball:* and *Score:*). In each SOUND statement, the final parameter controls whether the sound goes to the left or right output. For instance, the *Score:* routine contains these statements:

```
SOUND j,1,64,Who
SOUND j+400,1,64,3-Who
```

The program variable Who equals 0 when it's the left player's turn, and 1 on the right player's turn. Thus, when Who=0, the expressions Who and 3−Who create sound in channels 0 and 3, which both go to the left speaker. When Who=1, they output through channels 1 and 2, which go to the right speaker. To defeat the stero effect in these statements, replace Who and 3−Who with the values 0 and 3, or 1 and 2, depending on which output you're using. Similar changes to the other SOUND statements will confine them to one speaker as well.

If you don't specify otherwise, SAY commands cause the program to halt until the computer finishes saying the current phrase. But at certain points in Switchbox, the computer talks "in the background" while it performs other program tasks. At the beginning, for example, you'll see it draw several graphics shapes while it pronounces the welcoming phrase. This effect is also quite simple to achieve.

Look at the first set of DATA statements in the *Setup:* routine: These values are stored in an integer array (Voice%) for later use in SAY commands. Each element of the voice array controls a different aspect of the Amiga's speech, such as pitch, speaking rate, and so on. The next-to-last element in the array controls whether the program continues while SAY commands are in progress. Setting this value to 1 selects *synchronous* speech which proceeds in the background. Replacing the 1 with a 0 selects *asynchronous* speech mode, which halts program execution until the current phrase is finished.

numbers appear below the scorecards. The first is simply the total so far. The second is the total plus a bonus of the goal for the round if the player's points are equal to or greater than the goal. For example if the goal is 20 and you get 18, there's no bonus. If you score 22, the bonus is the goal for that round (20) and you'd have 42 points. The third number under the scoreboard is the difference between scores for the rounds. If you win by two points, two is added to your score (and two is subtracted from the other player). The final number is the grand total of the first three scores and bonuses. Rounds one and three are fairly low-scoring with low goals. You may want to seed the field with extra balls during these quarters, so you can collect more points in the second and fourth quarters.

Variations

Although the goal of the game is to score the most points, there's no reason you couldn't agree to play for low score. In a "lowball" game, you would try to avoid scoring points. You wouldn't necessarily play backwards, you would have to adjust the strategy of where to place the balls. Fill up the board as much as possible and leave your opponent in a situation where he or she is forced to score points.

The DATA statements at the beginning of the program (the *Setup:* routine in the Amiga version) determine the goal for each round and the point values for the exit paths. You can prolong the game by doubling the goals; this also dilutes the value of a big score at the beginning of a round, preventing one player from winning on the first or second turn. An interesting variation is to assign negative values to some slots. If some paths score negative points, you are forced to think harder about where the balls will drop.

In addition to the numbered keys (1–8), the plus (+) and minus (−) keys are active. Pressing plus drops a ball at random down one of the eight entry paths. Pressing minus allows you to pass your turn to your opponent.

Once you've mastered the regular game, you can add some new rules. Each player gets three passes per half, similar to the three timeouts in a football game. If you don't like the looks of the board, press the minus key to use one of your passes. After one player has skipped a turn, the other player must play (this prevents the possibility of six passes in a row). It's also a good idea to make a rule that a player can't pass on two consecutive turns. You can also give each player two random moves to be played for the opponent. In other words, after making a move, you could inform your opponent that you're going to give him one of your random moves and you would press the plus key.

Here's one more change you could make: Instead of alternating turns, allow a player to continue after scoring. When a player drops a ball and scores some points, the other player would have to pass (by pressing the minus key). If the first player scores again, the opponent passes again, and so on until no more points are scored.

Playing Solitaire

To drop a ball, press a numbered key (1–8). If you're using a 128, ST or Amiga, the numeric keypad is convenient for choosing a move. By using the pass and random turn options, you can play against the computer. Here are the rules for solitaire play:

1. The computer always scores first. At the beginning of every round, the computer plays randomly until at least one point is acquired. Press the plus key for the computer's turn. You must continue passing (skip your turn with the minus key) until the computer puts points on the board.

2. After the first score by the computer, you can begin to play. When the computer has a turn, press the plus key for a random move.

3. Whenever you make points, you must pass again until the computer scores. When the computer gets more points, you can begin to play again. This rule means you should hold back on the easy scores of a few points; wait until there's an avalanche available.

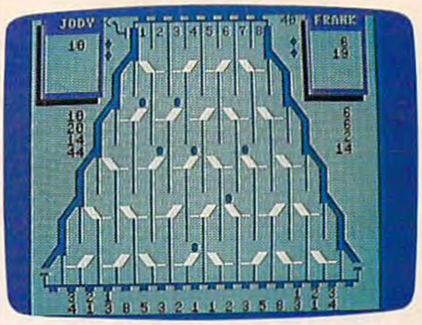
4. If you're the first to reach the goal, the computer gets a last chance. Don't make this move randomly; figure out the best opportunity for scoring and play that move for the last-chance turn.

In the interest of keeping these programs to a manageable length, no attempt has been made to provide an "intelligent" computer opponent. Once you become familiar with the game, you might find it an interesting project to try adding some routines that give the computer a rational basis for picking one move over another.

For instructions on entering these listings, please refer to "The New Automatic Proofreader for Commodore" and "COMPUTE!'s Guide to Typing In Programs" in this issue of COMPUTE!.

Program 1. Commodore 128 Switchbox

```
FP 10 DIMSW(4,7,1),SP$(1),LB(3
      2,4),AR$(1),PT(4,16),SC(
      1,8)
DE 12 SP$(Ø)="{OFF}E*3{RVS}E*3
      {OFF}E@3":SP$(1)="E@3
      {RVS}£{OFF}£":AR$(Ø)="
      <I {DOWN}{2 LEFT}JEW3":A
      R$(1)="EQ3K{UP}{2 LEFT}
      {SPACE}U>":QR=1:PRINTCHR
      $(27);"M"
EC 14 COLORØ,16:COLOR4,7:COLOR
      5,7:TX=RND(-TI/137)
QS 20 FORJ=1TO4:READPT(J,Ø):RE
      M NAME AND GOAL
XC 22 FORK=1TO8:READL:PT(J,K+8
      )=L:PT(J,9-K)=L:NEXTK,J:
      REM POINTS
RP 24 DATA 1Ø:REM ROUND 1 (EQU
      AL)
```



"Switchbox" for the Commodore 128, a challenging strategy game.

```
PE 25 DATA 2,2,2,2,2,2,2,2
PF 26 DATA 4Ø:REM ROUND 2 (FIB
      ONACCI)
HP 27 DATA 1,2,3,5,8,13,21,34
KJ 28 DATA 2Ø:REM ROUND 3 (ARI
      THMETIC)
BG 29 DATA 2,3,4,5,6,7,8,9
EB 3Ø DATA 8Ø:REM ROUND 4 (SQU
      ARES)
SF 31 DATA 1,4,9,16,25,36,49,6
      4
PB 4Ø SCNCLR:INPUT"PLAYER 1";P
      1$:INPUT"PLAYER 2";P2$:P
      1$=LEFT$(P1$,5):P2$=LEFT
      $(P2$,5):PRINTP1$;" VS "
      ;P2$
JD 42 PRINT"IS THIS CORRECT?":
      GETKEYA$:IFASC(A$)<>89TH
      EN4Ø
PB 5Ø GOSUB5ØØ:GOSUB7ØØ:REM SE
      TUP
HD 6Ø FORRR=1TO4:TX=1Ø72+4Ø*RR
      :POKETX,9Ø:POKETX+22,9Ø
XG 62 GOSUB62Ø:REM PUT SCORES
      {SPACE}AT BOTTOM
SF 65 QR=1-QR:COLOR5,7:TY=QR*2
      Ø:TX=28-TY:WINDOWTX,Ø,TX
      +2,1,1:PRINTRIGHT$(STR$(
      PT(RR,Ø)),3):PRINT"
      {2 HOME}":TX=8+TY:CHAR1,
      TX,QR,AR$(QR)
SK 7Ø GOSUB9ØØ:IFSC(1-QR,RR)=>
      PT(RR,Ø)THEN3ØØ:REM END
      {SPACE}OF ROUND
AK 8Ø GOTO65
EX 3ØØ FORJ=ØTO1:FORK=5TO8:SC(
       J,K)=Ø:NEXTK,J
QP 31Ø FORJ=ØTO1:FORK=1TO4:GL=
       PT(K,Ø):AC=SC(J,K):SC(J
       ,5)=SC(J,5)+AC:SC(J,6)=
       SC(J,6)-(AC=>GL)*GL:SC(
       J,7)=SC(J,7)+(SC(J,K)-S
       C(1-J,K)):NEXTK,J
QB 32Ø FORJ=ØTO1:FORK=6TO7:SC(
       J,K)=SC(J,K)+SC(J,5):NE
       XTK,J
SC 33Ø FORJ=ØTO1:FORK=5TO7:SC(
       J,8)=SC(J,8)+SC(J,K):NE
       XTK,J
ME 34Ø COLOR5,12:FORJ=ØTO1:FOR
       K=5TO8:Y$=STR$(SC(J,K))
       :L=LEN(Y$):TX=6+J*31-L:
       TY=3+K:CHAR1,TX,TY,Y$:N
       EXTK,J
CX 4ØØ NEXTRR:REM END OF MAIN
       {SPACE}LOOP 6Ø-499
EB 499 GETKEYA$:RUN
BA 5ØØ SCNCLR:PRINTSPC(11);"
       EA3{RVS}EO3{OFF}";:FORJ
       =1TO7:PRINT"{OFF}ER3
       {RVS}EO3";:NEXT:PRINT"
       {OFF}ES3":LL=7
QB 51Ø FORJ=ØTO4:TX=9-2*J:TY=1
```

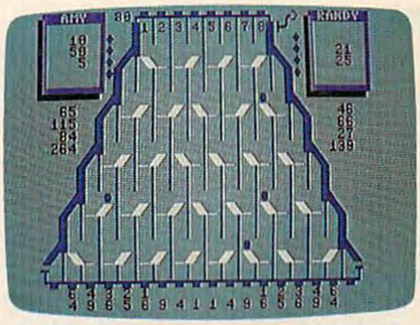
```
          +J*4:BX=TX+20+J*4:BY=TY
          +4:WINDOWTX,TY,BX,BY:R$
          ="- "
CD 520 FORK=1TO2:PRINT"
          {2 SPACES}{RVS} {OFF} "
          ;:GOSUB600:PRINT"{RVS}
          {SPACE}":NEXT
BQ 530 PRINT" {RVS}£ {OFF} ";
          :GOSUB600:PRINT"{RVS}
          Ɛ*Ʒ"
PM 540 LL=LL+2:PRINT"{RVS}£
          {OFF}£";:GOSUB600:PRIN
          T"{LEFT}Ɛ*Ʒ{RVS}Ɛ*Ʒ
          {OFF}";:NEXTJ
JP 550 WINDOW1,21,38,23:PRINT"
          ƐRƷ ";:GOSUB600:PRINT"
          ƐRƷ"
BF 560 R$="{RVS}ƐUƷ{OFF}ƐEƷ":L
          L=LL+1:PRINT"ƐZƷ";:GOSU
          B600:PRINT"{LEFT}ƐXƷ":W
          INDOW0,0,39,24
QS 599 RETURN
KX 600 FORL=1TOLL:PRINTR$;:NEX
          T:RETURN
MA 620 COLOR5,12:FORJ=1TO16:K=
          PT(RR,J):JJ=2+J*2
RK 630 IFK>9THENL=INT(K/10):L$
          =MID$(STR$(L),2,1):ELSE
          L$=CHR$(32)
MC 640 CHAR1,JJ,23,L$:CHAR1,JJ
          ,24,RIGHT$(STR$(K),1):N
          EXTJ:RETURN
SX 700 FORJ=0TO4:SY=4+J*4:FORK
          =0TOJ+3:SX=12-J*2+K*4:C
          HAR1,SX+1,SY-1," "
MX 710 WP=INT(RND(1)*2)
HA 720 SW(J,K,0)=WP:SW(J,K,1)=
          0:GOSUB800
RM 730 NEXTK,J
SK 740 FORJ=1TO8:POKE1074+J*2,
          48+J:NEXT
XJ 750 FORJ=0TO1:BX=J*31:WINDO
          WBX,0,BX+7,7
BQ 760 PRINT"{OFF}{BLK}ƐDƷ
          {RVS}{PUR}{7 SPACES}
          {BLK}ƐKƷ{PUR}ƐDƷƐ5 IƷ
          ƐFƷ";
EQ 770 FORK=1TO4:PRINT"{RVS}
          {BLK}ƐKƷ{OFF}{PUR}ƐKƷ
          {5 SPACES}{RVS}ƐKƷ";:NE
          XT
KQ 775 PRINT"{RVS}{BLK}ƐKƷ
          {PUR}ƐCƷ{OFF}Ɛ5 IƷ{RVS}
          ƐVƷ{OFF}{BLK}ƐCƷ{RVS}
          Ɛ6 IƷ{OFF}ƐVƷ";
HK 780 NEXT:PRINT"{2 HOME}":CO
          LOR5,5
RE 790 CHAR1,3+(LEN(P1$)=5),0,
          P1$,1
QJ 791 CHAR1,34+(LEN(P2$)=5),0
          ,P2$,1
RP 799 RETURN
BA 800 COLOR5,2:CHAR1,SX,SY,SP
          $(WP):RETURN
JJ 900 FORJ=0TO32:LB(J,0)=0:NE
          XT:NB=1:POKE208,0
RC 910 GETKEYA$:IFA$="-"THENRE
          TURN:ELSEIFA$="+"THENA$
          =STR$(INT(RND(1)*8+1))
FX 915 A=VAL(A$):IF(A<1)OR(A>8
          )THEN910
FK 920 LB(0,0)=1:FORJ=1TO3:LB(
          0,J)=0:NEXT:LB(0,4)=10+
          A*2
SF 1000 DO:EX=1
KR 1010 FORJ=0TO32:IFLB(J,0)TH
          ENEX=0:GOSUB1100
GP 1020 NEXT:IFEXTHENEXIT
EF 1030 LOOP:RETURN
KJ 1100 DY=LB(J,0):DX=LB(J,1):
          LY=LB(J,2):NY=LB(J,3):
          NX=LB(J,4):SM=1064+NX+
          LY*160+NY*40:IF(LY+NY)
          THENPOKESM,32
GJ 1110 LB(J,3)=(NY+1)AND3:ONN
          Y+1GOTO1200,1300,1400,
          1500
EE 1200 IFLY>4THENLB(J,0)=0:GO
          TO1700:REM SCORING ROU
          TINE
QE 1220 POKESM+40,81:ONINT(RND
          (1)*3+1)GOTO1800,1810,
          1820
QS 1300 VX=0:GOSUB1600:IF SW(W
          Y,WX,1)AND(SW(WY,WX,0)
          =SD)THEN VX=1-2*SD:LB(
          J,1)=VX:LB(J,3)=NY+1:L
          B(J,4)=NX+VX:POKESM+40
          +VX,81:GOTO1840
EG 1310 IF SW(WY,WX,0)=SDTHENL
          B(J,0)=0:SW(WY,WX,1)=1
          :POKE SM+40,81:GOTO183
          0
HC 1320 LB(J,3)=NY+1:POKESM+40
          ,81:ONINT(RND(1)*3+1)G
          OTO1800,1810,1820
QD 1400 LB(J,1)=0:LB(J,4)=NX+D
          X:POKESM+40+DX,81:GOTO
          1850
FD 1500 LB(J,2)=LY+1:POKESM+40
          ,81:GOSUB1600:SW(WY,WX
          ,0)=1-SW(WY,WX,0)
DA 1510 IF SW(WY,WX,1)THENLB(N
          B,0)=1:LB(NB,1)=0:LB(N
          B,2)=LY:LB(NB,3)=0:LB(
          NB,4)=NX+2-SD*4:NB=NB+
          1:SW(WY,WX,1)=0:POKESM
          -40+2-SD*4,32:GOSUB186
          0
PA 1520 SX=12-WY*2+WX*4:SY=4+W
          Y*4:WP=SW(WY,WX,0):GOS
          UB800:GOTO1840
FH 1600 WY=LY:JX=(NX/2)+LY-6:W
          X=INT(JX/2):SD=JXAND1:
          RETURN
KX 1700 SF=PT(RR,NX/2-1)
RA 1710 SG=SC(QR,RR)+SF:COLOR5
          ,12
GG 1720 TX=5+31*QR+(SG>9)+(SG>
          99)+(SG>999)
QS 1730 TY=1+RR:A$=MID$(STR$(S
          G),2)
JJ 1740 CHAR1,TX,TY,A$:SC(QR,R
          R)=SG:GOTO1870
MJ 1800 SOUND1,4500,8:RETURN
CP 1810 SOUND1,9000,8:RETURN
FC 1820 SOUND1,6750,8:RETURN
AH 1830 SOUND2,7500,8,1,6250,1
          25,1,1024:RETURN
QD 1840 SOUND2,6000,12,2,4200,
          150,3:RETURN
EH 1850 SOUND2,30000,12,2,1000
          0,5000,3:RETURN
BX 1860 SOUND3,1500,24,0,1450,
          25,3:RETURN
RQ 1870 SOUND1,12000,24:SOUND2
          ,7500,12,0,7300,25:SOU
          ND3,9000,18:RETURN
```

Program 2. Commodore 64 Switchbox

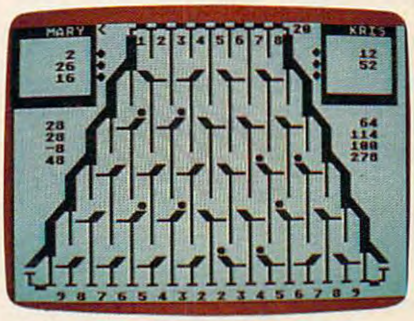
```
RB 100 FORA=54272TO54295:POKEA
          ,0:NEXT:POKE54296,15:PO
          KE54277,24:POKE54284,26
HE 110 V=54276:LB=54272:HB=LB+
          1
GP 120 DIMSW(4,7,1),SP$(1),LB(
          32,4),AR$(1),PT(4,16),S
          C(1,8)
RP 130 SP$(0)="{OFF}Ɛ*Ʒ{RVS}
          Ɛ*Ʒ{OFF}Ɛ@Ʒ":SP$(1)="
          Ɛ@Ʒ{RVS}£{OFF}£":AR$(
          0)="<I {DOWN}{2 LEFT}J
          ƐWƷ":AR$(1)="ƐQƷK{UP}
          {2 LEFT} U>":QR=1
CF 140 POKE53281,15:POKE53280,
          15:POKE646,6:TX=RND(-TI
          /137)
BD 150 FORJ=1TO4:READPT(J,0):R
          EM NAME AND GOAL
SQ 160 FORK=1TO8:READL:PT(J,K+
          8)=L:PT(J,9-K)=L:NEXTK,
          J:REM POINTS
HH 170 DATA 10:REM ROUND 1 (EQ
          UAL)
EE 180 DATA 2,2,2,2,2,2,2,2
RX 190 DATA 40:REM ROUND 2 (FI
          BONACCI)
PH 200 DATA 1,2,3,5,8,13,21,34
MD 210 DATA 20:REM ROUND 3 (AR
          ITHMETIC)
KP 220 DATA 2,3,4,5,6,7,8,9
SQ 230 DATA 80:REM ROUND 4 (SQ
          UARES)
ED 240 DATA 1,4,9,16,25,36,49,
          64
XS 250 PRINT"{CLR}":INPUT"PLAY
          ER 1";P1$
PD 260 INPUT"PLAYER 2";P2$:P1$
          =LEFT$(P1$,5):P2$=LEFT$
          (P2$,5):PRINTP1$;" VS "
          ;P2$
BH 270 PRINT"IS THIS CORRECT?"
          :POKE198,0:WAIT198,1:GE
          TA$:IFASC(A$)<>89THEN25
          0
EF 280 GOSUB450:GOSUB610:REM S
          ETUP
KP 290 FORRR=0TO4:TX=1072+40*R
          R:POKETX,90:POKETX+22,9
          0
HG 300 GOSUB560:REM PUT SCORES
           AT BOTTOM
RK 310 QR=1-QR:POKE646,6:TY=QR
          *20:TX=28-TY:CX=TX:CY=0
GJ 320 M$=RIGHT$(STR$(PT(RR,0)
          ),3)+"{DOWN}{3 LEFT}
          {3 SPACES}":GOSUB1180
GE 330 TX=8+TY:CX=TX:CY=QR:M$=
          AR$(QR):GOSUB1180
EA 340 GOSUB770:IFSC(1-QR,RR)=
          >PT(RR,0)THEN360:REM EN
          D OF ROUND
MJ 350 GOTO310
QP 360 FORJ=0TO1:FORK=5TO8:SC(
          J,K)=0:NEXTK,J
HH 370 FORJ=0TO1:FORK=1TO4:GL=
          PT(K,0):AC=SC(J,K):SC(J
          ,5)=SC(J,5)+AC
FF 380 SC(J,6)=SC(J,6)-(AC=>GL
          )*GL:SC(J,7)=SC(J,7)+(S
          C(J,K)-SC(1-J,K)):NEXTK
          ,J
AP 390 FORJ=0TO1:FORK=6TO7:SC(
          J,K)=SC(J,K)+SC(J,5):NE
          XTK,J
XS 400 FORJ=0TO1:FORK=5TO7:SC(
          J,8)=SC(J,8)+SC(J,K):NE
          XTK,J
RJ 410 POKE646,11:FORJ=0TO1:FO
          RK=5TO8:Y$=STR$(SC(J,K)
          ):L=LEN(Y$):TX=6+J*31-L
HE 420 TY=3+K:CX=TX+(TX<20):CY
          =TY:M$=Y$:GOSUB1180:NEX
          TK,J
SC 430 NEXTRR:REM END OF MAIN
          {SPACE}LOOP 60-499
XJ 440 POKE198,0:WAIT198,1:RUN
PQ 450 PRINT"{CLR}";:PRINTSPC(
          11);"ƐAƷ{RVS}ƐOƷ{OFF}";
          :FORJ=1TO7:PRINT"{OFF}
```

```
        ER3{RVS}EO3";:NEXT:PRIN
        T"{OFF}ES3":LL=7
CQ 460  FORJ=ØTO4:TX=9-2*J:TY=1
        +J*4:R$="- "
CJ 470  FORK=1TO2:CX=TX:CY=TY+K
        -1:M$="":GOSUB118Ø
QP 480  PRINT"{2 SPACES}{RVS}
        {OFF} ";:GOSUB55Ø:PRINT
        "{RVS} ":NEXT
MB 490  CX=TX:CY=TY+K-1:M$="":G
        OSUB118Ø
XD 500  PRINT" {RVS}£ {OFF} ";
        :GOSUB55Ø:PRINT"{RVS}
        E*3":CX=TX:CY=TY+K:M$="
        ":GOSUB118Ø
CA 510  LL=LL+2:PRINT"{RVS}£
        {OFF}£";:GOSUB55Ø:PRIN
        T"{LEFT}E*3{RVS}E*3
        {OFF}";:NEXTJ
MK 520  PRINT:PRINT"{RIGHT}ER3
        {SPACE}";:GOSUB55Ø:PRIN
        T"ER3"
CD 530  R$="{RVS}EU3{OFF}EE3":L
        L=LL+1:PRINT" EZ3";:GOS
        UB55Ø:PRINT"{LEFT}EX3"
QJ 540  RETURN
AJ 550  FORL=1TOLL:PRINTR$;:NEX

        T:RETURN
SX 560  POKE646,11:FORJ=1TO16:K
        =PT(RR,J):JJ=2+J*2
MM 570  IFK>9THENL=INT(K/1Ø):L$
        =MID$(STR$(L),2,1):GOTO
        59Ø
GB 580  L$=CHR$(32)
QH 590  CX=JJ:CY=23:M$=L$:GOSUB
        118Ø:CX=JJ:CY=24:M$=RIG
        HT$(STR$(K),1):GOSUB118
        Ø
KB 600  NEXTJ:RETURN
XJ 610  FORJ=ØTO4:SY=4+J*4:FORK
        =ØTOJ+3:SX=12-J*2+K*4
SR 620  CX=SX+1:CY=SY-1:M$=" ":
        GOSUB118Ø
XG 630  M$=" ":CX=SX+1:CY=SY-1:
        GOSUB118Ø:WP=INT(RND(1)
        *2)
DM 640  SW(J,K,Ø)=WP:SW(J,K,1)=
        Ø:GOSUB76Ø
SH 650  NEXTK,J
SC 660  FORJ=1TO8:POKE1Ø74+J*2,
        48+J:NEXT
JS 670  FORJ=ØTO1:BX=J*31:CX=BX
        :CY=Ø:M$="":GOSUB118Ø
AG 680  PRINT"{OFF}{BLK}ED3.
        {RVS}{PUR}{7 SPACES}
        {DOWN}{8 LEFT}{RVS}
        {BLK}EK3{PUR}ED3E5 I3
        EF3";
DQ 690  FORK=1TO5:CX=BX:CY=K:M$
        ="":GOSUB118Ø:PRINT"
        {RVS}{BLK}EK3{OFF}{PUR}
        EK3{5 SPACES}{RVS}EK3":
        NEXT
DA 700  CX=BX:CY=K:M$="":GOSUB1
        18Ø
GS 710  PRINT"{RVS}{BLK}EK3
        {PUR}EC3{OFF}E5 I3{RVS}
        EV3{DOWN}{8 LEFT}{OFF}
        {BLK}EC3{RVS}E6 I3{OFF}
        EV3"
XC 720  NEXT:POKE646,4
PD 730  CX=3+(LEN(P1$)=5):CY=Ø:
        M$="{RVS}"+P1$+"{OFF}":
        GOSUB118Ø
HP 740  CX=34+(LEN(P2$)=5):CY=Ø
        :M$="{RVS}"+P2$+"{OFF}"
        :GOSUB118Ø
KE 750  RETURN
RC 760  POKE646,1:CX=SX:CY=SY:M
        $=SP$(WP):GOSUB118Ø:RET
        URN
MD 770  FORJ=ØTO32:LB(J,Ø)=Ø:NE
        XT:NB=1
AG 780  POKE198,Ø:WAIT198,1:GET
        A$
RA 790  IFA$="-"THENRETURN
MX 800  IFA$="+"THENA$=STR$(INT
        (RND(1)*8+1))
HC 810  A=VAL(A$):IF(A<1)OR(A>8
        )THEN78Ø
SH 820  LB(Ø,Ø)=1:FORJ=1TO3:LB(
        Ø,J)=Ø:NEXT:LB(Ø,4)=1Ø+
        A*2
EX 830  EX=1
RM 840  FORJ=ØTO32:IFLB(J,Ø)THE
        NEX=Ø:GOSUB87Ø
BB 850  NEXT:IFEXTHENRETURN
DR 860  GOTO83Ø
AM 870  DY=LB(J,Ø):DX=LB(J,1):L
        Y=LB(J,2):NY=LB(J,3):NX
        =LB(J,4)
SF 880  SM=1Ø64+NX+LY*16Ø+NY*4Ø
        :IF(LY+NY)THENPOKESM,32
EF 890  LB(J,3)=(NY+1)AND3:ONNY
        +1GOTO9ØØ,92Ø,96Ø,97Ø
BC 900  IFLY>4THENLB(J,Ø)=Ø:GOT
        O1Ø3Ø:REM SCORING ROUTI
        NE
MS 910  POKESM+4Ø,81:ONINT(RND(
        1)*3+1)GOTO1Ø8Ø,1Ø9Ø,11
        ØØ
XR 920  VX=Ø:GOSUB1Ø2Ø:IF SW(WY
        ,WX,1)=ØOR(SW(WY,WX,Ø)=
        SD)=ØTHEN94Ø
HP 930  VX=1-2*SD:LB(J,1)=VX:LB
        (J,3)=NY+1:LB(J,4)=NX+V
        X:POKESM+4Ø+VX,81:GOTO1
        12Ø
HB 940  IF SW(WY,WX,Ø)=SDTHENLB
        (J,Ø)=Ø:SW(WY,WX,1)=1:P
        OKE SM+4Ø,81:GOTO111Ø
DP 950  LB(J,3)=NY+1:POKESM+4Ø,
        81:ONINT(RND(1)*3+1)GOT
        O1Ø8Ø,1Ø9Ø,11ØØ
JS 960  LB(J,1)=Ø:LB(J,4)=NX+DX
        :POKESM+4Ø+DX,81:GOTO11
        3Ø
MQ 970  LB(J,2)=LY+1:POKESM+4Ø,
        81:GOSUB1Ø2Ø:SW(WY,WX,Ø
        )=1-SW(WY,WX,Ø)
AH 980  IF SW(WY,WX,1)=ØTHEN1Ø1
        Ø
MD 990  LB(NB,Ø)=1:LB(NB,1)=Ø:L
        B(NB,2)=LY:LB(NB,3)=Ø:L
        B(NB,4)=NX+2-SD*4:NB=NB
        +1
AC 1000  SW(WY,WX,1)=Ø:POKESM-4
         Ø+2-SD*4,32:GOSUB114Ø
MC 1010  SX=12-WY*2+WX*4:SY=4+W
         Y*4:WP=SW(WY,WX,Ø):GOS
         UB76Ø:GOTO112Ø
FA 1020  WY=LY:JX=(NX/2)+LY-6:W
         X=INT(JX/2):SD=JXAND1:
         RETURN
SB 1030  SF=PT(RR,NX/2-1)
GE 1040  SG=SC(QR,RR)+SF:POKE64
         6,11
RJ 1050  TX=5+31*QR+(SG>9)+(SG>
         99)+(SG>999)
EJ 1060  TY=1+RR:A$=MID$(STR$(S
         G),2)
BE 1070  CX=TX:CY=TY:M$=A$:GOSU
         B118Ø:SC(QR,RR)=SG:GOT
         O115Ø
KK 1080  POKELB,48:POKEHB,4:POK
         E?V,32:POKEV,33:RETURN
QA 1090  POKELB,97:POKEHB,8:POK
         EV,32:POKEV,33:RETURN
BA 1100  POKELB,152:POKEHB,5:PO
         KEV,32:POKEV,33:RETURN
FA 1110  POKEV,32:POKEV,33:FORA
         =5ØTO1ØSTEP-1:POKEHB,A
         :NEXT:RETURN
HH 1120  RETURN
PB 1130  POKELB,152:POKEHB,1Ø:P
         OKEV,128:POKEV,129:RET
         URN
RM 1140  POKELB+7,Ø:POKEHB+7,2:
         POKEV+7,128:POKEV+7,12
         9:RETURN
DR 1150  POKELB,195:POKEHB,16:P
         OKELB+7,135:POKEHB+7,3
         3:POKEV,32:POKEV,33:PO
         KEV+7,32
QX 1160  POKEV+7,33:RETURN
HE 1170  REM CHAR COMMAND
FP 1180  POKE783,Ø:POKE781,CY:P
         OKE782,CX:SYS6552Ø:PRI
         NTM$;:RETURN
```



The Commodore 64 version of "Switchbox" makes good use of character graphics.



"Switchbox" for eight-bit Atari computers.

Program 3. Atari Switchbox

Version by Kevin Mykytyn, Editorial Programmer

```
HI 100 OPEN #1,4,Ø,"K:":SCR=
       PEEK(88)+256*PEEK(89)
       :POKE 82,Ø:POKE 752,Ø
AL 120 DIM SW(4,7),SX(4,7),S
       P$(6),LB(32,4),AR$(6)
       ,PT(4,16),SC(1,8),P1$
       (2Ø),P2$(2Ø)
AB 125 DIM M$(2Ø),T$(2Ø),Y$(
       1Ø),R$(1Ø),L$(1Ø),A$(
       5)
GA 127 FOR A=Ø TO 1:FOR B=Ø
       TO 8:SC(A,B)=Ø:NEXT B
       :NEXT A
NJ 130 SP$(1,3)="{■}{J}{N}":
       SP$(4,6)="{N}{H}{□}":
       AR$(1.3)="<   ":AR$(4,
       6)="   >":QR=1
BB 140 SETCOLOR 4,3,2:SETCOL
       OR 2,Ø,8:SETCOLOR 1,Ø
       ,Ø
EL 150 FOR J=1 TO 4:READ Q:P
       T(J,Ø)=Q:REM NAME AND
```

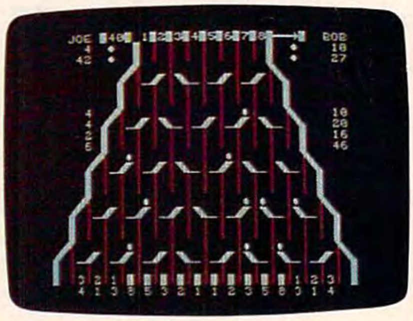
```
         GOAL
PB 16Ø  FOR K=1 TO 8:READ L:P
        T(J,K+8)=L:PT(J,9-K)=
        L:NEXT K:NEXT J:REM P
        OINTS
BD 17Ø  DATA 1Ø
HH 18Ø  DATA 2,2,2,2,2,2,2,2
BI 19Ø  DATA 4Ø
BB 2ØØ  DATA 1,2,3,5,8,13,21,
        34
AP 21Ø  DATA 2Ø
IO 22Ø  DATA 2,3,4,5,6,7,8,9
BH 23Ø  DATA 8Ø
JA 24Ø  DATA 1,4,9,16,25,36,4
        9,64
JI 25Ø  PRINT "{CLEAR}":PRINT
        "PLAYER 1 ";:INPUT P
        1$
NK 26Ø  PRINT "{DOWN}PLAYER 2
        ";:INPUT P2$:IF LEN(
        P1$)>5 THEN P1$=P1$(1
        ,5)
AP 264  IF LEN(P2$)>5 THEN P2
        $=P2$(1,5)
KA 266  PRINT :PRINT P1$;" VS
        ";P2$
MA 27Ø  PRINT "{DOWN}IS THIS
        CORRECT?":GET #1,A:IF
         CHR$(A)<>"Y" THEN 25
        Ø
BH 28Ø  POKE 752,1:GOSUB 45Ø:
        GOSUB 61Ø:REM SETUP
FJ 29Ø  FOR RR=1 TO 4:TX=SCR+
        48+4Ø*RR:POKE TX,96:P
        OKE TX+22,96
PO 3ØØ  GOSUB 56Ø:REM PUT SCO
        RES AT BOTTOM
DA 31Ø  QR=1-QR:TY=QR*2Ø:TX=2
        8-TY:CX=TX:CY=Ø
LF 32Ø  M$=STR$(PT(RR,Ø)):M$(
        3,3)=" "
GO 33Ø  GOSUB 118Ø:TX=8+TY:CX
        =TX:CY=Ø:M$=AR$(QR*3+
        1,QR*3+3):GOSUB 118Ø
IA 34Ø  GOSUB 77Ø:IF SC(1-QR,
        RR)>=PT(RR,Ø) THEN 36
        Ø:REM END OF ROUND
GF 35Ø  GOTO 31Ø
JK 36Ø  FOR J=Ø TO 1:FOR K=5
        TO 8:SC(J,K)=Ø:NEXT K
        :NEXT J
FA 37Ø  FOR J=Ø TO 1:FOR K=1
        TO 4:GL=PT(K,Ø):AC=SC
        (J,K):SC(J,5)=SC(J,5)
        +AC
EG 38Ø  SC(J,6)=SC(J,6)+(AC>=
        GL)*GL:SC(J,7)=SC(J,7
        )+(SC(J,K)-SC(1-J,K))
        :NEXT K:NEXT J
NC 39Ø  FOR J=Ø TO 1:FOR K=6
        TO 7:SC(J,K)=SC(J,K)+
        SC(J,5):NEXT K:NEXT J
LJ 4ØØ  FOR J=Ø TO 1:FOR K=5
        TO 7:SC(J,8)=SC(J,8)+
        SC(J,K):NEXT K:NEXT J
AP 41Ø  FOR J=Ø TO 1:FOR K=5
        TO 8:Y$=STR$(SC(J,K))
        :L=LEN(Y$):TX=6+J*31-
        L
NP 42Ø  TY=3+K:CX=TX-(TX<2Ø):
        CY=TY:M$=Y$:GOSUB 118
        Ø:NEXT K:NEXT J
GD 43Ø  NEXT RR:REM END OF MA
        IN LOOP
MG 44Ø  GET #1,TK:RUN
MM 45Ø  PRINT "{CLEAR}";:PRIN
        T "{11 SPACES}{Q}{E}";
        :FOR J=1 TO 7:PRINT "
        {W}{E}";:NEXT J:PRINT
         "{E}":LL=7
BD 46Ø  FOR J=Ø TO 4:TX=9-2*J
        :TY=1+J*4:R$="{=} "
BC 47Ø  FOR K=1 TO 2:CX=TX:CY
        =TY+K-1:M$="":GOSUB 1
        18Ø
AL 48Ø  PRINT "  ■ ";:GOSUB 5
        5Ø:PRINT "■":NEXT K
GF 49Ø  CX=TX:CY=TY+K-1:M$=""
        :GOSUB 118Ø
PG 5ØØ  PRINT " {H}■ ";:GOSUB
         55Ø:PRINT "■{J}":CX=
        TX:CY=TY+K:M$="":GOSU
        B 118Ø
EF 51Ø  LL=LL+2:PRINT "{H}
        {E}";:GOSUB 55Ø:PRINT
         "{LEFT}{M}{J}";:NEXT
         J
BG 52Ø  PRINT :PRINT "{RIGHT}
        {W} ";:GOSUB 55Ø:PRIN
        T "{W}"
JP 53Ø  R$="{U}{X}":LL=LL+1:P
        RINT " {Z}";:GOSUB 55
        Ø:PRINT "{LEFT}{C}"
HJ 54Ø  RETURN
MN 55Ø  FOR L=1 TO LL:PRINT R
        $;:NEXT L:RETURN
CD 56Ø  FOR J=1 TO 16:K=PT(RR
        ,J):JJ=2+J*2
LE 57Ø  IF K>9 THEN L=INT(K/1
        Ø):T$=STR$(L):L$=T$(1
        ,1):GOTO 59Ø
AB 58Ø  L$=CHR$(32)
NE 59Ø  CX=JJ:CY=22:M$=L$:GOS
        UB 118Ø:CX=JJ:CY=23:T
        $=STR$(K):M$=T$(LEN(T
        $),LEN(T$)):GOSUB 118
        Ø
DJ 6ØØ  NEXT J:RETURN
IG 61Ø  FOR J=Ø TO 4:SY=4+J*4
        :FOR K=Ø TO J+3:SX=12
        -J*2+K*4
EE 62Ø  CX=SX+1:CY=SY-1:M$="
        ":GOSUB 118Ø
GB 63Ø  M$=" ":CX=SX+1:CY=SY-
        1:GOSUB 118Ø:WP=INT(R
        ND(1)*2)
PF 64Ø  SW(J,K)=WP:SX(J,K)=Ø:
        GOSUB 76Ø
OI 65Ø  NEXT K:NEXT J
JD 66Ø  FOR J=1 TO 8:POKE SCR
        +5Ø+J*2,16+J:NEXT J
JH 67Ø  FOR J=Ø TO 1:BX=J*31:
        CX=BX:CY=Ø:M$="":GOSU
        B 118Ø
KK 68Ø  PRINT "{8 SPACES}";
IN 69Ø  FOR K=1 TO 5:CX=BX:CY
        =K:M$="":GOSUB 118Ø:P
        RINT "{Y}{6 SPACES}
        {Y}";:NEXT K
BH 7ØØ  CX=BX:CY=K:M$="":GOSU
        B 118Ø
KE 71Ø  PRINT "{8 SPACES}";
FH 72Ø  NEXT J:FOR TK=1 TO LE
        N(P1$):P1$(TK,TK)=CHR
        $(ASC(P1$(TK,TK))+128
        ):NEXT TK
JM 725  FOR TK=1 TO LEN(P2$):
        P2$(TK,TK)=CHR$(ASC(P
        2$(TK,TK))+128):NEXT
        TK
LO 73Ø  CX=3-(LEN(P1$)=5):CY=
        Ø:M$=P1$:GOSUB 118Ø
PF 74Ø  CX=34-(LEN(P2$)=5):CY
        =Ø:M$=P2$:GOSUB 118Ø
HM 75Ø  RETURN
GL 76Ø  CX=SX:CY=SY:M$=SP$(WP
        *3+1,WP*3+3):GOSUB 11
        8Ø:RETURN
GL 77Ø  FOR J=Ø TO 32:LB(J,Ø)
        =Ø:NEXT J:NB=1
KP 78Ø  GET #1,A:A$=CHR$(A)
FB 79Ø  IF A$="-" THEN RETURN
NH 8ØØ  IF A$="+" THEN A$=STR
        $(INT(RND(1)*8+1))
NA 8Ø5  IF A$<"1" OR A$>"8" T
        HEN 78Ø
LA 81Ø  A=VAL(A$)
CA 82Ø  LB(Ø,Ø)=1:FOR J=1 TO
        3:LB(Ø,J)=Ø:NEXT J:LB
        (Ø,4)=1Ø+A*2
OI 83Ø  EX=1:EV=Ø
CC 84Ø  FOR J=Ø TO 32:IF LB(J
        ,Ø) THEN EX=Ø:GOSUB 8
        7Ø
LK 85Ø  NEXT J:SOUND 1,Ø,Ø,Ø:
        SOUND 3,Ø,Ø,Ø:SOUND 2
        ,1ØØ,4,EV:EV=EV-(EV>Ø
        ):IF EX THEN RETURN
HC 86Ø  GOTO 83Ø
IG 87Ø  DY=LB(J,Ø):DX=LB(J,1)
        :LY=LB(J,2):NY=LB(J,3
        ):NX=LB(J,4)
KB 88Ø  SM=SCR+4Ø+NX+LY*16Ø+N
        Y*4Ø:IF (LY+NY) THEN
        POKE SM,Ø
JD 89Ø  LB(J,3)=(NY+1)-4*(INT
        ((NY+1)/4)):ON NY+1 G
        OTO 9ØØ,92Ø,96Ø,97Ø
PA 9ØØ  IF LY>4 THEN LB(J,Ø)=
        Ø:GOTO 1Ø3Ø:REM SCORI
        NG ROUTINE
KI 91Ø  POKE SM+4Ø,84:ON INT(
        RND(1)*3+1) GOTO 1Ø8Ø
        ,1Ø9Ø,11ØØ
HF 92Ø  VX=Ø:GOSUB 1Ø2Ø:IF SX
        (WY,WX)=Ø OR (SW(WY,W
        X)=SD)=Ø THEN 94Ø
EE 93Ø  VX=1-2*SD:LB(J,1)=VX:
        LB(J,3)=NY+1:LB(J,4)=
        NX+VX:POKE SM+4Ø+VX,8
        4:GOTO 112Ø
DM 94Ø  IF SW(WY,WX)=SD THEN
        LB(J,Ø)=Ø:SX(WY,WX)=1
        :POKE SM+4Ø,84:GOTO 1
        11Ø
KO 95Ø  LB(J,3)=NY+1:POKE SM+
        4Ø,84:ON INT(RND(1)*3
        +1) GOTO 1Ø8Ø,1Ø9Ø,11
        ØØ
CO 96Ø  LB(J,1)=Ø:LB(J,4)=NX+
        DX:POKE SM+4Ø+DX,84:G
        OTO 113Ø
PD 97Ø  LB(J,2)=LY+1:POKE SM+
        4Ø,84:GOSUB 1Ø2Ø:SW(W
        Y,WX)=1-SW(WY,WX)
BF 98Ø  IF SX(WY,WX)=Ø THEN 1
        Ø1Ø
AK 99Ø  LB(NB,Ø)=1:LB(NB,1)=Ø
        :LB(NB,2)=LY:LB(NB,3)
        =Ø:LB(NB,4)=NX+2-SD*4
        :NB=NB+1
KK 1ØØØ SX(WY,WX)=Ø:POKE SM-
        4Ø+2-SD*4,Ø:GOSUB 11
        4Ø
EA 1Ø1Ø SX=12-WY*2+WX*4:SY=4
        +WY*4:WP=SW(WY,WX):G
        OSUB 76Ø:GOTO 112Ø
EB 1Ø2Ø WY=LY:JX=(NX/2)+LY-6
        :WX=INT(JX/2):SD=JX-
        2*(INT(JX/2)):RETURN
ME 1Ø3Ø SF=PT(RR,NX/2-1)
LK 1Ø4Ø SG=SC(QR,RR)+SF
JI 1Ø5Ø TX=5+31*QR-(SG>9)-(S
        G>99)-(SG>999)
JF 1Ø6Ø TY=1+RR:A$=STR$(SG)
IC 1Ø7Ø CX=TX:CY=TY:M$=A$:GO
        SUB 118Ø:SC(QR,RR)=S
        G:GOTO 115Ø
EJ 1Ø8Ø SOUND 1,6Ø,1Ø,1Ø:RET
        URN
HI 1Ø9Ø SOUND 1,121,1Ø,1Ø:RE
        TURN
EF 11ØØ SOUND 1,81,1Ø,1Ø:RET
        URN
OI 111Ø FOR A=1Ø TO 3Ø:SOUND
         1,A,12,1Ø:NEXT A:SO
        UND 1,Ø,Ø,Ø:RETURN
KE 112Ø RETURN
IG 113Ø FOR A=4Ø TO 2Ø STEP
```

```
        -1:SOUND 1,A,12,10:N
        EXT A:SOUND 1,Ø,Ø,Ø:
        RETURN
MC 114Ø SOUND 2,1ØØ,4,15:EV=
        15:RETURN
AA 115Ø SOUND 1,121,1Ø,1Ø:SO
        UND 3,81,1Ø,1Ø
KI 116Ø RETURN
MK 117Ø REM CHAR COMMAND
CP 118Ø POSITION CX,CY:PRINT
          M$;:RETURN
```

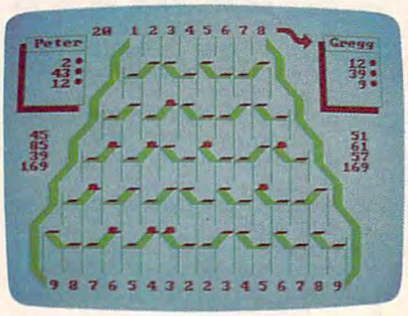
Program 4. Apple II Switchbox

Version by Tim Victor, Editorial Programmer

```
4D 1ØØ DIM SW(4,7,1),SP$(1),LB(3
       2,4),AR$(1),PT(4,16),SC(1
       ,8)
D4 11Ø SP$(Ø) = "%&)":SP$(1) = "
       )!" + CHR$ (34):AR$(Ø) =
       "<--":AR$(1) = "-->":QR =
        1
D3 12Ø FOR J = 1 TO 4: READ PT(J
       ,Ø)
6C 13Ø FOR K = 1 TO 8: READ L:PT
       (J,K + 8) = L:PT(J,9 - K)
        = L: NEXT K,J
B4 14Ø DATA 1Ø,2,2,2,2,2,2,2,2
AE 15Ø DATA 4Ø,1,2,3,5,8,13,21,3
       4
B5 16Ø DATA 2Ø,2,3,4,5,6,7,8,9
6E 17Ø DATA 8Ø,1,4,9,16,25,36,49
       ,64
16 18Ø HOME : FLASH : PRINT "REA
       DING DATA STATEMENTS- ONE
        MOMENT": NORMAL
72 19Ø IF PEEK (768) < > 169 THE
       N POKE 23Ø,64: GOSUB 97Ø
68 195 IF PEEK (19Ø*256) = 76 TH
       EN PRINT CHR$ (4) "PR#A$3
       5C": GOTO 21Ø
5C 2ØØ POKE 54,92: POKE 55,3: CA
       LL 1ØØ2: POKE 6,Ø
E1 21Ø TEXT : HOME : INPUT "PLAY
       ER 1: ";P1$: INPUT "PLAYE
       R 2: ";P2$
32 22Ø PRINT "IS THIS CORRECT?":
        GET A$:A = ASC (A$): IF
       A < > 89 AND A < > 121 TH
       EN 21Ø
EB 23Ø POKE 7,138: GOSUB 35Ø: GO
       SUB 53Ø
DB 24Ø FOR RR = 1 TO 4: POKE 7,1
       38: VTAB RR + 1: HTAB 8:
       PRINT "+";: HTAB 3Ø: PRIN
       T "+";
58 25Ø GOSUB 49Ø
2D 26Ø POKE 7,141:QR = 1 - QR: V
       TAB 1: HTAB 28 - QR * 21:
        PRINT " ";PT(RR,Ø);" ";:
        POKE 7,138: HTAB 8 + QR
       * 2Ø: PRINT AR$(QR)
94 27Ø GOSUB 63Ø: IF SC(1 - QR,R
       R) > = PT(RR,Ø) THEN 29Ø
22 28Ø GOTO 26Ø
69 29Ø POKE 7,141: FOR J = Ø TO
       1: FOR K = 5 TO 8:SC(J,K)
        = Ø: NEXT K,J
56 3ØØ FOR J = Ø TO 1: FOR K = 1
        TO 4:GL = PT(K,Ø):AC = S
       C(J,K):SC(J,5) = SC(J,5)
       + AC:SC(J,6) = SC(J,6) +
       (AC > = GL) * GL:SC(J,7)
       = SC(J,7) + (SC(J,K) - SC
       (1 - J,K)): NEXT K,J
4E 31Ø FOR J = Ø TO 1: FOR K = 6
        TO 7:SC(J,K) = SC(J,K) +
        SC(J,5): NEXT K,J
4B 32Ø FOR J = Ø TO 1: FOR K = 5
        TO 7:SC(J,8) = SC(J,8) +
        SC(J,K): NEXT K,J
4A 33Ø FOR J = Ø TO 1: FOR K = 5
        TO 8:Y$ = STR$ (SC(J,K))
       :L = LEN (Y$):TX = 6 + J
       * 31 - L:TY = 3 + K: VTAB
        TY: HTAB TX: PRINT Y$: N
       EXT K,J
C4 34Ø NEXT RR: VTAB 15: HTAB 16
       : PRINT "GAME OVER"
44 341 VTAB 17: HTAB 15: PRINT "
       PLAY AGAIN?"
44 345 GET G$: IF G$ = "" THEN 3
       45
54 346 IF G$ + "N" THEN : HOME :
        STOP
15 347 IF G$ = "Y" THEN RUN
C3 348 GOTO 345
E6 35Ø HOME : HGR2
CE 36Ø FOR I = Ø TO 5: FOR J = Ø
        TO 1
8A 37Ø HTAB 11 - I * 2: VTAB I *
        4 + J + 2: PRINT "*";: H
       TAB 27 + I * 2: PRINT "*"
       : NEXT
2C 38Ø NEXT : FOR I = Ø TO 4
84 39Ø HTAB 1Ø - I * 2: VTAB I *
        4 + 4: PRINT CHR$ (33);
       CHR$ (34);
97 4ØØ HTAB 27 + I * 2: PRINT CH
       R$ (37); CHR$ (38);
B6 41Ø HTAB 9 - I * 2: VTAB I *
       4 + 5: PRINT CHR$ (35); C
       HR$ (36);
C6 42Ø HTAB 28 + I * 2: PRINT CH
       R$ (39); CHR$ (4Ø)
Ø2 43Ø NEXT
19 44Ø HCOLOR= 5: FOR I = Ø TO 6
       : FOR HP = 87 - I * 14 TO
        171 + I * 14 STEP 28
7E 45Ø VS = I * 32 - 28:VE = VS
       + 5Ø: IF VS < 8 THEN VS =
        8
3D 46Ø IF VE > 182 THEN VE = 182
22 47Ø HPLOT HP,VS TO HP,VE: NEX
       T
DØ 48Ø NEXT : RETURN
CB 49Ø POKE 7,141: FOR J = 1 TO
       16:K = PT(RR,J):JJ = 2 +
       J * 2
4D 5ØØ IF K > 9 THEN L = INT (K
       / 1Ø):L$ = STR$ (L): GOTO
        52Ø
3E 51Ø L$ = " "
5Ø 52Ø VTAB 23: HTAB JJ: PRINT L
       $: HTAB JJ: PRINT RIGHT$
       ( STR$ (K),1);: NEXT J: R
       ETURN
96 53Ø FOR J = Ø TO 4:SY = 5 + J
        * 4: FOR K = Ø TO J + 3:
       SX = 12 - J * 2 + K * 4
8Ø 54Ø WP = INT ( RND (1) * 2)
15 55Ø SW(J,K,Ø) = WP:SW(J,K,1)
       = Ø: GOSUB 62Ø
31 56Ø NEXT K,J
A2 57Ø POKE 7,141
BB 58Ø VTAB 1: HTAB 12: FOR J =
       1 TO 8: PRINT J;" ";: NEX
       T
EØ 59Ø VTAB 1: HTAB 3 - ( LEN (P
       1$) = 5): PRINT P1$;
FD 6ØØ HTAB 34 - ( LEN (P2$) = 5
       ): PRINT P2$;
18 61Ø RETURN
27 62Ø VTAB SY: HTAB SX: PRINT S
       P$(WP): RETURN
CB 63Ø FOR J = Ø TO 32:LB(J,Ø) =
        Ø: NEXT :NB = 1
4B 64Ø GET A$: IF A$ = "-" THEN
       RETURN
FF 65Ø IF A$ = "+" THEN A$ = STR
       $ ( INT ( RND (1) * 8 + 1
       ))
2F 66Ø A = VAL (A$): IF A < 1 OR
        A > 8 THEN 64Ø
F7 67Ø LB(Ø,Ø) = 1: FOR J = 1 TO
        3:LB(Ø,J) = Ø: NEXT :LB(
       Ø,4) = 1Ø + A * 2
CA 68Ø EX = 1
B6 69Ø FOR J = Ø TO 32: IF LB(J,
       Ø) THEN EX = Ø: GOSUB 72Ø
2C 7ØØ NEXT : IF EX = Ø THEN 68Ø
19 71Ø RETURN
F3 72Ø DY = LB(J,Ø):DX = LB(J,1)
       :LY = LB(J,2):NY = LB(J,3
       ):NX = LB(J,4): IF (LY +
       NY) THEN GOSUB 1Ø6Ø
9Ø 73Ø LB(J,3) = NY + 1 - (NY =
       3) * 4: ON NY + 1 GOTO 74
       Ø,76Ø,79Ø,8ØØ
E1 74Ø IF LY > 4 THEN LB(J,Ø) =
       Ø: GOTO 84Ø
Ø6 75Ø GOSUB 1Ø8Ø: ON INT ( RND
       (1) * 3 + 1) GOTO 88Ø,89Ø
       ,9ØØ
E4 76Ø VX = Ø: GOSUB 83Ø: IF SW(
       WY,WX,1) AND (SW(WY,WX,Ø)
        = SD) THEN VX = 1 - 2 *
       SD:LB(J,1) = VX:LB(J,3) =
        NY + 1:BX = NX + VX:LB(J
       ,4) = BX:BY = NY + LY * 4
        + 3: GOSUB 1Ø9Ø: GOTO 93
       Ø
7D 77Ø IF SW(WY,WX,Ø) = SD THEN
       LB(J,Ø) = Ø:SW(WY,WX,1) =
        1: GOSUB 1Ø8Ø: GOTO 92Ø
F1 78Ø LB(J,3) = NY + 1: GOSUB 1
       Ø8Ø: ON INT ( RND (1) * 3
        + 1) GOTO 88Ø,89Ø,9ØØ
64 79Ø LB(J,1) = Ø:BX = NX + DX:
       LB(J,4) = BX:BY = NY + LY
        * 4 + 3: GOSUB 1Ø9Ø: GOT
       O 94Ø
B4 8ØØ LB(J,2) = LY + 1: GOSUB 1
       Ø8Ø: GOSUB 83Ø:SW(WY,WX,Ø
       ) = 1 - SW(WY,WX,Ø)
62 81Ø IF SW(WY,WX,1) THEN LB(NB
       ,Ø) = 1:LB(NB,1) = Ø:LB(N
       B,2) = LY:LB(NB,3) = Ø:LB
       (NB,4) = NX + 2 - SD * 4:
       NB = NB + 1:SW(WY,WX,1) =
        Ø:BX = NX + 2 - SD * 4:B
       Y = NY + LY * 4 + 1: GOSU
       B 1Ø7Ø: GOSUB 95Ø
E9 82Ø SX = 12 - WY * 2 + WX * 4
       :SY = 5 + WY * 4:WP = SW(
       WY,WX,Ø): GOSUB 62Ø: GOTO
        93Ø
5D 83Ø WY = LY:JX = (NX / 2) + L
       Y - 6:WX = INT (JX / 2):S
       D = JX - INT (JX / 2) * 2
       : RETURN
EØ 84Ø POKE 7,141:SF = PT(RR,NX
       / 2 - 1)
B6 85Ø SG = SC(QR,RR) + SF
4F 86Ø TX = 6 + 31 * QR - LEN (
       STR$ (SG))
DC 87Ø VTAB RR + 1: HTAB TX: PRI
       NT SG:SC(QR,RR) = SG: POK
       E 7,138: GOTO 96Ø
Ø5 88Ø POKE 776,8Ø: GOTO 91Ø
6A 89Ø POKE 776,16Ø: GOTO 91Ø
21 9ØØ POKE 776,2Ø1: GOTO 91Ø
69 91Ø POKE 781,2ØØ: POKE 841,1:
        POKE 849,196: POKE 798,9
       6: CALL 768: RETURN
44 92Ø POKE 776,2Ø8: POKE 781,22
       Ø: POKE 841,5: POKE 849,4
       : POKE 798,97: CALL 768:
       RETURN
Ø3 93Ø POKE 776,232: POKE 781,25
       5: POKE 841,Ø: POKE 849,Ø
       : POKE 798,24Ø: CALL 768:
        RETURN
FA 94Ø POKE 776,216: POKE 781,24
       Ø: POKE 841,4: POKE 849,4
       : POKE 798,24Ø: CALL 768:
        RETURN
F8 950 POKE 776,160: POKE 781,16
       Ø: POKE 841,1: POKE 849,9
       6: POKE 798,240: CALL 768
       : RETURN
EB 960 POKE 776,160: POKE 781,22
       Ø: POKE 841,6: POKE 849,6
       : POKE 798,97: CALL 768:
       RETURN
88 970 FOR I = 768 TO 947: READ
       A: POKE I,A: NEXT
AF 980 FOR I = 24576 TO 24831: P
       OKE I,128: NEXT
78 990 FOR I = 24832 TO 25087 ST
       EP 4: POKE I,128: POKE I
       + 1,136: POKE I + 2,170:
       POKE I + 3,136: NEXT
B9 1000 FOR I = 35328 TO 35439:
       READ A: POKE I,A: NEXT
51 1010 FOR I = 35552 TO 35559:
       READ A: POKE I,A: NEXT
F5 1020 FOR I = 35568 TO 35575:
       READ A: POKE I,A: NEXT
CØ 1030 FOR I = 35704 TO 35711:
       READ A: POKE I,A: NEXT
12 1040 FOR I = 36200 TO 36311:
       READ A: POKE I,A: NEXT
DØ 1050 FOR I = 36360 TO 36599:
       READ A: POKE I,A: NEXT :
        RETURN
Ø4 1060 BY = NY + LY * 4 + 2:BX
       = NX
6B 1070 VTAB BY: HTAB BX: PRINT
       " ": RETURN
C5 1080 BX = NX:BY = NY + LY * 4
        + 3
F8 1090 VTAB BY: HTAB BX: PRINT
       "O": RETURN
AF 1100 DATA 169,1,141,88,3,160,
       Ø,169
58 1110 DATA 160,141,49,3,169,25
       5,141,59
5B 1120 DATA 3,173,59,3,141,90,3
       ,78
5A 1130 DATA 88,3,144,12,185,Ø,1
       45,200
64 1140 DATA 141,89,3,169,128,14
       1,88,3
FC 1150 DATA 78,89,3,144,3,173,4
       8,192
19 1160 DATA 162,Ø,232,208,253,1
       44,3,173
A3 1170 DATA 48,192,162,159,232,
       208,253,238
25 1180 DATA 90,3,208,211,24,173
       ,59,3
8C 1190 DATA 233,3,141,59,3,173,
       49,3
51 1200 DATA 105,3,141,49,3,144,
       186,96
6C 1210 DATA 8,5,Ø,255,216,120,1
       33,69
25 1220 DATA 134,70,132,71,166,7
       ,10,10
AD 1230 DATA 176,4,16,62,48,4,16
       ,1
44 1240 DATA 232,232,10,134,27,2
       4,101,6
5Ø 1250 DATA 133,26,144,2,230,27
       ,165,40
F2 1260 DATA 133,8,165,41,41,3,5
       ,230
CC 1270 DATA 133,9,162,8,160,Ø,1
       77,26
95 1280 DATA 36,50,48,2,73,127,1
       64,36
39 1290 DATA 145,8,230,26,208,2,
       230,27
B7 1300 DATA 165,9,24,105,4,133,
       9,202
5B 1310 DATA 208,226,165,69,166,
       70,164,71
64 1320 DATA 88,76,240,253
5C 1330 DATA Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø
9Ø 1340 DATA Ø,64,96,112,120,124
       ,126,127
EØ 1350 DATA 127,63,31,15,7,3,1,
       Ø
E3 1360 DATA 64,96,112,120,124,1
       26,127,127
7D 1370 DATA 63,31,15,7,3,1,Ø,Ø
3F 1380 DATA 127,126,124,120,112
       ,96,64,Ø
A9 1390 DATA Ø,1,3,7,15,31,63,12
       7
81 1400 DATA 126,124,120,112,96,
       64,Ø,Ø
44 1410 DATA 1,3,7,15,31,63,127,
       127
AB 1420 DATA Ø,Ø,Ø,Ø,Ø,Ø,Ø,127
F7 1430 DATA 127,127,127,127,127
       ,127,127,127
EE 1440 DATA Ø,Ø,28,62,127,62,28
       ,Ø
66 1450 DATA Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø
7C 1460 DATA Ø,Ø,Ø,127,127,Ø,Ø,Ø
7C 1470 DATA Ø,12,6,127,127,6,12
       ,Ø
ØB 1480 DATA Ø,24,48,127,127,48,
       24,Ø
9A 1490 DATA Ø,Ø,28,62,62,62,28,
       Ø
ØD 1500 DATA Ø,Ø,Ø,Ø,14,Ø,Ø,Ø
FF 1510 DATA Ø,Ø,Ø,14,Ø,14,Ø,Ø
F1 1520 DATA Ø,60,102,48,24,Ø,24
       ,Ø
9C 1530 DATA Ø,60,102,118,110,10
       2,60,Ø
C9 1540 DATA Ø,24,28,24,24,24,60
       ,Ø
B4 1550 DATA Ø,60,102,48,12,102,
       126,Ø
29 1560 DATA Ø,60,102,48,96,102,
       60,Ø
B2 1570 DATA Ø,48,56,52,126,48,4
       8,Ø
3B 1580 DATA Ø,126,6,62,96,102,6
       Ø,Ø
E1 1590 DATA Ø,60,6,62,102,102,6
       Ø,Ø
AØ 1600 DATA Ø,126,96,48,24,12,1
       2,Ø
B5 1610 DATA Ø,60,102,60,102,102
       ,60,Ø
ØF 1620 DATA Ø,60,102,102,124,48
       ,24,Ø
B6 1630 DATA Ø,24,48,126,126,48,
       24,Ø
AD 1640 DATA Ø,124,102,102,126,1
       02,102,Ø
8D 1650 DATA Ø,62,102,102,62,102
       ,126,Ø
69 1660 DATA Ø,60,102,6,6,102,62
       ,Ø
CB 1670 DATA Ø,62,102,102,102,10
       2,62,Ø
ØC 1680 DATA Ø,126,6,6,62,6,126,
       Ø
48 1690 DATA Ø,126,6,6,62,6,6,Ø
FØ 1700 DATA Ø,60,102,6,118,102,
       62,Ø
73 1710 DATA Ø,102,102,102,126,1
       02,102,Ø
CC 1720 DATA Ø,24,24,24,24,24,24
       ,Ø
77 1730 DATA Ø,96,96,96,96,102,6
       Ø,Ø
64 1740 DATA Ø,102,102,54,30,102
       ,102,Ø
DD 1750 DATA Ø,6,6,6,6,6,126,Ø
87 1760 DATA Ø,102,126,102,102,1
       02,102,Ø
ØD 1770 DATA Ø,62,102,102,102,10
       2,102,Ø
41 1780 DATA Ø,60,102,102,102,10
       2,60,Ø
91 1790 DATA Ø,62,102,102,62,6,6
       ,Ø
9C 1800 DATA Ø,60,102,102,102,54
       ,108,Ø
4Ø 1810 DATA Ø,62,102,102,62,102
       ,102,Ø
11 1820 DATA Ø,60,102,12,48,102,
       62,Ø
7Ø 1830 DATA Ø,126,24,24,24,24,2
       4,Ø
FD 1840 DATA Ø,102,102,102,102,1
       02,62,Ø
Ø2 1850 DATA Ø,102,102,102,102,1
       02,24,Ø
D4 1860 DATA Ø,102,102,102,102,1
       26,102,Ø
1A 1870 DATA Ø,102,102,102,60,10
       2,102,Ø
BØ 1880 DATA Ø,102,102,102,60,24
       ,24,Ø
CE 1890 DATA Ø,126,48,24,12,6,12
       6,Ø
5C 1900 DATA Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø
6Ø 1910 DATA Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø
64 1920 DATA Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø
6A 1930 DATA Ø,Ø,24,60,60,24,Ø,Ø
```



Machine language creates the custom graphics in the Apple II version of "Switchbox."



IBM PC/PCjr "Switchbox," a colorful two-player game.

Program 5. IBM PC/PCjr Switchbox

Version by Tim Victor, Editorial Programmer

```
PB 100 RANDOMIZE TIMER
LD 110 SCREEN 1,Ø:CLS
LO 120 KEY OFF
6L 130 COLOR 7,Ø
JB 140 DIM BOX(4,7,1),FALLING(32
       ,4),POINTS(4,16),SCORE(1,
       8)
CA 150 DIM S(250),LEFTSW(35),RIG
       HTSW(35),BALL(4),UNBALL(4
       ),LARROW(35),RARROW(35)
QL 160 FOR J=1 TO 4:READ POINTS(
       J,Ø)
CK 170 FOR K=1 TO 8:READ L:POINT
       S(J,K+8)=L:POINTS(J,9-K)=
        L:NEXT K,J
GJ 18Ø  DATA 1Ø,2,2,2,2,2,2,2,2
GP 19Ø  DATA 4Ø,1,2,3,5,8,13,21,3
        4
OI 2ØØ  DATA 2Ø,2,3,4,5,6,7,8,9
PM 21Ø  DATA 8Ø,1,4,9,16,25,36,49
        ,64
BD 22Ø  LOCATE 1,1:INPUT "Player
        1: ";P1$:P1$=LEFT$(P1$,5)
DG 23Ø  INPUT "Player 2: ";P2$:P2
        $=LEFT$(P2$,5)
KN 24Ø  PRINT P1$;" vs ";P2$:PRIN
        T "Is this correct? (y/n)
        "
PP 25Ø  YN$=INKEY$:IF YN$="" THEN
         25Ø
DA 26Ø  IF YN$="n" OR YN$="N" THE
        N 22Ø
PJ 27Ø  ROUND=4
PA 28Ø  CLS:GOSUB 97Ø:GOSUB 7ØØ
EG 29Ø  CLS:GOSUB 1Ø3Ø:GOSUB 54Ø
KP 3ØØ  PLAYER=1:PUT (225,1),RARR
        OW:FOR ROUND=1 TO 4:GOSUB
         5ØØ
PB 31Ø  FOR I=Ø TO 1:CIRCLE (53+2
        56*I,18+ROUND*8),2
DL 32Ø  PAINT (53+256*I,18+ROUND*
        8),3:NEXT
EK 33Ø  PLAYER=1-PLAYER:LOCATE 1,
        9+PLAYER*21:PRINT SPACE$(
        2)
OA 34Ø  PUT (6Ø,1),LARROW:PUT(225
        ,1),RARROW
CN 35Ø  LOCATE 1,3Ø-PLAYER*21:PRI
        NT RIGHT$(STR$(POINTS(ROU
        ND,Ø)),2)
DE 36Ø  GOSUB 121Ø:IF SCORE(1-PLA
        YER,ROUND)<POINTS(ROUND,Ø
        ) THEN 33Ø
KO 37Ø  FOR J=Ø TO 1:FOR K=5 TO 8
JI 38Ø  SCORE(J,K)=Ø:NEXT K,J
DE 39Ø  FOR J=Ø TO 1:FOR K=1 TO 4
        :BONUS=POINTS(K,Ø):AMT=SC
        ORE(J,K)
HF 4ØØ  SCORE(J,5)=SCORE(J,5)+AMT
        :SCORE(J,6)=SCORE(J,6)-BO
        NUS*(AMT>=BONUS)
HL 41Ø  SCORE(J,7)=SCORE(J,7)+SCO
        RE(J,K)-SCORE(1-J,K):NEXT
         K,J
AD 42Ø  FOR J=Ø TO 1:FOR K=6 TO 7
        :SCORE(J,K)=SCORE(J,K)+SC
        ORE(J,5):NEXT K,J
JA 43Ø  FOR J=Ø TO 1:FOR K=5 TO 7
        :SCORE(J,8)=SCORE(J,8)+SC
        ORE(J,K):NEXT K,J
EK 44Ø  FOR J=Ø TO 1:FOR K=5 TO 8
        :SCORE$=STR$(SCORE(J,K))
HA 45Ø  LOCATE K+6,1+J*34:PRINT S
        PACE$(5)
NM 46Ø  LOCATE K+6,5-LEN(SCORE$)+
        J*34:PRINT SCORE$:NEXT K,
        J
KG 47Ø  NEXT ROUND:LOCATE 11,12:P
        RINT "Play again? (Y/N)"
PD 48Ø  K$=INKEY$:IF K$="n" OR K$
        ="N" THEN CLS:END:ELSE IF
         K$="y" OR K$="Y" THEN RU
        N:ELSE GOTO 48Ø
QO 5ØØ  FOR J=1 TO 16:K=POINTS(RO
        UND,J):JJ=3+J*2
IF 51Ø  LOCATE 24,JJ:IF K>9 THEN
        PRINT MID$(STR$(K),2,1);
        ELSE PRINT " ";
GK 52Ø  LOCATE 25,JJ:PRINT RIGHT$
        (STR$(K),1);:NEXT
MF 53Ø  RETURN
QI 54Ø  LINE (4,11)-(54,65),2,BF
NM 55Ø  LINE (9,6)-(59,6Ø),Ø,BF
IE 56Ø  LINE (9,6)-(59,6Ø),1,B
BA 57Ø  LINE (1Ø,18)-(58,18),1
EF 58Ø  GET (4,6)-(59,65),S:PUT (
        262,6),S,PSET
NL 59Ø  LOCATE 2,5-LEN(P1$)/2:PRI
        NT P1$
QP 6ØØ  LOCATE 2,37-LEN(P2$)/2:PR
        INT P2$
FD 61Ø  FOR J=1 TO 8:LOCATE 1,J*2
        +1Ø:PRINT J:NEXT
NC 62Ø  FOR SWITCHY=Ø TO 4
EH 63Ø  FOR SWITCHX=Ø TO SWITCHY+
        3
AC 64Ø  WP=INT(RND(1)*2):BOX(SWIT
        CHY,SWITCHX,Ø)=WP:BOX(SWI
        TCHY,SWITCHX,1)=Ø
MC 65Ø  GOSUB 67Ø
JA 66Ø  NEXT SWITCHX,SWITCHY:RETU
        RN
BI 67Ø  SY=24+SWITCHY*32:SX=92-SW
        ITCHY*16+SWITCHX*32
IO 68Ø  IF WP=Ø THEN PUT (SX,SY),
        LEFTSW,PSET ELSE PUT (SX,
        SY),RIGHTSW,PSET
NC 69Ø  RETURN
PP 7ØØ  FOR I=1 TO 1Ø:LINE (I+155
        ,52)-(I+157,51),2
BP 71Ø  LINE (I+189,2Ø)-(I+191,19
        ),2:NEXT
BO 72Ø  FOR I=172 TO 18Ø:LINE (I,
        12)-(I+1Ø,22),1
NO 73Ø  LINE (I+1,11)-(I+3,1Ø),2
LF 74Ø  LINE (I,44)-(I-1Ø,54),1
IO 75Ø  LINE (I+1,43)-(I+3,42),2:
        NEXT
HD 76Ø  LINE (186,21)-(2ØØ,22),1,
        BF
NB 77Ø  LINE (166,53)-(154,54),1,
        BF
BO 78Ø  GET (172,6)-(2Ø2,22),LEFT
        SW
MF 79Ø  GET (154,38)-(184,54),RIG
        HTSW
LE 8ØØ  ARC=3.14159/2
NL 81Ø  FOR I=1 TO 2:CIRCLE (8Ø,8
        ),I*4,3,ARC,ARC*2
GD 82Ø  CIRCLE (68,6),I*4,3,ARC*3
        ,ARC*4
OC 83Ø  CIRCLE (231,8),I*4,3,Ø,AR
        C
OP 84Ø  CIRCLE (243,6),I*4,3,ARC*
        2,ARC*3:NEXT
MP 85Ø  LINE (8Ø,1)-(88,4),3,BF
PI 86Ø  LINE (231,1)-(223,4),3,BF
FB 87Ø  LINE (61,9)-(67,13),3,BF
HL 88Ø  LINE (25Ø,9)-(244,13),3,B
        F
BG 89Ø  PAINT (74,7),3
LJ 9ØØ  PAINT (237,7),3
HD 91Ø  FOR I=5 TO 17:LINE (58,11
        )-(64,I),3
EM 92Ø  LINE (253,11)-(247,I),3:N
        EXT
IL 93Ø  GET (58,1)-(88,17),LARROW
EP 94Ø  GET (223,1)-(253,17),RARR
        OW
NN 95Ø  RETURN
KH 96Ø  '---------- DRAW SWITCHBOX
         ----------
IM 97Ø  CIRCLE (1ØØ,1ØØ),3,3
GE 98Ø  PAINT (1ØØ,1ØØ),3
NE 99Ø  GET (97,97)-(1Ø3,1Ø3),BAL
        L
AH 1ØØØ PUT (97,97),BALL,PRESET
HL 1Ø1Ø GET (97,97)-(1Ø3,1Ø3),UN
        BALL
IB 1Ø2Ø RETURN
GB 1Ø3Ø LINE (8Ø,24)-(87,39),1,B
        F
MC 1Ø4Ø LINE (224,24)-(231,39),1
        ,BF
MH 1Ø5Ø FOR I=Ø TO 7:LINE (81+I,
        23)-(96+I,8),1
PM 1Ø6Ø LINE (2Ø8+I,8)-(223+I,23
        ),1:NEXT
PD 1Ø7Ø GET (8Ø,8)-(1Ø3,39),S
HP 1Ø8Ø FOR I=Ø TO 3:PUT (64-I*1
        6,I*32+4Ø),S:NEXT
HK 1Ø9Ø GET (2Ø8,8)-(231,39),S
JE 11ØØ FOR I=Ø TO 3:PUT (224+I*
        16,I*32+4Ø),S:NEXT
LK 111Ø LINE (96,8)-(215,15),Ø,B
        F
DL 112Ø LINE (16,168)-(23,183),1
        ,BF
KI 113Ø LINE (288,168)-(295,183)
        ,1,BF
NG 114Ø FOR I=O TO 7:LINE (16+I,
        184)-(29,197-I),1
KK 115Ø LINE (288+I,184)-(282,19
        Ø+I),1:NEXT
BF 116Ø FOR I=Ø TO 6:FOR HP=123-
        I*16 TO 187+I*16 STEP 32
MF 117Ø VS=I*32-32:VE=VS+64:IF V
        S<8 THEN VS=8
ME 118Ø IF VE>186 THEN VE=186
DK 119Ø LINE (HP,VS)-(HP,VE),1:N
        EXT:NEXT
IP 12ØØ RETURN
IK 121Ø 'GAME STUFF
FD 122Ø FOR FBALL=Ø TO 32:FALLIN
        G(FBALL,Ø)=Ø:NEXT:NEWBAL
        L=1
LA 123Ø A$="":WHILE A$="":A$=INK
        EY$:WEND
GE 124Ø IF A$="-" THEN RETURN
PK 125Ø IF A$="+" THEN A$=CHR$(I
        NT(RND(1)*8+49))
EI 126Ø A=VAL(A$):IF A<1 OR A>8
        THEN 123Ø
HK 127Ø FALLING(Ø,Ø)=1:FOR J=1 T
        O 3:FALLING(Ø,J)=Ø:NEXT
BB 128Ø FALLING(Ø,4)=1Ø+A*2
QL 129Ø EXIT=Ø:WHILE EXIT=Ø:EXIT
        =1
OH 13ØØ FOR FBALL=Ø TO 32:IF FAL
        LING(FBALL,Ø)=1 THEN EXI
        T=Ø:GOSUB 132Ø
AA 131Ø NEXT:WEND:RETURN
FM 132Ø DY=FALLING(FBALL,Ø):DX=F
        ALLING(FBALL,1):LEVEL=FA
        LLING(FBALL,2)
HA 133Ø NY=FALLING(FBALL,3):NX=F
        ALLING(FBALL,4)
IH 134Ø IF LEVEL<>Ø OR NY<>Ø THE
        N GOSUB 157Ø
AB 135Ø NY=NY+1:FALLING(FBALL,3)
        =NY AND 3:ON NY GOTO 136
        Ø,138Ø,142Ø,143Ø
FH 136Ø IF LEVEL=5 THEN FALLING(
        FBALL,Ø)=Ø:GOTO 15ØØ
BM 137Ø GOSUB 156Ø:ON INT(RND(1)
        *3+1) GOTO 158Ø,159Ø,16Ø
        Ø
QK 138Ø VX=Ø:GOSUB 154Ø
LC 139Ø IF BOX(SWITCHY,SWITCHX,1
        )=1 AND BOX(SWITCHY,SWIT
        CHX,Ø)=SIDE THEN VX=1-2*
        SIDE:FALLING(FBALL,1)=VX
        :NX=NX+VX:FALLING(FBALL,
        4)=NX:GOSUB 156Ø:GOTO 16
        1Ø
DM 14ØØ GOSUB 156Ø:IF BOX(SWITCH
        Y,SWITCHX,Ø)=SIDE THEN F
        ALLING(FBALL,Ø)=Ø:BOX(SW
        ITCHY,SWITCHX,1)=1:GOTO
        162Ø
PA 141Ø ON INT(RND(1)*3+1) GOTO
        158Ø,159Ø,16ØØ
IG 142Ø FALLING(FBALL,1)=Ø:NX=NX
        +DX:FALLING(FBALL,4)=NX:
        GOSUB 156Ø:GOTO 163Ø
PE 143Ø FALLING(FBALL,2)=LEVEL+1
        :GOSUB 156Ø
CL 144Ø GOSUB 154Ø:BOX(SWITCHY,S
        WITCHX,Ø)=1-BOX(SWITCHY,
        SWITCHX,Ø)
DB 145Ø IF BOX(SWITCHY,SWITCHX,1
        )=Ø THEN 149Ø
QI 146Ø FALLING(NEWBALL,Ø)=1:FAL
        LING(NEWBALL,1)=Ø:FALLIN
        G(NEWBALL,2)=LEVEL
GL 147Ø FALLING(NEWBALL,3)=Ø:FAL
```

```
        LING(NEWBALL,4)=NX+2-SID
        E*4
HD 148Ø BOX(SWITCHY,SWITCHX,1)=Ø
        :NEWBALL=NEWBALL+1:GOSUB
         164Ø
OO 149Ø WP=BOX(SWITCHY,SWITCHX,Ø
        ):GOSUB 67Ø:GOTO 163Ø
PD 15ØØ AMT=POINTS(ROUND,NX/2-1)
        :SUBTOT=SCORE(PLAYER,ROU
        ND)+AMT
NJ 151Ø SUB$=STR$(SUBTOT):LOCATE
         ROUND+3,7-LEN(SUB$)+PLA
        YER*32:PRINT SUB$
MO 152Ø SCORE(PLAYER,ROUND)=SUBT
        OT
AC 153Ø GOTO 165Ø
LM 154Ø SWITCHY=LEVEL:JX=NX/2+LE
        VEL-6
JL 155Ø SWITCHX=INT(JX/2):SIDE=J
        X-INT(JX/2)*2:RETURN
CO 156Ø PUT (NX*8,8+LEVEL*32+NY*
        8),BALL,OR:RETURN
OE 157Ø PUT (NX*8,8+LEVEL*32+NY*
        8),UNBALL,AND:RETURN
QO 158Ø FOR I=Ø TO 1:SOUND 88Ø,1
        :SOUND 32767,1:NEXT:RETU
        RN
KL 159Ø FOR I=Ø TO 1:SOUND 66Ø,1
        :SOUND 32767,1:NEXT:RETU
        RN
CM 16ØØ FOR I=Ø TO 1:SOUND 44Ø,1
        :SOUND 32767,1:NEXT:RETU
        RN
OD 161Ø FOR I=1 TO 6:SOUND 11ØØ*
        RND(1)+37,1:NEXT:RETURN
IM 162Ø FOR I=8ØØ TO 2ØØ STEP -2
        Ø:SOUND I,.1:NEXT:RETURN
GA 163Ø FOR I=1 TO 6:SOUND 55Ø*R
        ND(1)+37,1:NEXT:RETURN
FB 164Ø FOR I=Ø TO 1:FOR J=44Ø T
        O 88Ø STEP 8Ø:SOUND J,.5
        :NEXT J,I:RETURN
KJ 165Ø FOR I=Ø TO 5:SOUND 33Ø,.
        5:SOUND 44Ø,.5:SOUND 55Ø
        ,.5:NEXT
KI 166Ø SOUND 32767,1:RETURN
```

Program 6. Amiga Switchbox

Version by Philip I. Nelson, Assistant Editor

```
'Switchbox for 512K Amiga←
'Set Preferences for 80 columns←

Restart:←
CLEAR:GOSUB Setup←

Main:←
FOR Round=1 TO 4←
PUT (80,7+Round*8),Ball←
PUT (515,7+Round*8),Ball←
GOSUB Values←
SAY TRANSLATE$(Intro$(Round))←
Keepgoing:←
Who=1-Who 'alternate players←
GOSUB Taketurn←
IF SC(1-Who,Round)=>Points(Round
,0) THEN Nextround←
GOTO Keepgoing←

Nextround:←
FOR j=0 TO 1:FOR k=5 TO 8←
SC(j,k)=0:NEXT:NEXT←
FOR j=0 TO 1:FOR k=1 TO 4←
gx=Points(k,0):ac=SC(j,k)←
SC(j,5)=SC(j,5)+ac←
SC(j,6)=SC(j,6)-(ac=>gx)*gx←
SC(j,7)=SC(j,7)+SC(j,k)-SC(1-j,k)←
NEXT:NEXT←
FOR j=0 TO 1:FOR k=6 TO 7←
SC(j,k)=SC(j,k)+SC(j,5)←
NEXT:NEXT←
FOR j=0 TO 1:FOR k=5 TO 7←
SC(j,8)=SC(j,8)+SC(j,k)←
NEXT:NEXT←
FOR j=0 TO 1←
FOR k=5 TO 8:y$=STR$(SC(j,k))←
x=LEN(y$):tx=8+j*64-x:ty=4+k←
LOCATE ty,tx-1:PRINT SPACE$(2)←
LOCATE ty,tx:PRINT y$←
NEXT:NEXT←
NEXT Round←

Gohome:←
LINE (240,70)-(362,100),2,bf←
LOCATE 11,32:PRINT " Play again? "←
text$=Who$(ABS(SC(1,8)>SC(0,8)))←
text$=text$+" wins this game.."←
text$=text$+"How about another?"←
SAY TRANSLATE$(text$),Voice%←
FOR j=0 TO 10:x$=INKEY$:NEXT←
Again:←
x$=INKEY$:IF x$="" THEN Again←
SAY TRANSLATE$("OK."),Voice%←
IF x$="y" OR x$="Y" THEN WINDO
W CLOSE 2:GOTO Restart←
SAY TRANSLATE$(" Bye-bye."),Voice
%←
WINDOW CLOSE 2←
END←

Taketurn:←
FOR j=0 TO nb:LB(j,0)=0:NEXT:nb=1←
SAY TRANSLATE$(Who$(Who)+CHR$(
46))←
PUT (140,5),Larrow:PUT (440,5),Rarro
w←
FOR j=0 TO 9:x$=INKEY$:NEXT←
Getkey:←
a$=INKEY$:IF a$="-" THEN RETURN
←
IF a$="+" THEN a$=STR$(INT(RND(1)
*8+1))←
a=VAL(a$):IF (a<1) OR (a>8) THEN Get
key←
LB(0,0)=1←
FOR j=1 TO 3:LB(0,j)=0:NEXT←
LB(0,4)=a+3←
Moreballs:←
ex=1:FOR j=0 TO nb←
IF LB(j,0) THEN ex=0:GOSUB Moveone←
NEXT:IF ex=0 THEN Moreballs←
x=0:FOR j=13 TO 7 STEP -3:FOR k=
x TO 15-x←
PUT (Column(k),Row(j)+1),Blank,AND
←
NEXT:x=x+1:NEXT:RETURN←

Moveone:←
dy=LB(j,0):dx=LB(j,1):LY=LB(j,2)←
ny=LB(j,3):nx=LB(j,4)←
IF ny THEN←
PUT (Column(nx),Row(ny+(LY*3))+1)
,Blank,AND←
END IF←
LB(j,3)=(ny+1) MOD 3←
ON ny+1 GOTO Pos0,Pos1,Pos2←

Pos0:←
IF LY>4 THEN LB(j,0)=0:GOTO Score←
vx=0:GOSUB Whichway←
IF (SW(wx,wy,1)) AND (SW(wx,wy,0)=
sd) THEN←
vx=1-2*sd:LB(j,3)=ny+1:LB(j,4)=nx
+vx←
GOTO Putball←
END IF←
IF SW(wx,wy,0)=sd THEN←
LB(j,0)=0 ←
SW(wx,wy,1)=1:ny=ny+1←
GOTO Putball←
END IF←
LB(j,3)=ny+1:GOTO Putball←

Pos1:←
LB(j,1)=0:LB(j,4)=nx+dx:GOTO Putbal
l←
←
Pos2:←
LB(j,2)=LY+1:GOSUB Whichway←
SW(wx,wy,0)=1-SW(wx,wy,0) ←
IF SW(wx,wy,1) THEN←
PUT (Column(LB(j,4)+1-sd*2),Row(ny
+(LY*3))),Blank,AND←
LB(nb,0)=1:LB(nb,1)=0:LB(nb,2)=LY←
LB(nb,3)=0:LB(nb,4)=nx+1-sd*2:nb
=nb+1←
SW(wx,wy,1)=0←
END IF←
sx=Xpos(wx,wy):sy=Ypos(wx,wy)←
wp=SW(wx,wy,0)←
'Always fall thru to switch←

Switch:←
PUT (sx,sy),Swblank, AND←
ON wp+1 GOTO Left,Right←
Left:←
PUT (sx,sy),Lswitch,OR:GOTO Bop←
Right:←
PUT (sx,sy),Rswitch,OR←
Bop:←
SOUND 100,1,64,Who←
SOUND 250,1,64,3-Who←
RETURN←

Putball:←
SOUND INT(RND(1)*10)*(30*LY)+200,1
,64,Who←
PUT (Column(nx),Row(ny+(LY*3)+1))
,Ball,OR←
RETURN←

Whichway:←
wx=LY:wy=INT((nx+LY-4)/2):sd=(
nx+LY) AND 1:RETURN←

Score:←
sf=Points(Round,nx+1):sg=SC(Who,
Round)+sf←
tx=8+63*Who+(sg>9)+(sg>99)+(sg
>999)←
ty=2+Round:a$=MID$(STR$(sg),2)←
LOCATE ty,tx:PRINT a$←
SC(Who,Round)=sg←
FOR j=1600 TO 200 STEP -300←
SOUND j,1,64,Who←
SOUND j+400,1,64,3-Who←
NEXT:RETURN←

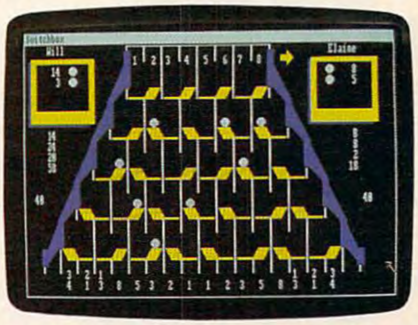
Values:←
FOR j=0 TO 1←
k=2+70*j:LOCATE 15,k←
PRINT SPACE$(3):LOCATE 15,k←
PRINT RIGHT$(STR$(Points(Round,0)),
3)←
NEXT←
FOR j=1 TO 16:k=Points(Round,j)←
m=6+j*3.75←
IF k>9 THEN←
x=INT(k/10)←
x$=MID$(STR$(x),2,1)←
ELSE←
x$=CHR$(32)←
END IF←
LOCATE 22,m:PRINT x$;←
LOCATE 23,m:PRINT RIGHT$(STR$(k),1
);←
NEXT:RETURN←

Setup:←
RANDOMIZE TIMER←
DIM Voice%(8)
FOR j=0 TO 8
READ Voice%(j):NEXT
DATA 110,0,150,0,22200,64,10,1,0
Greet$="Hi. Welcome to Switchbox."←
PRINT Greet$
SAY TRANSLATE$(Greet$),Voice%←
SCREEN 2,640,200,2,2←
PALETTE 0, 0, 0, 0 ←
PALETTE 1, 1, 1, 1←
PALETTE 2, 0, .1, .7 ←
PALETTE 3, 1, 1, .13←
WINDOW 2,"Switchbox",,0←
DIM Larrow(30),Rarrow(30),Wav%(256
),Lefthunk(400)←
DIM  Righthunk(400),Swblank(100),Rs
witch(200)←
DIM Lswitch(200),Column(16),Row(25)
←
DIM Blank(70),Ball(60),Piece(80)←
DIM  SW(8,8,1),LB(32,4),Points(4,16),SC
(1,8)←
FOR j=0 TO 10:LINE (0,5)-(10,j),3←
NEXT←
LINE (10,3)-(20,7),3,bf←
GET (0,0)-(20,10),Larrow←
PUT (0,0),Larrow←
FOR j=0 TO 10←
LINE (20,5)-(10,j),3←
NEXT←
LINE (0,3)-(10,7),3,bf←
GET (0,0)-(20,10),Rarrow←
PUT (0,0),Rarrow←
GET (8,2)-(22,9),Blank←
CIRCLE (15,4),7,1←
PAINT (16,4),1←
GET (8,0)-(22,9),Ball←
PUT (8,0),Ball←
FOR j=0 TO 127:Wav%(j)=-127←
Wav%(j+128)=127:NEXT←
FOR j=0 TO 3:WAVE j,Wav%←
NEXT←
DATA 10,"round 1. equal scores."←
DATA 2,2,2,2,2,2,2,2←
DATA 40,"round 2. fibonachie seequenc
e."←
DATA 1,2,3,5,8,13,21,34←
DATA 20,"round 3. arithmetic seequen
ce."←
DATA 2,3,4,5,6,7,8,9←
DATA 80,"round 4. seequence of square
s."←
DATA 1,4,9,16,25,36,49,64←
FOR j=1 TO 4:READ Points(j,0)←
READ Intro$(j)←
FOR k=1 TO 8:READ x←
Points(j,k+8)=x:Points(j,9-k)=x←
NEXT k:NEXT j←
a=215:b=2←
FOR j=0 TO 4←
a=a-30:b=b+30←
FOR k=0 TO j+3←
Xpos(j,k)=a+k*60←
Ypos(j,k)=b←
NEXT:NEXT←
k=0←
FOR j=70 TO 520 STEP 30←
Column(k)=j←
k=k+1:NEXT←
k=0←
FOR j=4 TO 154 STEP 10←
Row(k)=j:k=k+1:NEXT←
```

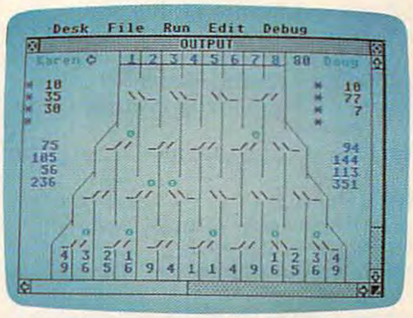
```
Start:←
SAY TRANSLATE$("First player's name
?"),Voice%←
INPUT"Name of Player 1";p0$←
SAY TRANSLATE$("Second player's na
me?"),Voice%←
INPUT"Name of Player 2";p1$←
Who$(0)=LEFT$(p0$,6):Who$(1)=LEF
T$(p1$,6)←
text$=Who$(0)+" plays "+Who$(1)+"
. Is this correct"←
PRINT text$;
SAY TRANSLATE$(text$),Voice%←
INPUT query$:an$=LEFT$(query$,1)←
IF LEN(an$)=0 OR an$="y" OR an$="
Y" THEN Draw←
GOTO start←

Draw:←
SAY TRANSLATE$("OK."),Voice%←
CLS←
LOCATE 1,6:PRINT Who$(0)←
LOCATE 1,66:PRINT Who$(1)←
x=4:FOR j=0 TO 1 'score boxes←
LINE (x,12)-(x+110,60),2,bf'shadow←
LINE  (x+6,10)-(x+120,58),3,bf'outli
ne←
LINE (x+16,14)-(x+110,48),0,bf'insi
de←
x=x+480:NEXT ←
x=1:FOR j=24 TO 50 STEP 3.7←
LOCATE 2,j:PRINT x←
x=x+1:NEXT←
LINE (180,0)-(182,40),,bf←
GET (180,0)-(182,40),Piece←
LINE (180,0)-(420,0)←
FOR j=210 TO 420 STEP 60←
LINE (j,0)-(j+2,12),,bf←
PUT (j,40),Piece←
PUT (j,100),Piece←
NEXT←
FOR j=180 TO 420 STEP 60←
PUT (j,0),Piece,OR←
PUT (j,70),Piece←
PUT (j,126),Piece←
NEXT←
PUT (120,126),Piece←
PUT (150,100),Piece←
PUT (450,100),Piece←
PUT (480,126),Piece←
ERASE Piece 'reclaim memory←
FOR j=30 TO 570 STEP 30←
LINE (j,155)-(j+2,170),1,bf←
NEXT←
LINE (176,4)-(186,32),2,bf←
LINE (416,4)-(426,32),2,bf←
LINE (176,32)-(156,42),2←
LINE STEP(0,0)-STEP(-10,0),2←
LINE STEP(0,0)-STEP(35,-32),2←
PAINT (175,31),2←
LINE (426,32)-(446,42),2←
LINE STEP(0,0)-STEP(10,0),2←
LINE STEP(0,0)-STEP(-36,-32),2←
PAINT (427,32),2←
GET (136,12)-(186,69),Lefthunk←
GET (416,12)-(456,62),Righthunk←
l=106:r=446:k=42←
FOR j=1 TO 4←
PUT (l,k),Lefthunk,OR←
PUT (r,k),Righthunk,OR←
l=l-30:r=r+30:k=k+30←
NEXT←
ERASE Lefthunk,Righthunk←
LINE (26,153)-(36,165),2,bf←
LINE (564,153)-(576,165),2,bf←
GET (245,32)-(299,40),Swblank←
FOR j=0 TO 18←
LINE (270+j,40)-(280+j,32),3←
```

```
NEXT←
LINE (245,39)-(280,40),3,bf←
GET (245,32)-(298,40),Rswitch←
PUT (184,32),Swblank,AND←
FOR j=0 TO 20←
LINE (184+j,32)-(193+j,40),3←
NEXT←
LINE (193,39)-(236,40),3,bf←
GET (184,32)-(236,40),Lswitch←
FOR m=0 TO 4:FOR n=0 TO m+3←
sx=Xpos(m,n):sy=Ypos(m,n)←
wp=INT(RND(1)*2)←
SW(m,n,0)=wp←
SW(m,n,1)=0←
Who=1-Who:GOSUB Switch←
NEXT n:NEXT m←
PUT (140,5),Larrow←
RETURN←
```



The Amiga version of "Switchbox" features speech and stereo sound effects.



"Switchbox" for the Atari 520ST computer.

Program 7. Atari 520ST Switchbox

Version by Kevin Mykytyn, Editorial Programmer

```
10 restore:dim sw(4,7,1),sp$(1),lb(32,4),ar$(
    1),pt(4,16),sc(1,8):qr=1
20 sp$(0)=" \ \_:sp$(1)="_//":ar$(0)=C
    HR$(4)+" ":ar$(1)=" "+CHR$(3)
30 color 1,1,1,1,1:Q1=-2:Q2=0:FOR J=
    1 to 4:read pt(j,0)
40 for a=0 to 1:for b=0 to 8:sc(a,b)=0:ne
    xt:next
50 for k=1 to 7:read l:pt(j,k+7)=l:pt(j,8-
    k)=l:next k,j
60 data 10
70 data 2,2,2,2,2,2,2
80 data 40
90 data 1,2,3,5,8,13,21
100 data 20
110 data 2,3,4,5,6,7,8
120 data 80
130 data 1,4,9,16,25,36,49
```

```
140 fullw 2:clearw 2:gotoxy 0,0:input "PL
    AYER 1";p1$
150 input "PLAYER 2";p2$:p1$=left$(p1$,
    5):p2$=left$(p2$,5):print p1$;" VS ";p
    2$
160 print "IS THIS CORRECT?":GK=IN
    P(2):if gk<>asc("Y") and gk<>asc("y"
    ) then 140
170 gosub 410:gosub 510:color 1,1,1
180 for rr=1 to 4:color 5:gotoxy 0,1+rr:pr
    int "*";:gotoxy 28,1+rr:print "*"
190 gosub 450:rem put scores at bottom
200 qr=1-qr:ty=qr*20:tx=26-ty:cx=tx
    :cy=0
210 color 5:m$=right$(str$(pt(rr,0)),2):gos
    ub 1110
220 CX=6+ty:cy=0:m$=ar$(qr):gosub 11
    10
230 gosub 660:if sc(1-qr,rr) >= pt(rr,0) th
    en 250:rem end of round
240 goto 200
250 for j=0 to 1:for k=5 to 8:sc(j,k)=0:ne
    xt k,j
260 for j=0 to 1:for k=1 to 4:gl=pt(k,0):a
    c=sc(j,k):sc(j,5)=sc(j,5)+ac
270 sc(j,6)=sc(j,6)-(ac>=gl)*gl:sc(j,7)=sc
    (j,7)+(sc(j,k)-sc(1-j,k)):next k,j
280 for j=0 to 1:for k=6 to 7:sc(j,k)=sc(j,
    k)+sc(j,5):next k,j
290 for j=0 to 1:for k=5 to 7:sc(j,8)=sc(j,
    8)+sc(j,k):next k,j
300 for j=0 to 1:for k=5 to 8:y$=str$(sc(j
    ,k)):l=len(y$):tx=5+j*28-1
310 ty=2+k:cx=tx+(tx<20):cy=ty:m$=
    y$:color 4:gosub 1110:next k,j
320 next rr:rem end of main loop
330 color 1,1,8
340 gotoxy 9,10:print spc (19)
350 gotoxy 9,11:print " PLAY AGAIN? (Y/
    N) "
360 gotoxy 9,12:print spc (19)
370 for a=78 to 231 step 153:linef a,100,a,
    109:next
380 linef 78,100,231,100:linef 78,109,231,10
    9
390 a=inp(2):if a=asc("Y") or a=asc("y"
    ) then clear:goto 10 else end
410 clearw 2:color 4,1,6
420 for j=1 to 8:gotoxy 7+2*j,0:print j:ne
    xt
430 for j=82 to 227 step 18.125:linef j,0,j,1
    90:next
440 linef 82,9,227,9:return
450 for j=1 to 14:k=pt(rr,j):jj=2+j*2
460 if k>9 then l=int(k/10):l$=mid$(str$
    (l),2,1):goto 480
470 l$=chr$(32)
480 gotoxy jj,16:print l$;:cx=jj:cy=17
490 gotoxy jj,17:print right$(str$(k),1);
500 next j:return
510 gosub 580:for j=0 to 3:sy=4+j*4:fo
    r k=0 to j+3:sx=12-j*2+k*4
520 cx=sx-1:cy=sy-2:m$=" ":gosub 11
    10:color 0,0,0,0,0
530 linef cx*9,cy*9+10,cx*9+3,cy*9+10:
    wp=int(rnd(1)*2)
540 sw(j,k,0)=wp:sw(j,k,1)=0:gosub 650
550 next k,j:color 11
560 cx=1:cy=0:m$=p1$:gosub 1110
570 cx=29:cy=0:m$=p2$:gosub 1110:retu
    rn
580 linef 82,51,64,69:linef 64,69,64,172
590 linef 64,87,46,105:linef 46,105,46,172
600 linef 46,123,28,141:linef 28,141,28,172
610 linef 228,51,246,69:linef 246,69,246,172
620 linef 246,87,264,105:linef 264,105,264,1
    72
630 linef 264,123,282,141:linef 282,141,282,
    172
640 return
650 color 2:cx=sx-2:cy=sy-1:m$=sp$(
    wp):gosub 1110:return
660 for j=0 to 32:lb(j,0)=0:next:nb=1
670 a=inp(2):a$=chr$(a)
680 if a$="-"then return
690 if a$="+"then a$=str$(int(rnd(1)*8
    +1))
700 a=val(a$):if (a<1)or(a>8) then 670
710 lb(0,0)=1:for j=1 to 3:lb(0,j)=0:next:l
    b(0,4)=10+a*2
720 ex=1
730 for j=0 to 32:if lb(j,0) then ex=0:gos
    ub 760
740 next:sound 1,0,0,0:if ex then return
750 goto 720
760 dy=lb(j,0):dx=lb(j,1):ly=lb(j,2):ny=l
    b(j,3):nx=lb(j,4):QT=LY*4+NY
770 if (ly+ny) AND LY<4 then gotoxy nx
    +q1,ly*4+ny+q2:print " "
780 color 11:lb(j,3)=(ny+1) and 3:on ny+
    1 goto 790,810,860,880
790 if ly>3 then lb(j,0)=0:goto 950:rem sc
    oring routine
800 gosub 1120:on int(rnd(1)*3+1) goto 10
    00,1010,1020
810 vx=0:gosub 940:if sw(wy,wx,1)=0 o
    r (sw(wy,wx,0)=sd)=0 then 840
820 vx=1-2*sd:lb(j,1)=vx:lb(j,3)=ny+1
830 lb(j,4)=nx+vx:gotoxy nx+q1+vx,ly*
    4+ny+q2-(qt<15):print "o":goto 10
    50
840 if sw(wy,wx,0)=sd then lb(j,0)=0:sw(
    wy,wx,1)=1:gosub 1120:goto 1030
850 lb(j,3)=ny+1:gosub 1120:on int(rnd(1
    )*3+1) goto 1000,1010,1020
860 lb(j,1)=0:lb(j,4)=nx+dx:gotoxy nx+
    q1+dx,ly*4+ny+q2-(qt<15):prin
    t "o"
870 goto 1060
880 if qt<15 then gosub 1120
890 lb(j,2)=ly+1:gosub 940:sw(wy,wx,0)
    =1-sw(wy,wx,0)
900 if sw(wy,wx,1)=0 then 930
910 lb(nb,0)=1:lb(nb,1)=0:lb(nb,2)=ly:lb(
    nb,3) =0:lb(nb,4)=nx+2-sd*4:nb=
    nb+1
920 sw(wy,wx,1)=0:gotoxy nx+q1+2-s
    d*4,ly*4+ny+q2-1:print"":gosub 10
    70
930 sx=12-wy*2+wx*4:sy=4+wy*4:w
    p=sw(wy,wx,0):gosub 650:goto 1050
940 wy=ly:jx=int(nx/2)+ly-6:wx=int(j
    x/2):sd=jx and 1:return
950 sf=pt(rr,nx/2-2)
960 sg=sc(qr,rr)+sf
970 tx=3+29*qr+(sg>9)+(sg>99)+(sg>9
    99)
980 ty=rr+1:a$=mid$(str$(sg),2):color 6
990 cx=tx:cy=ty:m$=a$:gosub 1110:sc(qr
    ,rr)=sg:goto 1080
1000 sound 1,15,1,3:wave 1,1,12,90,0:return
1010 sound 1,15,1,4:wave 1,1,12,90,0:return
1020 sound 1,15,6,3:wave 1,1,12,90,0:return
1030 for a=12 to 1 step-2:sound 1,15,a,5:
     wave 1,1,10,20
1040 next:return
1050 return
1060 wave 16,2,0,1000,3:return
1070 wave 16,2,0,18000,5:return
1080 for a=7 to 1 step-1:sound 1,15,1,a:w
     ave 1,1,12,90,2:next
1090 sound 1,0,0,0:return
1100 rem char command
1110 gotoxy cx,cy:print m$:return
1120 gotoxy nx+q1,ly*4+ny+q2-(qt<1
     5):print "o":return
```

©

The Works! For Commodore And Apple

James V. Trunzo

Requirements: Commodore 64 or 128 (in 64 mode) with a disk drive; or an Apple II-series computer with at least 64K RAM and a disk drive. Printer recommended.

"Jack of all trades but master of none" is a saying that could be applied to a collection of programs entitled *The Works!* from First Star Software. However, the saying would reflect only upon the level of sophistication of the individual programs making up *The Works!*, and should not be considered a criticism of the package as a whole.

The Works! is a compendium of useful programs for computer novices by Fernando Herrera, who first gained prominence with a program entitled *My First Alphabet*, winner of an Atari First Star Award. When considering *The Works!*, it is essential to keep in mind the audience for which it is intended.

The package is subtitled "A Complete Collection of Home Software," and that's just what *The Works!* is—with an emphasis on "home." It contains 13 programs divided into four main categories: Tools, Organizers, Arts, and Learning. Under the heading of Tools, you find such programs as Letter Writer, Loans & Investments, Calculator, Weights & Measures, and Math Formulas; the Organizers section includes Family Finances, Calendar Pad, Address Book, and Stock Portfolio; the Arts section has Graphics Painter and Music Composer; and the Learning section has Typing Teacher and Math Races.

All of the programs that make up *The Works!* are completely functional. However, none of them are—nor do they pretend to be—the final answer in their genre. Letter Writer, for example, is a more-than-adequate word processor for writing letters. It contains basic commands such as Move, Copy, Delete, and Insert, as well as a number of print-formatting commands. You wouldn't use it to do a college term paper with elaborate footnotes, though.

Similarly, all the other programs in *The Works!* provide a simple, working introduction to each type of software. They take advantage of the latest windowing techniques and are very easy to use. Also, there's a certain amount of integration among the programs. For example, when using Letter Writer, you can look up an entry in the Address Book program and merge it with a letter; or you can insert the result of a calculation done on the Calculator program into a report you are writing. You're also free to copy any of the programs onto a separate disk to be used apart from the rest, if you desire.

The value of *The Works!* lies in this: It gives new users a taste of a wide variety of programs and introduces some of the useful functions that can be performed by a home computer. Furthermore, it does so at a reasonable cost. You could pay $100 or more for a sophisticated financial program and then discover that you don't need it or don't like to use it. Family Finances in *The Works!* gives you the opportunity to try a program of this type before you invest in a more expensive package.

For those new to the world of computers and computer software, *The Works!* provides an easy entry into a sometimes bewildering domain.

The Works!
First Star Software, Inc.
18 East 41st Street
New York, NY 10017
$49.95

Under Fire For Apple

James V. Trunzo

Requirements: Apple II-series computer with at least 64K memory and a disk drive. A joystick is required for the Apple II+, but is optional on the Apple IIe and IIc. A version for the Commodore 64 and 128 is scheduled for release this spring.

If you're a war game buff and you've been waiting for the ultimate World War II infantry combat simulation, your wait may be over. Released by Avalon Hill, Ralph Bosson's *Under Fire* is an innovative milestone in all areas of computerized war gaming. It's one of the best war game simulations I've ever seen.

In fact, *Under Fire* is more than just a game: It's a complete, open-ended system in the same vein as its board game predecessor, the award-winning *Squad Leader*. With the three disks that come with *Under Fire*—a master disk, a scenario disk, and a mapmaker disk—you can design your own scenarios as well as play the standard games.

Although *Under Fire* is as complex as it is realistic, it is not a difficult game to learn (though playing and playing well are two different things). An extremely well-written rule book, complete with a step-by-step scenario, helps you get under way and allows you to absorb details bit by bit as you become more immersed in the mechanics of the game.

Under Fire lets you play solitaire or against another person, using one of nine prepared scenarios or one you have created yourself. You can assume command of men and weapons from the United States, Germany, or the Soviet Union. Each infantry squad, gun, and tank is individually represented on any one of three available maps: a situational map, showing the large-scale picture; a strategic map, depicting a smaller, more detailed portion of the battlefield; and a tactical map that shows the terrain and units to a degree of detail that is hard to believe. Frankly, an entire review could be written on this program's graphics alone.

Unprecedented Flexibility

Under Fire is so flexible that it truly lives up to Avalon Hill's boast that it's a "War Game Construction Set." When you combine the unit types, the terrain selections, the battlefield objectives, and the various orders of battle, there is almost no land engagement that cannot be accurately simulated. That's why the nine scenarios provided are named after historical encounters; they represent types of conflicts ranging from open-field firefights to house-to-house battles. You can attack or defend objectives, recreate breakthroughs, or enter into all-out slugfests.

Lavish attention has been paid to details such as troop morale, training, supplies, skill levels, hidden units, line-of-sight fire, and animated combat. At the end of a battle, you get a complete report of men lost, men remaining, armor lost, and other statistics.

This review really just scratches the surface of *Under Fire*. For example, the Apple version even allows for the optional use of a Mockingboard to enhance the sound effects of raging battles. Avalon Hill and designer Bosson have created what is sure to become a standard for computerized war games in the future.

Under Fire
Avalon Hill Game Company
4517 Harford Road
Baltimore, MD 21214
$59.95

M-Disk For Atari ST

George Miller, Assistant Technical Editor

Requirements: Atari ST computer with at least 512K RAM; extra RAM recommended.

Do you often find yourself wishing for extremely fast, temporary storage to supplement the floppy disk drive on your Atari ST? *M-Disk*, by MichTron, lets you set aside a portion of Random Access Memory (RAM) as a RAM disk. This area of memory is used like a disk drive, except it's much faster. By moving small, frequently used programs or data files into the RAM disk, you can speed up access and make disk-intensive programs run more efficiently. (Of course, you still have to copy the programs or files you want to save onto a real disk before ending the session because the RAM disk disappears when power is shut off.)

M-Disk is easy to use. Michtron's user manual, although small, is well-written. Installing the RAM disk is no problem. And since the ST's operating system (TOS) sees the RAM disk as just another floppy disk drive, transferring files from memory or floppy disk to the RAM disk is a snap.

With *M-Disk*, you can specify the size of the RAM disk in 12K blocks up to a maximum of 800K, if your ST has this much memory available. Using the standard 520ST with 512K RAM, you can set up a RAM disk of 84K, or 111K if no GEM desktop accessories are loaded.

However, some larger application programs can't be used with a 512K machine and *M-Disk* due to memory limitations. For instance, it was almost impossible to use *M-Disk* with ST BASIC because BASIC normally leaves only about 5K free to begin with. If Atari carries through with plans to put TOS in Read Only Memory (ROM), more than 200K RAM will be freed up for such purposes.

When TOS is available in ROM, or when you add more memory, *M-Disk* will become an indispensible accessory for your Atari ST.

M-Disk
MichTron
576 S. Telegraph
Pontiac, MI 48053
$39.95

Atari XM301 Modem

Tom R. Halfhill, Editor

Requirements: Atari 400/800, XL, or XE computer with at least 48K RAM and a disk drive. The 1200XL requires a slight hardware modification (see text).

If you've been waiting for a (nearly) painless way to get started in telecomputing, the new Atari XM301 modem might be just the ticket. For about a quarter of what a bare-bones acoustic modem cost just a few years ago, the XM301 package includes a reliable, 300 bits-per-second (bps), direct-connect modem with autoanswer and autodial; an easy to use terminal program with full upload/download capabilities; free introductory time on popular commercial information services; and a well-written manual that guides you step by step through the often-confusing world of telecommunications.

Thanks to the latest modem-on-a-chip technology, the XM301 is just slightly larger and heavier than a pack of cigarettes. And that includes the power supply and interface, because the XM301 doesn't require a power supply and interface—it plugs directly into the Atari's serial input/output (SIO) port and draws its power from same. This is a major improvement over early Atari modems, which forced you to buy the $200 850 Interface Module and add yet another power transformer to the existing clutter.

Hooking up the XM301 takes just two steps. First, plug its permanently attached serial cable into the SIO port. Second, unplug the modular phone cord on your telephone and connect it to the XM301's modular jack.

The only complication is if you're using a 1200XL computer. The 1200XL designers wanted to discourage manufacturers from making peripherals that drew power from the computer, so they added a current-limiting resistor to the SIO port which keeps devices such as the XM301 from operating properly. Fortunately, the fix is not difficult for an Atari service technician or experienced electronic hobbyist. According to Atari, resistor R53 on the SIO port must be bypassed or replaced with a jumper. Atari recommends that you take your 1200XL into an Atari service center for this modification. (It won't affect any other operation of the computer.)

Upload And Download

Once the modem is hooked up, you're ready to run the terminal software included in the package, *XE Term*. Despite its name, *XE Term* works on 400/800 and XL series computers with at least 48K RAM as well as on the newer XE machines. The disk includes DOS 2.5 and an autoboot file that automatically runs *XE Term* when you switch on the computer.

Pop-up menus and single-keystroke commands make *XE Term* extremely easy to use. Yet it's not a stripped-down terminal emulator; it's actually a fairly versatile program that contains enough features to satisfy most people's telecomputing needs. Earlier Atari terminal programs, such as the *TeleLink I* and *TeleLink II* cartridges, often were criticized for their lack of file transfer functions. *XE Term* is a sharp departure from the *TeleLink* series. Not only does it allow you to upload and download files with other computers, it even provides three different protocols (file exchange schemes) for this purpose.

The simplest protocol is the ASCII transfer function. It's most often used for exchanging text files, such as documents created with a word processor. You can also "capture" any incoming text with this option and send it to the disk drive or printer. ASCII transfers don't employ any error-checking, however, so characters can get garbled if the phone line is noisy.

The second transfer protocol in *XE Term* is called XMODEM, a standardized scheme that is popular on many

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electronic bulletin board systems (BBSs). XMODEM is somewhat slower than ASCII protocol, but it checks for transmission errors during the transfer. This makes it particularly useful for uploading and downloading such critical files as programs.

XE Term's third transfer scheme was a surprise—the A-protocol used by the CompuServe Information Service. *XE Term* automatically recognizes A-protocol, so it's easy to download programs and other files from CompuServe.

The only drawback to *XE Term*'s file transfer capabilities is its rather small buffer—only about 14K. Most Atari terminal programs have larger buffers. This restriction means that files longer than 14K must be broken up into pieces before uploading or downloading.

Online Phone Book

XE Term strikes a balance between ease of use and full-featured telecommunications. You can link up with Ataris, most other personal computers, information services, and BBSs of almost any flavor. But if the other computer is an oddball or a mainframe with unusual requirements, you may need a program that provides more communication options.

To reach *XE Term*'s Options menu, you press O from the main Functions menu (a keystroke that Atari forgot to list on the Functions menu, by the way). The Options menu pops up and lets you change the input parity (none, even, odd, or clear); output parity (none, even, odd, or set); the duplex mode (half or full); and translation mode (ASCII and Atari ASCII, called ATASCII). You can also change the left screen margin from its normal indentation of two characters.

A few convenience features make *XE Term* even easier to use. You can save the communication settings to disk in a configuration file so the program always boots up the way you want it to. A dialing menu lets you switch between tone and pulse dialing, store up to five phone numbers that can be dialed with a single keystroke, or dial directly from the computer keyboard. When you're establishing a connection, all telephone sounds are routed through the TV or monitor speaker. That way, you can listen to the modem dialing the number and hear any busy signals, recorded messages, or humans that may be encountered on the other end of the line.

Automatic log-on sequences can be programmed to speed up access to remote computer systems. For instance, you can tell *XE Term* to dial your local CompuServe access number, type a CTRL-C to get CompuServe's attention, and enter your ID number and password—all without any intervention on your part. You can also set up the modem for autoanswer mode in case someone wants to call your computer.

A Few Extras

The 50-page manual is very well-written and contains just about everything you need to know to use the XM301 modem and *XE Term*. There's even a short glossary of telecommunication terms. For advanced users, a file on the *XE Term* disk contains technical information about the modem and its software interface. Another disk file, HANDLER.OBJ, is the modem's device driver. This makes it possible for programmers to write their own custom terminal or BBS software for the XM301.

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EduCalc And *NoteCard Maker*

Karen G. McCullough

Requirements: Commodore 64 or 128 (in 64 mode) with a disk drive; Apple II-series computer with at least 64K RAM and a disk drive; or an IBM PC/PCjr with a disk drive. The Apple version was reviewed.

Recent attempts to teach computer literacy have focused on familiarizing students with the software tools commonly used on personal computers. To assist that effort, Grolier Electronic Publishing, Inc. has released two programs: *EduCalc* and *NoteCard Maker.* Each is a simplified version of a popular type of software for personal computers and is aimed at junior to senior high school students.

EduCalc is a spreadsheet—a stripped-down, bare-bones version of programs like *VisiCalc, Multiplan,* and *Lotus 1-2-3.* Spreadsheets allow computers to perform sophisticated mathematical operations on large quantities of numbers. As with all spreadsheets, *EduCalc* lets you enter numbers, mathematical formulas, or text in rows and columns on the screen. Each piece of information is stored in a cell identified by a letter for the column and a number for the row. The numbers entered into the cells can be manipulated in various ways by other cells containing formulas. The result of a particular operation is displayed in that formula's cell.

EduCalc includes a tutorial which serves as an excellent introduction to spreadsheets in general as well as to *EduCalc.* It's simple, clear, and should make novices comfortable with the program in 15 to 20 minutes. A practice template lets you experiment with the program. Unlike more powerful spreadsheets intended for professional business applications, *EduCalc* is extremely easy to use. Menus guide you through lists of options, and various functions are displayed on the screen along with advice on using them. The program does a good job of protecting you against errors.

No Shortcuts

But there's a price for that simplicity. Where *EduCalc* is friendly to novice users, it may frustrate those who become more experienced with it. The program structure is rigid—there are no shortcuts.

For example, to enter a formula to add up a column of numbers, you choose Enter from the Tool menu, move the highlighted cursor to the cell where the results are to be displayed, choose Formula from the Entry menu, and press S for sum. Then you move the cursor to the first cell of the column to be totaled, press RETURN, move the cursor to the last cell of the column, and press RETURN again. It sounds easy and logical, but it's also frustratingly time-consuming if the column is 40 figures long.

There are other limitations as well. Only mathematical operations can be performed—there are no logical or lookup functions. And you can't jump directly to a specific cell on the spreadsheet—you must move there with the cursor. That can be very slow on a large sheet, because the program redraws the screen each time the cursor moves off the edge.

The *EduCalc* manual could use larger print, an index, and better explanations. For example, when you're saving a spreadsheet on disk for the first time, the manual says the program should ask if you want to initialize the disk. But the program doesn't. Fortunately my disk was already initialized, so I had no problem reloading the spreadsheet.

A Quick Organizer

NoteCard Maker is a simplified database manager program. As its name implies, *NoteCard Maker* is intended to help students collect and organize information, especially when writing reports or term papers. It transforms the screen into a series of electronic note and bibliography cards. After entering information onto the cards, students can search for specific items or sort them in various ways.

The tutorial that comes with *NoteCard Maker* is just as effective as *EduCalc*'s. Most junior high school students will be comfortable with the program after 20 minutes' work. And if they forget what to do at any point while entering information, they can simply press CTRL-A to bring up a screenful of advice.

The process of entering information and editing the cards is simple and straightforward, and once the cards are created, there are plenty of options for using them. Both notecards and bibliography cards can be searched, sorted, viewed on screen, and listed on a printer.

Like *EduCalc, NoteCard Maker*'s main drawback is rigid structure. There are only three options for file size, and the size can't be changed once the file is created. Nor can you alter the format of the cards or bibliographic information. Also, *NoteCard Maker* lets you create a duplicate file without warning that a file of the same name already exists.

Both *EduCalc* and *NoteCard Maker* are excellent programs for introducing students or novices to spreadsheets and database managers. They also may be the solution if you need a simple spreadsheet or database without a lot of complex commands. For these purposes, both programs are effective tools.

EduCalc
NoteCard Maker
Grolier Electronic Publishing, Inc.
95 Madison Avenue
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Hex For Atari ST

George Miller,
Assistant Technical Editor

Requirements: Atari ST computer and a joystick.

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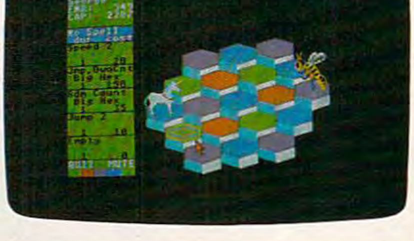

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Hex is a colorful and deceptively simple game. Your goal is to change the 19 hexagonal blocks of the arena to green before your opponent—controlled by the computer—can turn them to purple. All it takes to change a block's color is to jump on it with your onscreen character. Each block changes color in a sequence displayed at the start of each level: green, then red, then purple, and finally blue before the sequence repeats. Seemingly a simple enough task.

Each of the 12 opponents you face employs a different strategy. Some opponents try to overpower you by the force of their magic, while others combine magic with cunning strategy and wisdom. If that isn't enough, at higher levels you may be confronted by several rival magicians, all working against you. You must learn the game well and plan your strategy carefully on the lower levels, because the computer becomes relentless as you progress to higher levels. There is no margin for error.

After successfully completing a round, you're offered the chance to learn a new magic spell. Each spell is costly, and you must exercise good judgment before undertaking the necessary instruction. Is the cost of the spell too high in energy points? Will it leave you too weak to face your next opponent?

Fast reflexes won't help in *Hex*. In fact, the key to early success is to play slowly and carefully, considering each move, much as in chess. Don't let the speed at which the computer plays trick you into making quick decisions. You're facing an opponent who is analyzing your tactics much faster than you can respond. Each rapid-fire move by the computer has a purpose; you must watch closely and try to disrupt its plans.

Hex may be one of the most challenging and fascinating strategy games yet devised for a computer. Although the game is simple to learn, you need to develop complex strategies to win consistently. You'll be amazed at how quickly your opponent ceases to be just a computer and seems to acquire distinct personality traits of its own.

Hex
Mark of the Unicorn, Inc.
222 Third Street
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$39.95

Sylvia Porter's Personal Financial Planner

Selby Bateman, Features Editor

Requirements: Commodore 64 or 128 (in 64 mode or 128 mode); Apple IIc or IIe with 128K RAM; or an IBM PC/PCjr with at least 128K RAM. One or two disk drives are also required. Printer optional, but highly recommended. The Commodore 64 version was reviewed.

For many people, gaining control of a household budget is an exercise in frustration. Where do you start? How do you organize all those daily purchases, bill payments, unexpected expenses, and (far-too-few) paychecks into a coherent picture? Faced with this confusion, many of us go from day to day and month to month with little idea how much we have, how much we owe, and what's left over for savings and long-term financial goals. This is especially critical now, when consumer debt is at an all-time high and personal savings have plummeted.

The good news is that you *can* bring order to your financial chaos. *Sylvia Porter's Personal Financial Planner* is a well-organized, flexible, and sophisticated computer program that can make a major difference in your budgeting and planning efforts. The sobering news is that you're still going to have to invest a significant amount of time and concentration to set up your personal system and then use it on a regular basis. This isn't meant as a criticism of the *Personal Financial Planner*, however. It's simply a reality of personal financial planning in general, whether you manage it with pen and paper or on a computer screen.

Many people will be familiar with Sylvia Porter's name. She's been a respected and popular financial adviser for years—the author of a variety of articles and books, plus a nationally syndicated newspaper column, about budgeting, financial planning and management, and economics. More recently, she's lent her name and expertise to *Sylvia Porter's Personal Finance Magazine*.

The editors of that magazine have contributed to the overall approach and content of the *Personal Financial Planner*, which is supposed to be the first module in an integrated series of financial planning and management programs from Timeworks bearing Sylvia Porter's name. The next program, tentatively scheduled for this spring or summer, is *Personal Investment Planner*.

Six Programs In One

The strength of *Personal Financial Planner* lies in its flexibility, integration of information, and its well-planned structure. Think of *Personal Financial Planner* as six interrelated programs which share all of your financial information:

Transaction Manager: A program that lets you record and monitor all of your cash, bank account, and credit card transactions.

Budget Manager: A budget planning tool which automatically incorporates information from the Transaction Manager.

Asset/Liability Manager: An overview showing all that you own and all that you owe.

Income and Expense Statement: A part of the program that lets you organize and then print out income and expense statements in a variety of ways.

Balance Sheet: A similar component which allows you to arrange and print your asset and liability statements.

Financial Planner: A long-range planning guide that helps you set goals based on your income, expenses, and your changing asset/liability picture.

Pull-down menus and submenus make it quite easy to move around in the system. The documentation is clear, even for someone unfamiliar with computers.

Backups Take Time

Before you can begin using the program, you must initialize a data disk for each of the program managers—three data disks in all. On the Commodore 64, this initialization process requires more than a half-hour to complete. A data disk can generally store up to 1,250 transactions, so this initialization is only an occasional necessity. However, making backup copies of your data disks (an important precaution) is also time-consuming. The backup process doesn't just add new information to the backup disk; it completely rewrites the disk each time you make a backup. Because of the delay, it's tempting to skip this step now and then—risking disaster if your original disk should get lost or crash.

At least with the Commodore 64 version, there are a few instances when the manual doesn't mention that disk swaps are necessary. However, onscreen prompts are very helpful here. And although the disk swapping can be an annoyance, the limitations lie with the 64 and 1541 disk drive, rather than with the program itself. Other computer versions, while functionally similar, have more space for information storage than the Commodore 64 version.

Once your data disks are prepared, your next step is to use the Transaction Manager to enter two-digit codes for up to five bank accounts (checking, money market, etc.) and up to ten credit card accounts, along with complete account information. As a part of this initial cataloging, you'll also set up a series of transaction/budget categories that you'll use with your various transactions. There are 14 major categories, including Income, Loans, Taxes, Groceries, Residence, Utilities, Clothing, Transportation, Insurance, Recreation, Medical/Dental, Education, Miscellaneous, and Other.

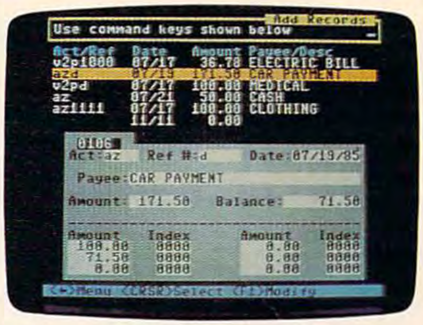
Each category has up to ten subcategories—a total of 140 separate budget/transaction items. What's more, each can be individually tailored to your specific requirements, a very nice feature of this program.

Why all of those categories and codes? If *Personal Financial Planner* was just a checkbook balancing program or a simple budget package, little cross-referencing would be required. But each of the categories you establish can be transferred among the Transaction, Budget, and Asset/Liability managers. Hence, the computer must have a good way of keeping track of each item. This is also important when you later want the program to find and print (on screen, paper, or disk) information on individual accounts, credit cards, or subcategories. Once you've set these up and used the program a couple of times, you'll find you're comfortable with the structure. And you can easily generate a printout of the different categories and codes for quick reference.

Calculator And Notepad

The initial effort it takes to establish budget categories is the most time-consuming aspect of *Personal Financial Planner*. Once that's done, much of the program transfers information automatically, or with just a few keystrokes. Templates automatically appear on the screen, letting you add, delete, and alter virtually any part of your budget. The program also lets you include information on automatic transactions—those recurring accounts such as rent, house payments, or loans—so that each month you don't have to enter all of the information by hand.

Among the many features are procedures for monthly reconciliation of bank statements; searching for, changing, and printing out almost any part of your transaction, budget, or asset/liability data; automatically updating budget goals versus budget realities; setting up graphs and charts to show important aspects of your budget; tracking your financial inventory; and using financial planning worksheets that can be compared and contrasted with past, present, and future financial information.



```
Use command keys shown below                Add Records
Act/Ref   Date   Amount Payee/Desc
v2p1000   07/17   36.78 ELECTRIC BILL
azd       07/19  171.50 CAR PAYMENT
v2pd      07/17  100.00 MEDICAL
az        07/21   50.00 CASH
az1111    07/17  100.00 CLOTHING
          11/11    0.00
 0106
Act:az      Ref #:d         Date:07/19/85
 Payee:CAR PAYMENT
Amount: 171.50   Balance:        71.50
Amount    Index           Amount   Index
 100.00    0000             0.00    0000
  71.50    0000             0.00    0000
   0.00    0000             0.00    0000
<←>Menu <CRSR>Select <F1>Modify
```

There are many nice touches in *Personal Financial Planner*. In addition to the flexibility within each of the manager sections, there's a calculator and a notepad which can be called up at anytime. Also, you can search and modify your data, print out checks, track and print out tax information, and produce custom-tailored financial statements.

Timeworks and Sylvia Porter have created a serious tool with which individuals and families can track just about any aspect of their finances. But for the program to be truly useful, you'll have to make a commitment to keep your transaction information up to date. And that means spending as much as an hour per week (sometimes more, depending on what you're doing) working with the *Personal Financial Planner*.

If you devote this time to using the program, you'll have a clearer picture of your financial status than ever before; your budgeting will be tied in with your daily transactions; and you'll find yourself planning for the future with concrete information. For those who have trouble budgeting, tracking their transactions, and planning toward financial goals, *Sylvia Porter's Personal Financial Planner* can be an excellent investment.

Sylvia Porter's Personal Financial Planner
Timeworks, Inc.
444 Lake Cook Road
Deerfield, IL 60015
Commodore 64 version—$59.95
Commodore 128 version—$69.95
Apple IIc/IIe version—$99.95
IBM PC/PCjr version—$129.95

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HOTWARE: Software Best Sellers

This Month	Last Month	Title	Publisher	Remarks	Apple	Atari	Commodore	IBM	Macintosh
Entertainment									
1.	1.	*F-15 Strike Eagle*	MicroProse	Air combat simulation	●	●	●	●	
2.	2.	*Karateka*	Brøderbund	Action karate game	●	●	●		
3.	5.	*Ultima IV*	Origin Systems, Inc.	Fantasy game	●	●	●	●	
4.		*Silent Service*	MicroProse	Submarine simulation	●	●	●	●	
5.	4.	*Flight Simulator II*	SubLogic	Aircraft simulation	●	●	●		
Education									
1.	1.	*Typing Tutor III*	Simon & Schuster	Typing instruction program	●		●	●	●
2.	2.	*Math Blaster!*	Davidson	Introductory math program, ages 6-12	●	●	●	●	
3.	3.	*New Improved MasterType*	Scarborough	Typing instruction program	●	●	●	●	●
4.	4.	*Music Construction Set*	Electronic Arts	Music composition program	●	●	●		
5.		*I Am The C-64*	Creative/ Activision	Introduction to the C-64			●		
Home Management									
1.	1.	*Print Shop*	Brøderbund	Do-it-yourself print shop	●	●	●		
2.	2.	*The Newsroom*	Springboard	Do-it-yourself newspaper	●		●	●	
3.		*Print Shop Graphics Library III*	Brøderbund	Upgraded graphics library	●	●	●		
4.	4.	*Print Shop Graphics Library*	Brøderbund	100 additional graphics	●	●	●		
5.	5.	*Three-In-One Bundle*	Timeworks	Word processor			●		

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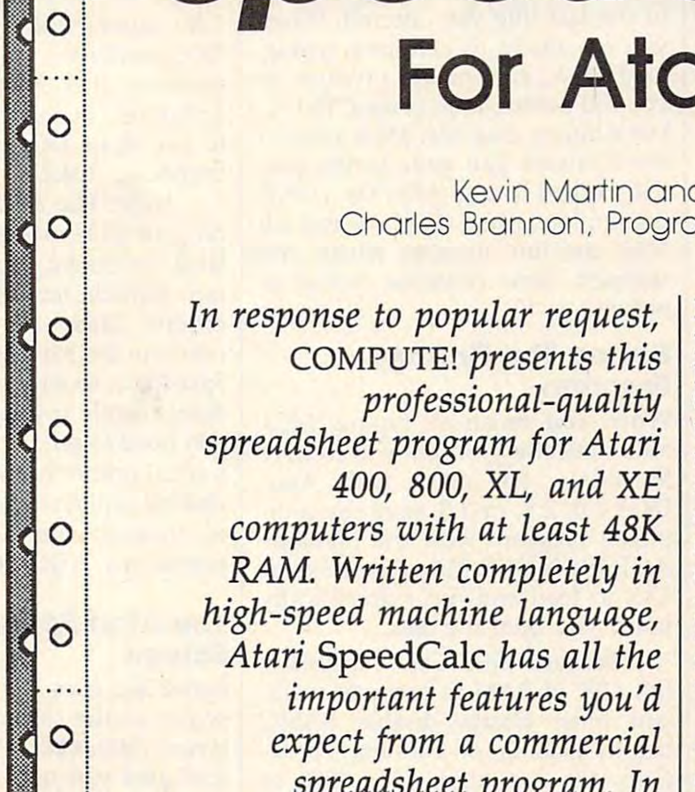

SpeedCalc For Atari

Kevin Martin and
Charles Brannon, Program Editor

In response to popular request, COMPUTE! *presents this professional-quality spreadsheet program for Atari 400, 800, XL, and XE computers with at least 48K RAM. Written completely in high-speed machine language, Atari* SpeedCalc *has all the important features you'd expect from a commercial spreadsheet program. In addition, its data files can be merged into text files created with the Atari* SpeedScript *word processor published last year in* COMPUTE!. *Atari* SpeedCalc *requires a disk drive, and a printer is optional but recommended.*

Have you ever planned a budget for your home or office? If so, you probably used some sort of worksheet divided into rows and columns. Perhaps you wrote the months of the year along the top of the sheet and listed categories for earnings and expenses along one side. After entering data for each category and month of the year, you could calculate total income figures by adding or subtracting numbers in each of the sheet's "cells."

That's a classic example of a worksheet. It lets you enter and organize data, then perform calculations that produce new information. A *spreadsheet* program is an electronic version of the familiar paper worksheet. Since it does all the calculations for you at lightning speed, an electronic spreadsheet is far more convenient than its paper counterpart. And spreadsheet programs also offer editing features that let you enter and manipulate large amounts of data with a minimum of effort.

Atari SpeedCalc is an all machine language spreadsheet program for Atari 400, 800, XL, and XE computers with at least 48K RAM. Though relatively compact in size, *SpeedCalc* is fast, easy to use, and has many of the features found in commercial spreadsheet programs.

Even better, if you print a *SpeedCalc* file to disk (see below), you can then merge it with a word processing document created with *SpeedScript*, COMPUTE!'s popular word processor (see COMPUTE!, May 1985, or *SpeedScript: The Word Processor for Atari Computers*, published by COMPUTE! Books).

Working together, *SpeedCalc* and *SpeedScript* make a powerful team. You can merge a chart of sales figures into a company report, create a table of scientific data for a term paper, and manipulate numeric information in many other ways. In a sense, a spreadsheet program brings to arithmetic all of the flexibility and power that a word processor brings to writing.

Preparing The Program

Although Atari *SpeedCalc* is small in comparison to similar commercial programs, it is one of the longest programs COMPUTE! has ever published. Fortunately, the "Atari MLX" machine language entry utility makes it easier to type a program of this size. Be sure to carefully read the Atari MLX article elsewhere in this issue before you begin. Here are the addresses you need to enter *SpeedCalc* with Atari MLX:

Starting address: 8192
Ending address: 16813
Run/Init Address: 8192

Next you'll be asked "Tape or Disk." *SpeedCalc* requires a disk drive, so type D. MLX will ask "Boot Disk or Binary File." Press F to select the Binary File option. (Although you could save *SpeedCalc* as a boot disk, it makes no sense, since such a disk cannot contain DOS, and DOS is necessary for file-oriented disk access.)

The screen then shows the first prompt, the number 8192 followed by a colon. Type in each three-digit number shown in the listing. You do not need to type the comma shown in the listing. MLX inserts the comma automatically.

The last number you enter in each line is a *checksum*. It represents the values of the other numbers in the line summed together. If you type the line correctly, the checksum calculated by MLX and displayed on the screen should match the checksum number in the listing. If it doesn't match, you have to retype the line. MLX is not foolproof, though. It's possible to fool the checksum by exchanging the position of the three-digit numbers. Also, an error in one number can be offset by an error in another. MLX will help catch your errors, but you still must be careful.

If you want to stop typing at some point and pick up later, press CTRL-S and follow the screen prompts. MLX will ask you for a disk filename; use any legal Atari filename except AUTORUN.SYS. Remember to note the line number of the last line you entered. When you are ready to continue typing, load MLX, answer the prompts as you did before, then press CTRL-L. For a binary disk file, MLX asks for the filename you gave to the partially typed listing. After the LOAD is complete, press CTRL-N and tell MLX the line number where you stopped. Now continue typing as before.

Saving The Finished Program

When you finish all typing, MLX automatically prompts you to save *SpeedCalc*. For disks with Atari DOS 2.0, 2.5, or 3.0, save the completed program with the filename AUTORUN.SYS. This allows *SpeedCalc* to load and run automatically when you boot the disk.

Because *SpeedCalc* requires a full 48K of RAM in order to work, you must *always* disable BASIC before loading or running *SpeedCalc*. On an Atari 400, 800, or 1200XL, unplug the BASIC cartridge (or any other cartridge, for that matter). On an Atari 600XL, 800XL, or 130XE, unplug any cartridges and disable BASIC by holding down the OPTION button when you first switch on and boot the computer. If you forget to disable BASIC, *SpeedCalc* won't work correctly.

To use *SpeedCalc* with an Atari DOS disk, you must save or copy it on a disk that also contains DOS.SYS and DUP.SYS. Since you've saved *SpeedCalc* as AUTORUN.SYS, it will automatically load and run when you turn on your computer with this disk in the drive. *SpeedCalc* should always be named AUTORUN.SYS in order to load properly with Atari DOS. If you want to prevent it from automatically running for some reason, you can save it with another name, then rename it AUTORUN.SYS later.

If you're using Optimized System Software's OS/A+ DOS or a compatible successor, you can give *SpeedCalc* any filename you like. Just use the LOAD command from DOS, and *SpeedCalc* will automatically run. Or you can give it a filename with the extension .COM, such as CALC.COM. Then you can start up by just typing CALC at the DOS prompt. You can also write a simple batch file to boot up *SpeedCalc* automatically. Some enhanced DOS packages may use so much memory that they conflict with *SpeedCalc*. In this case, you'll need to use Atari DOS instead on your *SpeedCalc* disks.

Note: The AUTORUN.SYS file on your DOS master disk is responsible for booting up the 850 Interface Module for RS-232 communications. There is no easy way to combine the 850 boot program with *SpeedCalc*, so you can't access the R: device while using this program. If you need to send a *SpeedCalc* file to a serial printer or modem, print it to disk as explained below, then print or transmit the file data as you would any ATASCII text.

The Atari *SpeedCalc* Screen

SpeedCalc uses the top line of the screen as the *command line*. This is where *SpeedCalc* displays messages and asks you questions.

Screen lines 2–4 are the *input buffer* area. This is the work area where you enter and edit data. As you'll see in a moment, the input buffer also displays the data contained in the current cell. The work area cursor is a left arrow symbol (←). After you begin to enter data, most *SpeedCalc* commands (except for the cursor movement keys) are deactivated until you press RETURN to enter the data into the worksheet.

The lower 19 screen lines are your window into the spreadsheet. Though the spreadsheet contains many rows and columns, only a few can fit on the screen at one time. By scrolling the screen back and forth with the cursor, you can

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move the display window to any part of the spreadsheet.

The *SpeedCalc* worksheet consists of 50 vertical columns labeled with letters (AA, AB ... BX) and 100 horizontal rows numbered from 1–100. The rectangle where a row and column intersect is called a *cell*. Cells are where you store data. With 50 columns and 100 rows, the *SpeedCalc* spreadsheet has a maximum of 5,000 (50*100) cells. Due to memory limitations, however, only about a third of these can actually contain data. But you may spread out the data over all 5,000 cells if necessary, depending on the format you need.

Moving The Cursor

Each cell is identified with the letters of its column and the number of its row. For example, the cell at the extreme upper-left corner of the sheet is called AA1, since it's in column AA and row 1. The cell below that is AA2. Moving one cell to the right from AA2 puts you in cell AB2, and so on.

Your current position in the spreadsheet is shown by the highlighted cursor. The simplest way to move around the sheet is with the cursor keys, which work just as they do when you're writing or editing a BASIC program. Press CTRL and the right cursor key to move right, and so on. Another way to move the cursor is with CTRL-H. Press CTRL-H once to "home" the cursor on the current screen: The cursor moves to the upper-left cell. Press CTRL-H twice in succession to move the cursor to cell AA1, the home position for the entire sheet.

SpeedCalc also has a *goto* command for moving the cursor over long distances. When you press CTRL-G, the command line displays GOTO: followed by a cursor. The cursor generally indicates that *SpeedCalc* is waiting for data—in this case it expects the name of the cell where you wish to go. If you enter BA88 at this point, *SpeedCalc* moves the cursor to the cell at column BA in row 88, adjusting the screen window as needed. Take a few moments to practice moving around the spreadsheet with all three methods; you'll be using them a lot. In a later section, we'll discuss how to change the size and format of a cell.

Keyboard Commands

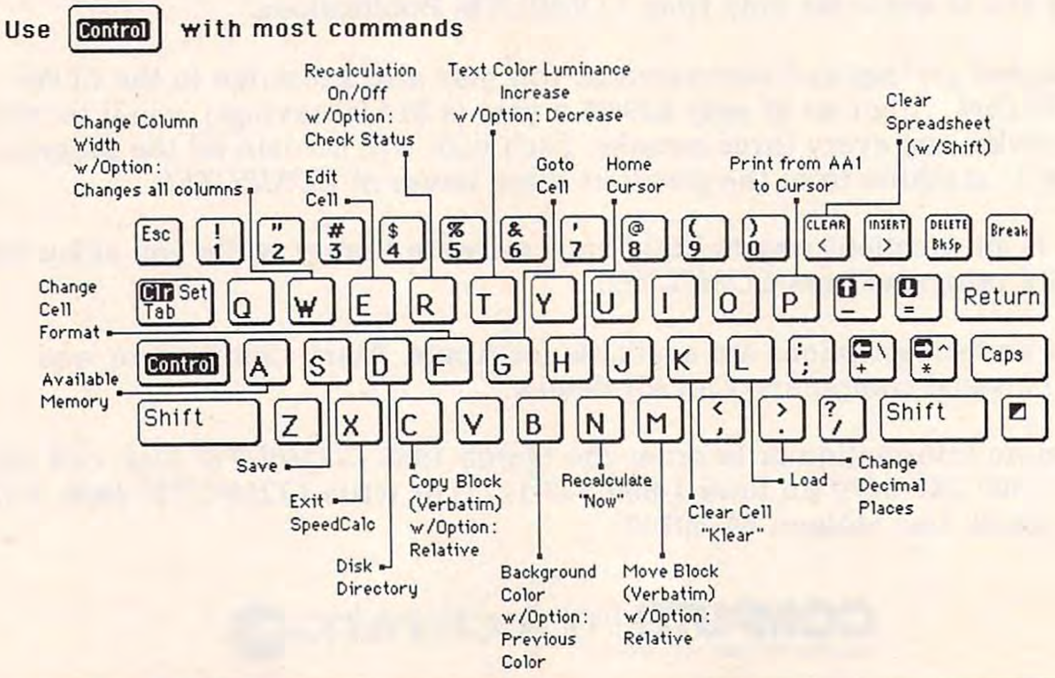
SpeedCalc offers many different commands, a few of which are entered by pressing one key. However, most commands are entered by pressing CTRL along with another key. CTRL-G, as you've seen, is the goto command. CTRL-A displays the amount of free memory available, and so on.

The most drastic command is CTRL-X, which exits *SpeedCalc* and returns to DOS. Since this effectively erases all data in memory, *SpeedCalc* prompts you with ARE YOU SURE Y/N? before it shuts down. To cancel the command, simply type N (or any key other than Y). If your Atari DOS 2.0/2.5 disk contains the file MEM.SAV (created with the CREATE MEM.SAV option on the DOS menu), you can exit to DOS and then return to *SpeedCalc*—however, all spreadsheet data will be lost. To restart *SpeedCalc* from the DOS menu after exiting, select menu option M (Run At Address), then enter the address 2000. If you're using OS/A+ or DOS XL, use RUN 2000 instead.

If you press SYSTEM RESET in *SpeedCalc*, you'll see the message SYSTEM RESET TRAPPED. No spreadsheet data is lost. If you're using OS/A+ or DOS XL, type RUN 2000 to return to *SpeedCalc*.

A few commands require you to press three keys at once. This sounds more awkward than it is in practice, since two of the three keys are OPTION and CTRL. For instance, the *relative copy* command

SpeedCalc Keyboard Reference



Use Control with most commands
Recalculation On/Off w/Option: Check Status
Text Color Luminance Increase w/Option: Decrease
Clear Spreadsheet (w/Shift)
Change Column Width w/Option: Changes all columns
Edit Cell
Goto Cell
Home Cursor
Print from AA1 to Cursor
Change Cell Format
Available Memory
Save
Exit SpeedCalc
Disk Directory
Copy Block (Verbatim) w/Option: Relative
Background Color w/Option: Previous Color
Recalculate "Now"
Move Block (Verbatim) w/Option: Relative
Clear Cell "Klear"
Load
Change Decimal Places
Esc
Clr Set Tab
Control
Shift
Return
Caps
Break
CLEAR
INSERT
DELETE BkSp

is performed by pressing OPTION-CTRL-C (hold down the OPTION console key and CTRL, then press C). The table lists all the *SpeedCalc* commands, and the figure shows the keyboard layout with a description of what each key does. We'll be discussing each command in more detail below.

Three Data Types

Before entering any data, you must know what kind of data *SpeedCalc* accepts. There are three different types: numbers, text, and formulas. Let's look at each type in turn.

1. Numeric data consists of numbers—the basic stuff that spreadsheets work with. *SpeedCalc* has a few simple rules for numeric data: A number must be a decimal value (base 10, not hexadecimal) composed of one or more digits from 0–9, with an optional plus or minus sign. A decimal point is also optional. If you include any other characters in numeric input, *SpeedCalc* treats the entire input as text data (as explained below). Thus, the numbers 123, .001, and −65535 are valid numeric data. The number 65,535 is invalid because it includes a comma.

The allowable range for numbers in Atari *SpeedCalc* is similar to the range for Atari BASIC, roughly −1.7E+97 to 1.7E+98. If a calculation produces a number outside the allowable range, you'll see the message *ERROR* in the cell containing the formula. This doesn't happen very often, since *SpeedCalc* won't let you enter a number more than 36 digits long, and there's rarely a need to use such large numbers unless you're tracking the national debt.

Although an input value can be up to 36 digits long, numbers in *SpeedCalc* calculations are accurate only to nine digits. This must be taken into account when doing any calculation involving large values. For example, you can enter the value 1122334455.66 into a cell, and the cell holds the value with no rounding. However, if you use the value from that cell in a formula, the value is rounded to nine digits—112233446.00—and the result of the calculation is accurate only for the first nine digits.

You can enter values in scientific notation by following a number with the letter E and the appropriate power of 10. For example, you can enter 1,234,000 as 1.234E+06. However, scientific notation should generally be avoided, since values outside the Atari's maximum range may crash the program (if this happens, press RESET and rerun the program from DOS as explained above). Since there's only room for about 36 digits, unpredictable results may occur if you enter any number in scientific notation with an exponent greater than 35 (E+35).

To see how entering numeric data works, let's enter the number 123 in cell AA1. No special commands are required to enter data: Just move the cursor to AA1 and begin typing. The left-arrow symbol shows the end of the data. While you're entering the number, it appears only in the input buffer near the top of the screen (the inverse-arrow cursor shows your cursor position). As soon as you press RETURN, the number appears in cell AA1 and the letter N appears at the upper right of the screen. The N signifies *numeric*, meaning that *SpeedCalc* has accepted the entry as valid numeric data. Move the cursor to a vacant cell, then move it back to AA1. The input buffer displays whatever data is found in the cell under the cursor. When the current cell is empty, the buffer is empty as well.

If you want to change anything during data entry, press the BACKSPACE key (BACKS on some Atari machines). BACKSPACE always deletes the character before the cursor (or has no effect if the cell is empty). Later on, we'll explain how to edit existing data.

As you've seen, pressing RETURN enters a data item into the current cell. You can also end the input by pressing CTRL and a cursor key. The data is entered as if you had pressed RETURN, and the cursor moves in the indicated direction. This feature is handy for entering a lot of data: Simply type the entry, move the cursor to the next cell, enter more data, and so on.

2. Text data is not "data" in the strict sense, since *SpeedCalc* doesn't use it in calculations as it does numbers and formulas. Text data is there only to help people understand what the other data means. Text may consist of comments, titles, column headings, subheadings, or whatever you need to interpret the numbers and formulas. As an example, move the cursor to cell AA2 (just under AA1) and type the following line:

```
THIS IS A PIECE OF TEXT DATA.
```

You can use the BACKSPACE key to erase mistakes while you're typing. When you press RETURN, *SpeedCalc* displays T (for text) in the upper-right corner. In this example, the cell isn't large enough to accept all the text, so only the leftmost portion appears in AA2. But even though you can't see it, all of the text is there. Move the cursor to another cell, then move it back to AA2. As soon as you return to AA2, *SpeedCalc* displays all the text in the input buffer area.

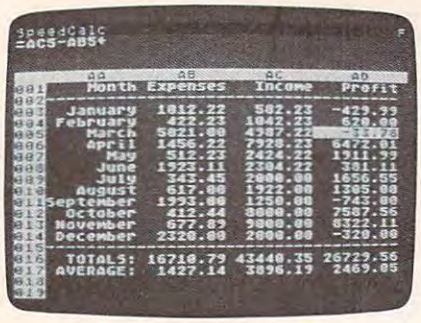
3. Formula data is a mathematical expression or formula. It may be as simple as 2 + 2 or as complex as your imagination (and mathematical prowess) allows. The first character in a formula must always be an equal sign (=). If you omit this symbol, *SpeedCalc* either signals an error or treats the data as text.

The true power of a spreadsheet is that a formula in one cell can refer to another cell. This is easier to demonstrate than to explain. Move the cursor to cell AA3 and type the following line:

```
=AA1*25.01+@SQR(4)
```

As soon as you press RETURN, *SpeedCalc* displays F (for formula) in the upper-right corner of the screen and puts the *result* of the formula (not the formula itself) in AA3. If AA1 contains 123, the value 3078.23 appears in AA3. In plain English, this formula means "multiply the contents of cell AA1 by 25.01 and add the square root of 4."

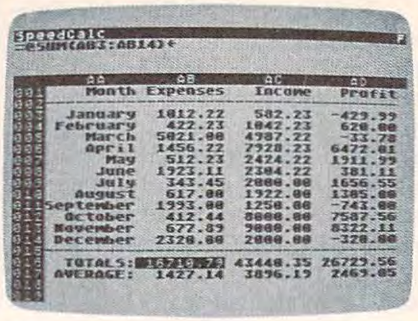
Before we examine the formula more closely, here's a quick demonstration of what makes a spreadsheet such a powerful tool. Move the cursor back to AA1 and press CTRL-R. The command line displays the message RECALCULATION IS ON, meaning *SpeedCalc* now automatically recalculates the



```
SpeedCalc                                        F
=AC5-AB5←

           AA         AB          AC          AD
001      Month  Expenses      Income      Profit
002
003    January   1012.22      582.23     -429.99
004   February    422.23     1042.23      620.00
005      March   5021.00     4987.22      -33.78
006      April   1456.22     7928.23     6472.01
007        May    512.23     2424.22     1911.99
008       June   1923.11     2304.22      381.11
009       July    343.45     2000.00     1656.55
010     August    617.00     1922.00     1305.00
011  September   1993.00     1250.00     -743.00
012    October    412.44     8000.00     7587.56
013   November    677.89     9000.00     8322.11
014   December   2320.00     2000.00     -320.00
015
016    TOTALS:  16710.79    43440.35    26729.56
017   AVERAGE:   1427.14     3896.19     2469.05
018
019
```

A typical screen from Atari Speed-Calc*—a compact, powerful spreadsheet program written entirely in machine language.*



```
SpeedCalc                                        F
=@SUM(AB3:AB14)←

           AA         AB          AC          AD
001      Month  Expenses      Income      Profit
002
003    January   1012.22      582.23     -429.99
004   February    422.23     1042.23      620.00
005      March   5021.00     4987.22      -33.78
006      April   1456.22     7928.23     6472.01
007        May    512.23     2424.22     1911.99
008       June   1923.11     2304.22      381.11
009       July    343.45     2000.00     1656.55
010     August    617.00     1922.00     1305.00
011  September   1993.00     1250.00     -743.00
012    October    412.44     8000.00     7587.56
013   November    677.89     9000.00     8322.11
014   December   2320.00     2000.00     -320.00
015
016    TOTALS:  16710.79    43440.35    26729.56
017   AVERAGE:   1427.14     3896.19     2469.05
018
019
```

Atari SpeedCalc*'s input buffer always displays the contents of the data cell under the highlighted cursor.*

entire sheet whenever you make a change. Now change the number in AA1 to 456 (simply move to the cell and start typing). The new result (11406.56) automatically appears in cell AA3. We'll explain more about automatic recalculation later.

Note that the referenced cell must contain data that *SpeedCalc* can evaluate: a number or another formula. If the formula refers to an empty cell, or one that contains text, *SpeedCalc* signals the error by printing *ERROR* in the cell containing the incorrect formula.

Mathematical Operators

These symbols can be used as *operators* in a formula:

Operator	Function
+	addition
−	subtraction
*	multiplication
/	division
^	exponentiation
=	equality

One factor that affects formulas is *precedence*, or the order in which mathematical operations are performed. In *SpeedCalc*, formula operators have the same precedence as in ordinary math.

The first operators to be evaluated—those with the highest precedence—are those enclosed in parentheses. Where one set of parentheses encloses another, the expression in the innermost set is evaluated first. The next operators to be evaluated are exponents. Multiplication and division have equal precedence; both operations are lower than exponentiation. Addition and subtraction have the lowest precedence of all. To take one example, *SpeedCalc* evaluates the formula =5*(8+3*−2)^2−10/+2 as the value 15, just as in ordinary math. Note how the result is affected by the plus and minus signs before the two 2's.

Functions

Formulas may also include any of the functions listed here:

@ABS( )	**absolute value**
@AVE( )	**average of a block of cells**
@EXP( )	**natural exponent**
@INT( )	**integer**
@LOG( )	**natural logarithm**
@RND()	**round to nearest integer**
@SGN( )	**sign**
@SQR( )	**square root**
@SUM( )	**sum of a block of cells**
PI	**value of pi (3.14159265)**

All the functions except PI begin with the @ symbol and are followed by parentheses. The parentheses of a function may contain a number or a formula. For example, the formula =@SQR(4) generates the square root of 4. The formula =@SQR(AA1) returns the square root of whatever value cell AA1 contains. The function @INT( ) generates an integer (whole number) by truncating (discarding the fractional part of) a numeric value; note that this is different from rounding (for instance, the result of @INT(−4.3) is −4, not −5). Use the rounding function @RND() to round a value up to the nearest whole number.

The function @AVE( ) calculates the mean average of the values in a block (group) of cells. The function @SUM( ) calculates the sum of a block. Both functions require you to define the block so *SpeedCalc* knows which cells to include in the calculation. This is done by putting two cell names separated by a colon in the parentheses. The first cell name defines the upper-left corner of the block, and the second defines the bottom-right corner. To define a block in a single column, specify the top and bottom cells in the column. For instance, @AVE(AA1:AD20) calculates the average of all the cells from AA1 to AD20. The function @SUM (AA1:AD20) calculates the sum of AA1 through AD20, and so on. *An error results if any cell in the block is blank or contains text data.*

Editing The Sheet

Editing is a very important spreadsheet function. The simplest way to change what a cell contains is to move to it and start typing. The old data in that cell is replaced by whatever you enter. For instance, to replace the contents of cell AA1 with the number 456, move to that cell, type 456, and press RETURN or exit with a cursor key. Press CTRL-K (think of *kill*) to erase what's in the current cell. To erase everything in the sheet, press SHIFT-CLEAR. Before carrying out this drastic operation, *SpeedCalc* asks you to confirm it by pressing Y or N.

In some cases, only a minor change is needed. *Edit mode* lets you change the data in a cell without retyping the entire entry. To activate edit mode, move to the desired cell and press CTRL-E. In this mode, up and down cursor movement is disabled, and the left/right cursor keys move within the input buffer. Typing in edit mode inserts new characters in the line: Everything to the right of the new character moves right one space (unless the buffer is already full). Because all keys insert automatically, the CTRL-INSERT key combination is disabled: Press the space bar to insert a blank space. Erase unwanted characters with the BACKSPACE key or CTRL-DELETE. The CTRL-DELETE combination does not move the cursor: It simply pulls the text to the right of the cursor toward the cursor position. Since the cursor keys have a different function in edit mode, you cannot use them to end the input. Press RETURN to enter the new data and escape from edit mode.

SpeedCalc displays *ERROR* in a cell when you enter an erroneous formula. Usually this means you've made a typing error in that cell, or the formula refers to text or an empty cell. A line of asterisks (*********) signals that a number is too large to be printed in the cell. Though these messages appear in the cell area, no data is lost. You may move to the affected cell, view its contents in the input buffer, and make whatever correction is needed.

Recalculation

Recalculation is the very core of a spreadsheet. As you know, entering or editing a piece of data makes *SpeedCalc* perform a calculation and put the result in the cell under the cursor. In most cases, the new data relates to data in other cells, so you'll ultimately want to recalculate the entire spreadsheet as well. This can be done manually or automatically.

To recalculate the spreadsheet manually, enter CTRL-N. *SpeedCalc* begins at AA1 and recalculates every cell that contains data, placing fresh results wherever needed. If you switch to automatic recalculation mode, *SpeedCalc* automatically recalculates the entire spreadsheet each time you enter new data or edit what exists. When you press CTRL-R, *SpeedCalc* changes the recalculation status and displays it at the top of the screen. If automatic recalculation was turned off before, it is now on (and vice versa). If you aren't sure which mode you're in, press OPTION-CTRL-R; *SpeedCalc* displays the mode without changing it.

Automatic recalculation can be fun to watch in a large spreadsheet: Every time you make a change, new results appear everywhere on the screen. However, the more data your spreadsheet contains, the longer it takes to update the entire sheet. For this reason, you may want to turn off automatic recalculation most of the time, recalculating manually whenever you need to view results.

One problem with recalculation arises from the order in which cells are calculated. Because only one cell can be calculated at a time, you must sometimes recalculate the entire spreadsheet two or three times to get correct results in every cell (this is common to all spreadsheet programs). For instance, say you have a formula in AA1 which refers to a formula in AB15. When *SpeedCalc* calculates AA1, it must use the existing data from AB15—which is probably out of date, since the formula in AB15 hasn't been recalculated yet. To avoid this problem, you should always recalculate a sheet manually two or three times before printing it or saving it to disk.

SpeedCalc offers a number of other features. Before experimenting with them, you should spend some time typing in a hypothetical spreadsheet—perhaps a fictitious yearly budget—to become thoroughly familiar with the basic commands covered so far. Most importantly, create formulas using all the operators in different combinations.

Change Format

The default (normal) format for numeric data is flush right with rounding to two decimal places. In other words, the number is displayed in the rightmost part of the cell, with two numbers after the decimal point. Text and formulas are also displayed flush right. *SpeedCalc* offers several commands for changing cell formats.

Change Format (CTRL-F). This command changes the location of data in the cell. When you press CTRL-F, the *SpeedCalc* command line displays the question FORMAT: LEFT, CENTER, OR RIGHT JUSTIFY?. Press L, C, or R to move the data to the left, center, or right of the cell.

Change Decimal Places (CTRL-.). *SpeedCalc* also lets you change the number of decimal places for any cell. The default number of decimal places is 2, but you may change it to anything from 0–15. Press CTRL and the period key (CTRL-.) to change this value: *SpeedCalc* prompts you to enter a number from 0–15. If you choose zero decimal places, any number in that cell is rounded off to the nearest integer (whole number). If you choose 15, a number in that cell is not rounded off at all—*SpeedCalc* displays it exactly as you entered it or as it was calculated from a formula.

Width (CTRL-W). The width command changes the width of an entire column of cells. Move the cursor to any cell in the desired column, then press CTRL-W. When *SpeedCalc* displays the prompt WIDTH:, respond with a number from 4–36. The entire screen is redrawn to accommodate the new format, and may look very different depending on what value you chose. For instance, if you increase a column's width, the rightmost column of the former display may disappear: *SpeedCalc* only displays as many complete columns as it can fit on the screen. If you decrease the width of a column, you may see asterisks where numbers used to be (indicating the cell is now too small to display the entire number). To get rid of the asterisks, expand the column as necessary.

Global Format (OPTION-CTRL-F). This is the same as the ordinary format command, but operates globally, changing every cell in the sheet instead of just one.

Global Width (OPTION-CTRL-W). This is a global version of the width command. Every column in the sheet changes to the designated width.

Screen Color And Luminance

SpeedCalc makes it easy to change the screen background and character colors to your liking.

Background Color (CTRL-B). Press CTRL-B to cycle forward through the available screen background colors.

Text Color (CTRL-T). This command increases the luminance of characters on the screen, cycling forward through all of the available text colors.

Previous Background Color (OPTION-CTRL-B). The reverse of CTRL-B, this command cycles backward through the range of background colors.

Previous Text Color (OPTION-CTRL-T). The reverse of CTRL-T, this command cycles backward through the range of text colors.

Macro Editing

After typing in a large spreadsheet, you may decide to make a major change. You may want to add new data somewhere in the middle, delete a section, or move a group of cells from one location to another. *SpeedCalc*'s macro (large-scale) editing commands simplify such operations, affecting an entire block of cells at once. A *block* is simply a group of cells connected in rectangular fashion. You can define it as a single cell, a row or column, or any rectangular area within the spreadsheet.

There are two ways macro commands work: *verbatim* or *relative*. To take a simple example, say that cell AA2 contains the formula =AA1*5 and you want to move its contents to cell AB2. When this is done in verbatim mode, AB2 contains an exact copy of what was in AA2 (=AA1*5). Note that the cell name used in the formula does not change: The formula still refers to AA1. If you perform the same operation in relative mode, the cell name in the formula is adjusted to fit the new location. In this case, AB2 would contain the formula =AB1*5.

Copy (CTRL-C). The copy command copies a block of cells into a different location without disturbing the original cells. Place the cursor on the upper-left corner of the block you want to copy, then press CTRL-C. *SpeedCalc* prompts you to move the cursor to the lower-right corner of the block you want to copy. Once the cursor is in place, press RETURN. Now *SpeedCalc* prompts you to move the cursor to the place where you want to put the block: This is the upper-left corner of the new position. Once the cursor is there, press RETURN again. The new data replaces whatever was contained in the designated cells. Note that if you define an impossible block (for instance, moving the cursor to the upper-left of the original position, rather than below and to the right), *SpeedCalc* does not copy any data. Press ESC if you change your mind and wish to cancel this command.

Move (CTRL-M). This command works like a copy, but it fills the original cells with blanks. Though *SpeedCalc* has no express insert command, you can use this command to make space for new data in the middle of a spreadsheet. Simply move everything below the insertion point down as far as you need. As with the copy command, you can press ESC to cancel this command.

Relative Copy (OPTION-CTRL-C). This form of the copy command adjusts the cell names used in formulas within the copied block (see explanation above). When copying or moving data in relative mode, you may see some strange characters displayed very briefly in the input buffer area of the screen: This harmless effect occurs because *SpeedCalc* uses that area for temporary storage during these operations, conserving memory for other purposes.

Relative Move (OPTION-CTRL-M). This is the relative form of the move command. Cell names in formulas are adjusted to reflect the move.

Memory Management

SpeedCalc makes about 20K (roughly 20,000 characters) of memory available for data. As noted earlier, *SpeedCalc* lets you spread your data out over a much larger number of cells than you can actually fill with data. The extra space is provided to give you full control over the final format of the spreadsheet and to leave some elbow room for move and copy operations.

Because memory is limited, you should keep careful track of how much is free while using the program. Press CTRL-A to display the amount of free memory. We suggest limiting your spreadsheets to 1,600 cells (equivalent to 40 rows by 40 columns). If you've filled nearly all of free memory, you may have to break the spreadsheet into two smaller sheets.

Although *SpeedCalc* checks the amount of available memory and displays an error message if you run out, you should be careful not to exhaust free memory. Any move or copy operation in process will be aborted if sufficient memory is not available.

Disk Operations

SpeedCalc has three disk commands for saving and loading data from

SpeedCalc Commands

Command	Action
CTRL-A	available memory check
CTRL-B	next background color
CTRL-C	copy block verbatim
CTRL-D	disk directory
CTRL-E	edit current cell
CTRL-F	change cell format
CTRL-G	goto selected cell
CTRL-H	home cursor
CTRL-K	clear current cell
CTRL-L	load *SpeedCalc file*
CTRL-M	move block verbatim
CTRL-N	recalculate sheet now
CTRL-P	print cells from AA1 to cursor
CTRL-R	turn recalculation on/off
CTRL-S	save *SpeedCalc* file
CTRL-T	increase text luminance
CTRL-W	change column width
CTRL-X	exit *SpeedCalc* to DOS
CTRL-.	change decimal places
SHIFT-CLR	clear spreadsheet
OPTION-CTRL-B	previous background color
OPTION-CTRL-C	copy block relative
OPTION-CTRL-M	move block relative
OPTION-CTRL-R	check recalculation status
OPTION-CTRL-T	decrease text luminance
OPTION-CTRL-W	change width of all columns

disk and displaying the disk directory. The disk directory command is the easiest to use: Simply press CTRL-D. To save a spreadsheet to disk, press CTRL-S. *SpeedCalc* prints SAVE: on the command line, followed by a cursor. Enter a valid Atari filename (including D:) and press RETURN. (If you change your mind and decide not to save anything, press RETURN without typing a filename.) If no disk error occurs while the spreadsheet is being saved, *SpeedCalc* displays NO ERRORS in the command line and returns you to command mode. If there was an error, you'll hear a beep and see the message I/O ERROR # followed by an error number in the command line. Your DOS manual explains the meaning of the various DOS errors.

To load a saved file from disk, press CTRL-L. Again, you can cancel the operation by pressing RETURN without entering a filename. *SpeedCalc* prompts you to enter the filename and displays the error status when the operation is complete. If an error occurs while loading, *SpeedCalc* clears the partially loaded sheet to prevent a program crash.

Printing

SpeedCalc lets you print data to three different devices: to the screen for previewing output (E:), to a printer for permanent documentation (P:), or to a disk file for integrating the data with a *SpeedScript* document (D:*filename*).

To print a hardcopy of the spreadsheet to a printer, press CTRL-P and then enter P: when asked for (Device:Filename). *Before using this command, you must position the cursor below and to the right of the block of cells you wish to print.* The upper-left corner of the printout starts at cell AA1. To preview the printed output on the screen, enter E: in response to the same prompt.

You can also print *SpeedCalc* data to a disk file for use in a *SpeedScript* document. When *SpeedCalc* prints the prompt (Device:Filename), enter D:*filename*. The data is saved as a disk file of that name. Note that *printing* to disk creates a different type of file than *saving* to disk, and *SpeedCalc* cannot reload files in the print format. You should *save* files you wish to reload into *SpeedCalc*, and *print* files you wish to load into *SpeedScript*.

SpeedScript Integration

SpeedCalc sends data to the printer in simple, plain vanilla form. That may be fine for personal use, but if you're creating a document for others to view, you may want special features such as boldface, underlining, italics, and so on. Since Atari *SpeedScript*—COMPUTE!'s popular word processor—already offers a way to access these features (and many more), no attempt has been made to duplicate them in *SpeedCalc*.

No special tricks are needed to load a *SpeedCalc* file into *SpeedScript*. After printing the file to disk as explained above, exit *SpeedCalc*, then load and run *SpeedScript*. Now load the file as you would any *SpeedScript* document. The data appears on the screen, ready to be edited in any way you wish. Again, keep in mind that *SpeedScript* can load only those files which have been *printed* to disk, not saved.

Program 1: Atari *SpeedCalc*

Please refer to the "MLX" article in this issue before entering the following listing.

```
8192:165,Ø89,2Ø1,188,24Ø,Ø18,133
8198:169,Ø63,16Ø,Ø94,Ø32,Ø89,1Ø1
82Ø4:Ø33,Ø32,Ø28,Ø33,169,ØØ1,Ø52
821Ø:141,Ø68,ØØ2,1Ø8,252,255,Ø76
8216:169,Ø63,16Ø,Ø35,162,ØØØ,1Ø1
8222:Ø32,Ø89,Ø33,Ø32,181,Ø35,176
8228:Ø32,Ø26,Ø35,169,Ø66,Ø24,132
8234:1Ø5,ØØ1,141,174,Ø65,Ø24,Ø4Ø
824Ø:1Ø5,Ø41,133,159,169,ØØØ,143
8246:141,173,Ø65,141,175,Ø65,Ø46
8252:133,158,141,Ø49,Ø62,169,ØØ4
8258:187,141,176,Ø65,169,2Ø3,239
8264:2Ø5,Ø54,Ø66,141,Ø54,Ø66,146
827Ø:24Ø,Ø3Ø,Ø32,1Ø8,Ø35,165,176
8276:Ø12,141,ØØ5,Ø33,165,Ø13,197
8282:141,ØØ6,Ø33,169,ØØ4,133,Ø64
8288:Ø12,169,Ø33,133,Ø13,169,113
8294:ØØØ,141,Ø68,ØØ2,169,ØØ1,227
83ØØ:133,ØØ9,Ø32,182,Ø35,Ø32,Ø19
83Ø6:ØØ3,Ø38,Ø32,Ø28,Ø33,Ø72,Ø64
8312:Ø32,152,Ø33,1Ø4,174,173,Ø2Ø
8318:Ø32,221,173,Ø32,24Ø,Ø22,Ø78
8324:2Ø2,2Ø8,248,2Ø1,Ø32,144,143
833Ø:23Ø,2Ø1,123,176,226,2Ø1,Ø15
8336:Ø91,144,ØØ4,2Ø1,Ø97,144,Ø57
8342:218,Ø76,182,Ø36,2Ø2,138,234
8348:Ø1Ø,17Ø,169,Ø32,Ø72,169,Ø1Ø
8354:112,Ø72,189,213,Ø32,Ø72,Ø84
836Ø:189,212,Ø32,Ø72,Ø96,Ø24,Ø25
8366:125,ØØ8,Ø23,ØØ6,ØØ7,Ø16,1Ø3
8372:ØØ3,Ø19,Ø12,Ø24,Ø28,Ø29,Ø39
8378:Ø31,Ø3Ø,Ø11,ØØ5,Ø14,ØØ2,Ø23
8384:Ø2Ø,ØØ1,Ø18,ØØ4,Ø13,Ø96,Ø88
839Ø:Ø13,Ø17,Ø18,Ø19,Ø2Ø,Ø21,Ø5Ø
8396:Ø22,Ø23,Ø24,Ø25,Ø16,Ø11,Ø69
84Ø2:Ø13,Ø14,Ø83,Ø35,Ø67,Ø42,2Ø8
84Ø8:127,Ø4Ø,Ø41,Ø37,178,Ø41,168
8414:117,Ø44,244,Ø45,217,Ø49,17Ø
842Ø:179,Ø5Ø,Ø84,Ø54,Ø9Ø,Ø41,214
8426:Ø65,Ø41,113,Ø41,155,Ø41,178
8432:Ø35,Ø52,Ø96,Ø52,149,Ø51,163
8438:Ø7Ø,Ø33,Ø52,Ø33,131,Ø53,1Ø6
8444:Ø54,Ø52,Ø15,Ø58,212,Ø45,176
845Ø:1Ø7,Ø37,Ø32,Ø64,Ø21,Ø32,Ø39
8456:Ø26,Ø35,Ø32,ØØ3,Ø38,Ø32,174
8462:182,Ø35,169,Ø63,16Ø,Ø72,183
8468:162,ØØ7,Ø32,Ø89,Ø33,Ø76,163
8474:113,Ø32,173,252,ØØ2,2Ø1,Ø31
848Ø:255,24Ø,249,133,146,138,169
8486:Ø72,152,Ø72,Ø32,125,Ø59,Ø38
8492:133,151,1Ø4,168,1Ø4,17Ø,1Ø6
8498:165,151,Ø96,162,ØØ2,Ø32,146
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8516:Ø52,Ø62,Ø96,162,ØØ2,Ø32,218
8522:1Ø9,Ø58,2Ø8,ØØ2,162,254,Ø99
8528:Ø24,138,1Ø9,Ø51,Ø62,141,Ø93
8534:Ø51,Ø62,Ø96,133,2Ø4,132,252
854Ø:2Ø3,142,Ø5Ø,Ø62,169,ØØØ,2Ø6
8546:133,Ø84,133,Ø85,169,ØØ1,191
8552:141,24Ø,ØØ2,Ø32,14Ø,Ø33,18Ø
8558:16Ø,ØØØ,14Ø,255,ØØ2,177,Ø76
8564:2Ø3,24Ø,ØØ6,Ø32,229,Ø58,116
857Ø:2ØØ,2Ø8,246,Ø96,162,Ø5Ø,Ø6Ø
8576:157,18Ø,Ø65,2Ø2,2Ø8,25Ø,166
8582:169,Ø4Ø,141,231,Ø65,Ø96,1Ø8
8588:16Ø,ØØØ,169,ØØØ,145,Ø88,19Ø
8594:2ØØ,192,Ø4Ø,2Ø8,247,Ø96,1Ø5
86ØØ:173,Ø65,188,2Ø1,112,24Ø,1Ø7
86Ø6:ØØ9,169,Ø63,16Ø,Ø25,162,234
8612:ØØØ,Ø32,Ø89,Ø33,Ø56,Ø32,15Ø
8618:Ø78,Ø55,144,ØØ3,Ø76,165,179
8624:Ø39,Ø76,175,Ø39,Ø32,176,2Ø1
863Ø:Ø34,141,1Ø4,188,169,Ø94,144
8636:141,1Ø5,188,162,118,169,Ø47
8642:ØØØ,157,1Ø5,188,2Ø2,2Ø8,Ø3Ø
8648:248,16Ø,ØØ1,2Ø8,ØØ2,16Ø,211
8654:ØØØ,185,1Ø4,188,ØØ9,128,Ø52
866Ø:153,1Ø4,188,Ø32,Ø28,Ø33,238
8666:141,249,Ø65,185,1Ø4,188,126
8672:Ø41,127,153,1Ø4,188,173,242
8678:249,Ø65,174,154,Ø34,221,1Ø3
8684:154,Ø34,24Ø,Ø55,2Ø2,2Ø8,1Ø5
869Ø:248,2Ø1,Ø32,144,216,2Ø1,ØØ4
8696:125,176,212,Ø32,176,Ø34,235
87Ø2:141,249,Ø65,14Ø,25Ø,Ø65,14Ø
87Ø8:2Ø6,25Ø,Ø65,162,119,189,227
8714:1Ø4,188,2Ø1,Ø94,24Ø,191,ØØ4
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8726:188,2Ø2,236,25Ø,Ø65,2Ø8,147
8732:244,173,249,Ø65,153,1Ø4,248
8738:188,2ØØ,Ø76,2Ø7,Ø33,2Ø2,172
8744:138,Ø1Ø,17Ø,189,163,Ø34,232
875Ø:Ø72,189,162,Ø34,Ø72,Ø96,159
8756:16Ø,ØØØ,185,1Ø4,188,2Ø1,122
8762:Ø94,24Ø,ØØ6,153,ØØØ,ØØ6,Ø45
8768:2ØØ,2Ø8,243,169,ØØØ,153,Ø13
8774:ØØØ,ØØ6,14Ø,234,Ø65,Ø96,Ø99
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8786:ØØØ,24Ø,ØØ1,136,Ø76,2Ø7,23Ø
8792:Ø33,173,Ø54,Ø62,24Ø,Ø19,157
8798:185,1Ø4,188,2Ø1,Ø94,24Ø,Ø82
88Ø4:241,2ØØ,Ø76,2Ø7,Ø33,173,ØØ6
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8816:Ø33,165,146,141,252,ØØ2,Ø83
8822:Ø76,Ø52,Ø34,192,ØØØ,24Ø,2ØØ
8828:217,136,185,1Ø4,188,2Ø1,131
8834:Ø94,24Ø,2Ø9,152,17Ø,189,16Ø
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8858:ØØ7,155,126,Ø28,Ø29,Ø3Ø,Ø17
8864:Ø31,254,Ø51,Ø34,12Ø,Ø34,172
887Ø:1Ø4,Ø34,1Ø4,Ø34,Ø75,Ø34,Ø39
8876:Ø88,Ø34,125,Ø34,Ø72,Ø41,Ø54
8882:128,133,151,1Ø4,Ø41,127,Ø94
8888:2Ø1,Ø96,176,Ø13,2Ø1,Ø32,135
8894:176,ØØ6,Ø24,1Ø5,Ø64,Ø76,129
89ØØ:2Ø1,Ø34,Ø56,233,Ø32,ØØ5,245
89Ø6:151,Ø96,Ø72,Ø41,128,133,Ø55
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8918:176,Ø11,2Ø1,Ø64,144,ØØ5,Ø47
8924:233,Ø64,Ø76,227,Ø34,1Ø5,191
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8942:Ø37,Ø78,141,Ø1Ø,212,141,Ø89
8948:Ø24,2Ø8,141,2ØØ,ØØ2,173,224
8954:Ø52,Ø62,Ø69,Ø79,Ø37,Ø78,115
896Ø:141,Ø23,2Ø8,174,Ø5Ø,Ø62,146
8966:189,Ø55,Ø62,141,198,ØØ2,141
8972:169,Ø1Ø,141,197,ØØ2,169,188
8978:ØØØ,141,182,ØØ2,1Ø4,17Ø,1Ø5
8984:1Ø4,Ø64,169,Ø64,141,Ø14,Ø68
899Ø:212,169,23Ø,141,ØØØ,ØØ2,Ø16
8996:169,Ø34,141,ØØ1,ØØ2,173,Ø44
9ØØ2:Ø48,ØØ2,133,151,173,Ø49,Ø86
9ØØ8:ØØ2,133,152,16Ø,ØØ3,169,155
9Ø14:194,145,151,169,192,141,Ø22
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9Ø26:Ø14,212,173,Ø51,Ø62,141,2Ø7
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9044:169,063,160,226,162,002,098
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9056:041,095,201,089,208,003,221
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IBM Fractal Graphics

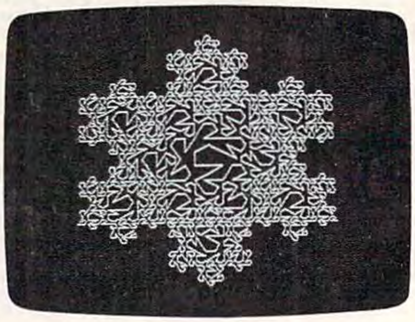
Paul W. Carlson

One of the hottest topics in mathematics these days is fractals—*fractional dimensions. Fractals are being used for everything from simulating random plant growth to generating realistic planetary landscapes for science-fiction films and arcade games. This article, adapted from "Apple Fractals" in the September 1985 issue of* COMPUTE!, *introduces the fascinating world of fractals with three programs that work on any IBM PCjr or PC with color/graphics adapter.*

The term *fractal* was coined by Benoit Mandelbrot, a pioneer in their study, to denote curves or surfaces having *fractional dimension*. The concept of fractional dimension can be illustrated as follows: A straight curve (a line) is one-dimensional, having only length. However, if the curve is infinitely long and curves about in such a manner as to completely fill an area of the plane containing it, the curve could be considered two-dimensional. A curve partially filling an area would have a fractional dimension between one and two.

Many types of fractals are *self-similar,* which means that all portions of the fractal resemble each other. Self-similarity occurs whenever the whole is an expansion of some basic building block. In the language of fractals, this basic building block is called the *generator*. The generator in the accompanying programs consists of a number of connected line segments. The curves that the programs plot are the result of starting with the generator and then repeatedly replacing each line segment with the whole generator according to a defined rule. Theoretically, these replacement cycles would continue indefinitely. In practice, the screen resolution limits the number of cycles.

The programs illustrate two types of fractal curves. The curves generated by Program 1 and Program 2 are *self-contacting,* while the curve generated by Program 3 is *self-avoiding*. A self-contacting curve touches itself but does not cross itself. A self-avoiding curve never actually touches itself although it may appear to because of the limited screen resolution.



The Dragon Sweep

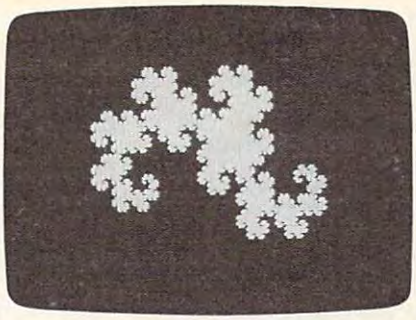
Program 1 plots what Mandelbrot refers to as a "dragon sweep." It demonstrates in a step-by-step fashion how a fractal curve is filled.

The generator consists of two line segments of equal length forming a right angle. During each replacement cycle, the generator is substituted for each segment on alternating sides of the segments, that is, to the left of the first segment, to the right of the second segment, and so on. Figure 1 shows the first few cycles of substitution. The program is written in BASIC so the plotting is slow enough to let you observe the development of the curve.

The program prompts you to enter an even number of cycles (for reasons of efficiency and screen resolution, only even numbers of cycles are plotted). When a plot is complete, pressing any key clears the screen and returns you to the prompt. I recommend starting with two cycles, then four, six, etc. It takes fourteen cycles to completely fill in the "dragon," but since this requires almost two hours, you will probably want to quit after about ten cycles. You can see the complete dragon by running Program 2, which always plots the dragon first in less than 30 seconds.

Since it's not at all obvious how the program works, here's a brief explanation. NC is the number of cycles; C is the cycle number; SN is an array of segment numbers indexed by cycle number; L is the segment length; D is the segment direction, numbered clockwise from the positive x direction; and X and Y are the high-resolution screen coordinates.

Lines 100–140	Get number of cycles from user.
Line 150	Computes segment length.
Line 160	Sets starting coordinates.
Line 170	Sets segment numbers for all cycles to the first segment.
Lines 180–220	Find the direction of the segment in the last cycle by rotating the segment in each cycle that will contain the segment in the last cycle.
Lines 230–260	Increase or decrease X or Y by the segment length, depending on the segment direction.
Lines 270–290	Plot the segment and update the current segment number for each cycle.
Lines 300–320	If the segment number for cycle zero is still zero, do the next segment; otherwise, we're done.

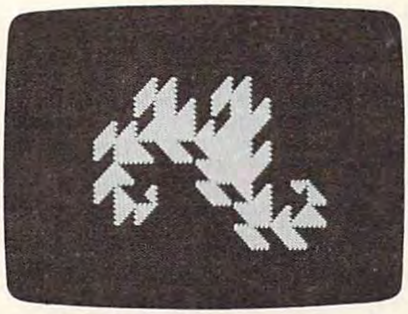


Eight Thousand Dragons

Program 2 plots more than 8,000 different dragons. It does this by randomly determining on which side of the first segment the generator will be substituted for all cycles after the first cycle. The generator is always substituted to the left of the first segment in the first cycle to avoid plotting off the screen. Other than the randomization, this program uses the same logic as Program 1. The main part of this program is written in machine language to reduce the time required to plot a completely filled-in dragon from about two hours to less than half a minute.

All the dragons are plotted after 14 cycles of substitution. All have exactly the same area, which equals half of the square of the distance between the first and last points plotted. All the dragons begin and end at the same points.

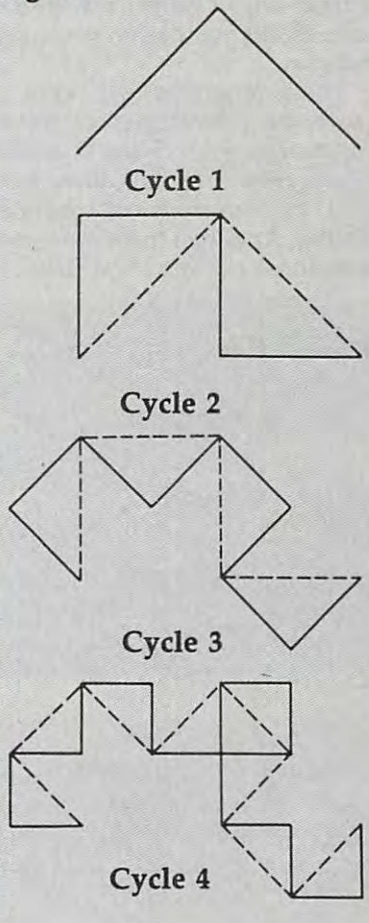
When a plot is complete, press the space bar to plot another dragon, or press the Q key to quit.



Snowflakes

Program 3 plots what Mandelbrot refers to as a "snowflake sweep." The generator, shown in Figure 2, was discovered by Mandelbrot. The segments are numbered zero through six, starting at the right. The program is basically the same as Program 1. The variables NC, C, SN, D, X, and Y represent the same values except that the direction D is numbered counterclockwise from the negative x direction. For each segment, the accompanying table gives the value of RD (relative direction), LN (length factor), and SD (flags indicating which side of the segment the generator is to be placed).

Figure 1: Substitution Cycles, Program 1



Line 20	Reads values of SD and RD. Compute LN values.
Lines 30–50	Compute delta x and delta y factors for each direction.
Lines 60–100	Get number of cycles from user.
Line 120	Sets starting coordinates.
Line 130	Sets the segment numbers for all cycles to the first segment.
Lines 140–170	Find the direction of the segment in the last cycle.

Lines 180–190 Compute the coordinates of the end of the segment, plot the segment, and update the segment numbers for each cycle.

Lines 200–220 Same as lines 300–320 in Program 1.

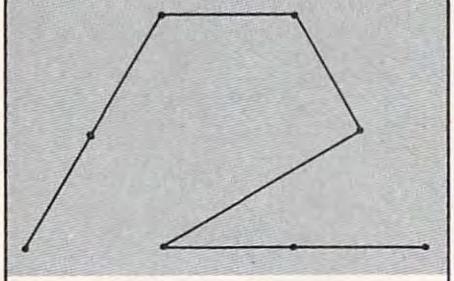
Like Program 1, pressing any key when a plot is complete clears the screen and brings another prompt.

Experiment

I hope these programs encourage you to look further into the fascinating world of fractals. Don't be afraid to experiment with the programs—try modifying the shape of the generator in Program 3, for example. Better yet, design your own generator.

These programs just begin to explore the possibilities of fractal computer graphics. There is another whole class of fractals, those generated by functions of complex variables. And then there are three-dimensional fractals. And then...

Figure 2: Generator, Program 3



Values For Program 3

Segment Number SN	Relative Direction RD	Length Factor LN	Side Flag SD
0	0	1/3	0
1	0	1/3	1
2	7	$\sqrt{1/3}$	1
3	10	1/3	0
4	0	1/3	0
5	2	1/3	0
6	2	1/3	1

Program 1: The Dragon Sweep

```
MH 9Ø DIM SN(14):KEY OFF
MN 1ØØ CLS:SCREEN Ø
PI 11Ø PRINT"ENTER AN EVEN NO. O
       F CYCLES (2 TO 14)"
DD 12Ø INPUT"              OR ENTER
       A ZERO TO QUIT: ";NC
EH 13Ø IF NC = Ø THEN KEY ON:END
MO 14Ø IF NC MOD 2 = 1 OR NC < 2
        OR NC > 14 THEN 1ØØ
DL 15Ø L=128:FOR C=2 TO NC STEP
       2:L=L/2:NEXT
AE 16Ø X=192:Y=133:CLS:SCREEN 2:
       PSET (X,Y),1
DL 17Ø FOR C=Ø TO NC:SN(C)=Ø:NEX
       T
KJ 18Ø D=Ø:FOR C=1 TO NC:IF SN(C
       -1)=SN(C) THEN D=D-1:GOTO
        2ØØ
GC 19Ø D=D+1
BP 2ØØ IF D=-1 THEN D=7
MI 21Ø IF D=8 THEN D=Ø
NC 22Ø NEXT
OA 23Ø IF D=Ø THEN X=X+L+L:GOTO
       27Ø
EM 24Ø IF D=2 THEN Y=Y+L:GOTO 27
       Ø
GA 25Ø IF D=4 THEN X=X-L-L:GOTO
       27Ø
GM 26Ø Y=Y-L
PL 27Ø LINE -(X,Y),1:SN(NC)=SN(N
       C)+1
QP 28Ø FOR C=NC TO 1 STEP -1:IF
       SN(C)<>2 THEN 3ØØ
OH 29Ø SN(C)=Ø:SN(C-1)=SN(C-1)+1
       :NEXT
GA 3ØØ IF SN(Ø)=Ø THEN 18Ø
MM 31Ø IF INKEY$="" THEN 31Ø
AC 32Ø GOTO 1ØØ
```

Program 2: Eight Thousand Dragons

```
PP 1ØØ DEF SEG:CLEAR,&H3FFØ:N=&H
       4ØØØ
LL 11Ø READ A$:IF A$="/" THEN 13
       Ø
LI 12Ø POKE N,VAL("&H"+A$):N=N+1
       :GOTO 11Ø
OC 13Ø N=&H44ØF:FOR K=1 TO 15:PO
       KE N,Ø:N=N+1:NEXT
NH 14Ø POKE &H4425,Ø
IF 15Ø N=&H4ØØØ:CALL N:POKE &H44
       25,1
EA 16Ø A$=INKEY$:IF A$="" THEN 1
       6Ø
PI 17Ø IF A$=" " THEN 15Ø
ID 18Ø IF A$<>"Q" AND A$<>"q" TH
       EN 16Ø
IH 19Ø SCREEN Ø:CLS:KEY ON:END
EI 1ØØØ DATA 1E,ØE,1F,B8,Ø5,ØØ,C
        D,1Ø,8Ø,3E
DN 1Ø1Ø DATA 25,44,ØØ,75,ØB,B4,Ø
        Ø,CD,1A,89
NF 1Ø2Ø DATA 16,23,44,EB,31,9Ø,B
        E,Ø2,ØØ,B9
OE 1Ø3Ø DATA Ø8,ØØ,A1,23,44,33,D
        2,A9,Ø2,ØØ
JE 1Ø4Ø DATA 74,Ø2,B2,Ø1,A9,Ø4,Ø
        Ø,74,Ø2,B6
NG 1Ø5Ø DATA Ø1,32,D6,DØ,EA,D1,D
        8,E2,E8,A3
BJ 1Ø6Ø DATA 23,44,24,Ø1,88,84,Ø
        F,44,46,83
FH 1Ø7Ø DATA FE,ØF,75,D3,B8,ØØ,Ø
        6,33,C9,BA
LI 1Ø8Ø DATA 4F,18,32,FF,CD,1Ø,B
        9,ØF,ØØ,33
NJ 1Ø9Ø DATA F6,C6,84,ØØ,44,ØØ,4
        6,E2,F8,C7
JD 11ØØ DATA Ø6,1E,44,6Ø,ØØ,C7,Ø
        6,2Ø,44,84
HF 111Ø DATA ØØ,B8,Ø1,ØC,8B,ØE,1
        E,44,8B,16
DC 112Ø DATA 2Ø,44,CD,1Ø,C6,Ø6,2
        2,44,ØØ,B9
LO 113Ø DATA ØE,ØØ,33,FF,BE,Ø1,Ø
        Ø,8A,A5,ØF
KC 114Ø DATA 44,8Ø,FC,ØØ,75,18,F
        E,Ø6,22,44
CL 115Ø DATA 8A,85,ØØ,44,3A,84,Ø
        Ø,44,75,2Ø
LG 116Ø DATA FE,ØE,22,44,FE,ØE,2
        2,44,EB,16
OD 117Ø DATA FE,ØE,22,44,8A,85,Ø
        Ø,44,3A,84
HK 118Ø DATA ØØ,44,75,Ø8,FE,Ø6,2
        2,44,FE,Ø6
DC 119Ø DATA 22,44,8Ø,3E,22,44,F
        F,75,Ø7,C6
HN 12ØØ DATA Ø6,22,44,Ø7,EB,ØC,8
        Ø,3E,22,44
NN 121Ø DATA Ø8,75,Ø5,C6,Ø6,22,4
        4,ØØ,47,46
FE 122Ø DATA E2,AB,EB,Ø2,EB,9A,8
        Ø,3E,22,44
CH 123Ø DATA ØØ,75,Ø6,FF,Ø6,1E,4
        4,EB,1E,8Ø
KP 124Ø DATA 3E,22,44,Ø2,75,Ø6,F
        F,Ø6,2Ø,44
IG 125Ø DATA EB,11,8Ø,3E,22,44,Ø
        4,75,Ø6,FF
CO 126Ø DATA ØE,1E,44,EB,Ø4,FF,Ø
        E,2Ø,44,B8
ID 127Ø DATA Ø1,ØC,8B,ØE,1E,44,8
        B,16,2Ø,44
LL 128Ø DATA CD,1Ø,FE,Ø6,ØE,44,B
        F,ØD,ØØ,BE
KL 129Ø DATA ØE,ØØ,B9,ØE,ØØ,8Ø,B
        C,ØØ,44,Ø2
PI 13ØØ DATA 75,ØD,C6,84,ØØ,44,Ø
        Ø,FE,85,ØØ
FM 131Ø DATA 44,4F,4E,E2,EC,8Ø,3
        E,ØØ,44,ØØ
OK 132Ø DATA 75,Ø2,EB,9C,1F,CB,/
```

Program 3: The Snowflake Sweep

```
DE 1Ø DIM DX(11),DY(11):KEY OFF
MC 2Ø FOR N = Ø TO 6:READ SD(N),
      RD(N):LN(N)=1!/3!:NEXT:LN(
      2)=SQR(LN(1))
LC 3Ø A=Ø:FOR D=6 TO 11:DX(D)=CO
      S(A):DY(D)=SIN(A)
JN 4Ø A=A+.52359879#:NEXT
CK 5Ø FOR D=Ø TO 5:DX(D)=-DX(D+6
      ):DY(D)=-DY(D+6):NEXT:X1=5
      34:Y1=147:TL=324
OG 6Ø CLS:SCREEN Ø
AB 7Ø PRINT"ENTER NUMBER OF CYCL
      ES ( 1 - 4 )"
GK 8Ø INPUT "            OR ENTER A
      ZERO TO QUIT: ";NC
JA 9Ø IF NC = Ø THEN END
DA 1ØØ IF NC > 4 THEN 6Ø
OP 11Ø CLS:SCREEN 2
CL 12Ø X=534:Y=147:TL=324:PSET (
       X,Y),1
CD 13Ø FOR C=Ø TO NC:SN(C)=Ø:NEX
       T
MI 14Ø D=Ø:L=TL:NS=Ø:FOR C=1 TO
       NC:I=SN(C):L=L*LN(I):J=SN
       (C-1):NS=NS+SD(J):IF NS M
       OD 2 = 1 THEN D=D+12-RD(I
       ):GOTO 16Ø
GE 15Ø D=D+RD(I)
EG 16Ø D = D MOD 12
OL 17Ø NEXT
BN 18Ø X=X+1.33*L*DX(D):Y=Y-.5*L
       *DY(D):LINE -(X,Y),1:SN(N
       C)=SN(NC)+1:FOR C = NC TO
        1 STEP -1:IF SN(C) <> 7
       THEN 2ØØ
OG 19Ø SN(C)=Ø:SN(C-1)=SN(C-1)+1
       :NEXT
AH 2ØØ IF SN(Ø)=Ø THEN 14Ø
KE 21Ø IF INKEY$="" THEN 21Ø
PD 22Ø GOTO 6Ø
AF 23Ø DATA Ø,Ø,1,Ø,1,7,Ø,1Ø,Ø,Ø
       ,Ø,2,1,2
```

©

Commodore ML Saver

Buck Childress

This short, useful program saves any machine language program directly from memory into a disk or tape file. It works on any Commodore 64 or 128 (in 64 mode).

There are many useful machine language (ML) utilities available in public domain collections, on computer bulletin boards, and in publications like COMPUTE!. The most common way to place an ML program in memory is with a BASIC loader—a BASIC routine which READs the necessary values from DATA statements and POKEs them into memory. That method is fine for short ML programs, but can involve quite a delay when the ML program is long. It takes time, first of all, to load the BASIC loader. Then there's another wait while it POKEs everything into memory.

A much faster technique is to load the ML from disk or tape directly into memory. The only problem is making the tape or disk file. Machine language monitors such as Supermon can save any ML program directly from memory. But if you don't have a monitor, or don't know how to use one, that's not a viable option, either.

A Better Way

"ML Saver" is a short BASIC utility that can save any machine language program on disk or tape directly from where it resides in memory. After you type in and save ML Saver, load and run the program that creates the ML code you want to save. Make a note of the starting and ending addresses. If the ML is POKEd into memory with a FOR-NEXT loop, these addresses usually appear in the loop itself. For instance, if the loop is FOR J=49152 to 51000:READ Q:POKE J,Q:NEXT then you know the starting address is 49152 and the ending address is 51000. Now check the SYS address used to activate the program. This is usually the same as the starting address (for example, SYS 49152), but some programs are activated by jumping to an address somewhere in the middle of the code.

Once you have this information, you're ready to load and run ML Saver. The program asks you for the name you want to save the ML program under: Enter any name up to eight characters in length (extra characters are ignored). After you've supplied the name, enter D to save to disk or T for tape. Then enter the starting and ending addresses you wrote down earlier. ML Saver proceeds to save the ML code.

After the file has been created, you can load it with LOAD"*filename*",8,1 for disk or LOAD"*filename*",1,1 for tape (of course, you should replace *filename* with the filename you used when saving the program). Then SYS to the correct address to activate the program. To do this under program control, put the following statements at the beginning of your program:

```
10 IF J=1 THEN 30
20 J=1:LOAD"filename",8,1
30 REM PROGRAM CONTINUES HERE
```

When you run a program containing these lines, the variable J equals 0, so the computer falls through the IF test in line 10 and performs line 20. This line sets J to a nonzero value and loads the ML. After the load is complete, the computer automatically reruns the program beginning at line 10, but does not erase previously established variables. This time around, J equals 1, so the computer skips line 20 and proceeds with line 10. ©

Commodore ML Saver

For instructions on entering this listing, please refer to "The New Automatic Proofreader for Commodore" in this issue of COMPUTE!.

```
FE 10 INPUT"{CLR}{DOWN}PROGRAM
       NAME";PN$:IFLEN(PN$)>8T
      HENPN$=LEFT$(PN$,8)
JC 40 FORJ=1TOLEN(PN$):POKE203
      9+J,ASC(MID$(PN$,J,1)):N
      EXTJ
AM 50 PRINT"{DOWN}{RVS}D{OFF}I
      SK OR {RVS}T{OFF}APE? ";
GH 60 GETA$:IFA$=""THEN60
HC 70 IFA$="D"THENDEVICE=8:GOT
      O100
EC 80 IFA$="T"THENDEVICE=1:GOT
      O100
FH 90 GOTO60
EC 100 PRINTA$:POKE780,15:POKE
       781,DEVICE:POKE782,255:
       SYS65466
DB 110 POKE780,LEN(PN$):POKE78
       1,248:POKE782,7:SYS6546
       9
FK 120 INPUT"{DOWN}BEGINNING A
       DDRESS";BA
XA 130 HI=INT(BA/256):LO=BA-(H
       I*256)
MS 140 POKE251,LO:POKE252,HI
PP 150 INPUT"{DOWN}ENDING ADDR
       ESS";EA
SJ 160 HI=INT(EA/256):LO=EA-(H
       I*256)+1
PF 170 POKE780,251:POKE781,LO:
       POKE782,HI
RF 180 PRINT"{DOWN}SAVING ML V
       ERSION OF ";PN$
KX 190 SYS65496:END            ©
```

Loading And Linking Commodore Programs
Part 1

Jim Butterfield, Associate Editor

This series covers the ins and outs of loading, chaining, and overlaying programs on Commodore computers.

The LOAD command seems easy enough to understand: It brings a program into memory from disk or tape. But it has special features and pitfalls. And when you cause one program to load another program, you enter the special field of chaining, overlaying, and bootstrapping. Let's take a close look at all of these operations, beginning with the LOAD command.

LOAD performs some subtle tasks, including relocating a program if necessary and a delicatȩ job called relinking. There are special rules that apply when you load a program that was saved on a different type of Commodore computer. In fact, it sometimes works better to forget about LOAD and use a different technique. And the LOAD command behaves differently when executed by a program than it does when you enter it directly from the keyboard.

Most of the principles we'll cover in this series apply to programs stored on both disk and tape. It's easier to give examples that apply to disk systems, mostly because of the simplicity of setting up demonstration files. But you can still learn a lot about LOAD even if you don't have a disk drive.

What LOAD Does

When a LOAD command is executed, the following things happen:

- A PRG (PRoGram-format) file is brought into memory. *Program* is just the name for a certain type of file. The material contained in the file doesn't need to be a program. It could be a block of data, a screen, a character set, or anything.
- If the LOAD command doesn't specify nonrelocation, the information is normally *relocated.* That is, no matter what memory location it was saved from, it's loaded into memory beginning at the start of BASIC program space. PET/CBM computers are an exception to this rule: They never relocate programs. There's also a special cassette format available on VIC-20 and Commodore 64 computers which forces nonrelocation. (Unfortunately, this format is not easy for the beginner to create.)
- If the LOAD command specifies nonrelocation, the information is placed in memory at the same addresses from which it was saved. This is generally done by adding ,1 at the end of the LOAD command. For example, LOAD "PROG",8 loads the file PROG from disk and relocates it in memory, but LOAD"PROG",8,1 loads without relocating.
- If there were no errors during the load, the reserved variable ST is set to 0 (for tape) or 64 (for disk). It's often a good idea to check ST after loading. You can't rely on BASIC to catch every conceivable load error, particularly with tape. If you're using a disk drive, it's a good idea to check the drive status or at least see if the red error light is flashing.
- After the load is complete, the program is relinked (more about relinking in a moment).
- If the LOAD command was issued in direct mode (from the keyboard), all variables are cleared and the BASIC start-of-variables pointer is set to the first byte past the last byte that was loaded.
- If the LOAD command was issued by a program, variables are not cleared and the program automatically reruns from the beginning. This creates powerful opportunities, but requires some special handling to work correctly.

After a load is finished, what ends up in the computer's memory isn't quite the same as what you originally typed on the keyboard. For one thing, keywords are *tokenized*—compressed into single-byte values. When you type in the letters P-R-I-N-T, the BASIC word PRINT is "crunched" together into a single byte which the computer recognizes as PRINT. And the picture is further complicated because different Commodore computers use slightly different tokenizing schemes (we'll return to this point a bit later).

Relinking

When a BASIC program is in memory, each program line is linked to the next line by a chain of pointers (often called *line links*). At the start of each line there's a two-byte pointer that shows where the next line starts. The end of the program is marked by a pointer that consists of two zeros.

What's the purpose of the chain? When the computer runs a program, there are many times when it needs to find a line number quickly—to execute a GOTO or GOSUB, for example. Rather than wade through every character of every line, it can skip from one link to the next until it finds the line it needs.

Each two-byte pointer shows the actual memory address where the next line begins, and these links are saved with the program. After a relocating load, which may bring the program into a different memory area, the pointers may point to the wrong locations. To fix everything up, the computer automatically *relinks* every line in the program after loading it into memory.

Relinking is a simple job. The computer scans through each program line, looking for the zero byte that marks the end of that line. As soon as it finds this address, the computer knows where the next line begins—at the next byte past the first line's end. It then rewrites the link for the first line and leaps ahead to repeat the process.

Relinking Problems

Two things can go wrong during the relinking process. If you load a chunk of data that doesn't contain any zero bytes, the computer can't find any end-of-line markers and won't be able to relink at all. The second difficulty is fortunately quite obscure: There's a model of computer called the B system in North America and the 700 series in Europe. The most well-known model in the USA is the B128 (not to be confused with the Commodore 128), but the comments here apply to all B and 700 models. When you save a BASIC program from these computers, the program is stored in an unusually low memory address. Because the saved program contains zeros in unexpected places, other Commodore computers can't make any sense of the chain.

Let's create an unlinkable file. If you have a disk drive, enter the following statements in direct mode (without line numbers), pressing RETURN after each line:

```
OPEN 8,8,8,"0:CRASHER,P,W"
PRINT#8,CHR$(1);CHR$(4);
FOR J=1 TO
300:PRINT#8,CHR$(4);:NEXT
CLOSE 8
```

Don't forget to put a semicolon at the end of each of the two PRINT# statements.

IF you LOAD "CRASHER",8 the computer prints LOADING and READY, but the cursor doesn't return. It's stuck in an endless loop, looking for the nonexistent zero that marks the end of the first BASIC line. This kind of crash is fairly common on cassette systems, when a bad load fills memory with garbage. It can also occur with disk if you forget to add ,1 to a LOAD command that requires relocation, loading something odd like a screen image into the BASIC program area. You can usually recover control by pressing RUN/STOP–RESTORE and entering NEW.

Before we look at a solution to the second problem, let's talk about another area where incompatibility arises between machines.

LOAD Address Incompatibility

PET/CBM computers can't relocate programs at all. On a PET/CBM, BASIC program space starts at location 1025. Most other Commodore computers use a different address, meaning that the PET/CBM can't load programs saved on those computers. The program following this article is a converter to solve both of these problems. You'll need a disk drive to use it.

The new file created by the program is loadable by any eight-bit Commodore computer. Since it sets the load address to 1025, PET/CBM computers can load it properly (all other models relocate it automatically). To make B128 program files usable by other computers, it puts dummy link bytes (both containing a 1) at the beginning of each line. Remember, all these computers relink programs automatically, so this problem can be solved by putting any nonzero values in the links.

This program works only with BASIC programs, since it stops at the two zero bytes that mark the end of the program. If there's something more "pasted" onto the end of the BASIC text—a machine language routine, for example—it will not be copied.

Alternative Method

If you have access to the type of computer which generated the original program, there's an easier way to do the same thing. You can make a Commodore 64 emulate the memory configuration of another machine so BASIC programs are kept in a more compatible part of memory. If you move the start of BASIC to location 1025, the links will be more conventional and the program will be PET-compatible.

To make the area at 1025 available for BASIC, we'll also need to relocate the screen to a new area. To fit the following commands onto two screen lines, you can abbreviate PRINT as ? and POKE as P SHIFT-O:

```
POKE56576,5:POKE 53272,4:POKE648,128
 :POKE1024,0:POKE44,4:POKE56,128
 :PRINTCHR$(147):NEW
```

The first three POKEs move the screen. The next three move the start and end of the BASIC area, and the last two commands clear the new screen and set up the new BASIC work area.

Once you've entered the above commands, your Commodore 64 emulates a PET/CBM's BASIC configuration. You may now convert a BASIC program into compatible format by loading it into the reconfigured machine and saving it again. By using this load/save sequence, you're making several things happen. When you load the program, it's relocated into a new area. The chain links are then rebuilt to be compatible with the new memory space. When you save, the newly relocated program—complete with new links—is placed on disk or tape.

The modified program seems the same, but it now has a "universal" style. Whether you created it with the Converter program below or with the POKEs and LOAD/SAVE sequence, it can now be loaded into any eight-bit Commodore machine. Its addresses are directly compatible with the PET/CBM, and other machines will relocate the program as it loads. And we've eliminated the possibility of the peculiar B128 chain that confuses other Commodore computers.

Incompatible Tokens

Some programs won't transfer from one machine to another because of differences in the BASIC tokens. You'll have little trouble with commonly used commands such as PRINT and IF. The difference comes with more advanced commands that aren't part of every version of Commodore BASIC. If you write a program in CBM BASIC 4.0 and use commands like DLOAD and SCRATCH, don't be surprised to find that it doesn't run properly on a Commodore 64. Those commands don't exist in the 64's BASIC.

You might also be surprised to find that a Plus/4 or Commodore 128 (in 128 mode) can't run the PET/CBM program either, even though both of those machines have DLOAD and SCRATCH commands. Why not? The commands are there, but they're represented by different token values.

In such cases, you can't use LOAD and SAVE at all. What you'll have to do is detokenize the program by LISTing it to a disk file, then bring it back into memory with a "merge" method like the one described in "Commodore Dynamic Keyboard, Part 3" (COMPUTE!, December 1985).

We've only scratched the surface of the many uses of the LOAD command. When we start to look into chaining, overlaying, and reloading techniques, we'll discover that the LOAD command has amazing potential.

Commodore Program Converter

For instructions on entering this listing, please refer to "The New Automatic Proofreader for Commodore" published in this issue of COMPUTE!.

```
CA 11Ø  OPEN15,8,15
QA 12Ø  INPUT "NAME OF PROGRAM"
        ;N$
JA 13Ø  OPEN 2,8,2,"Ø:"+N$+",P,
        R"
KH 14Ø  INPUT#15,E,E$,E1,E2:IF
        {SPACE}E THEN PRINT E$:
        STOP
JC 15Ø  INPUT"NAME OF CONVERTED
         PROGRAM";C$
BG 16Ø  OPEN3,8,3,"Ø:"+C$+",P,W
        "
RF 17Ø  INPUT#15,E,E$,E1,E2:IF
        {SPACE}E THEN PRINT E$:
        STOP
JQ 18Ø  Z$=CHR$(Ø)
FA 19Ø  REM:READ LOAD ADDRESS
FX 2ØØ  GET#2,A$,B$
DC 21Ø  PRINT#3,CHR$(1);CHR$(4)
        ;
SR 22Ø  REM:READ CHAIN
CB 23Ø  GET#2,A$,B$
SS 24Ø  IF LEN(A$)+LEN(B$)=Ø GO
        TO 37Ø
GA 25Ø  PRINT#3,CHR$(1);CHR$(1)
        ;
CH 26Ø  REM: READ LINE NUMBER
QG 27Ø  FOR J=1 TO 2
HK 28Ø  GET#2,A$:IF A$="" THEN
        {SPACE}A$=Z$
HQ 29Ø  PRINT#3,A$;
HJ 3ØØ  NEXT J
FE 31Ø  REM:READ LINE
JP 32Ø  GET#2,A$:IF A$="" THEN
        {SPACE}A$=Z$
ES 33Ø  PRINT#3,A$;
SD 34Ø  IF A=Z$ GOTO 23Ø
DJ 35Ø  GOTO 32Ø
QB 36Ø  REM:WIND UP FILES
EJ 37Ø  INPUT#15,E,E$,E1,E2: IF
          E THEN PRINT E$:STOP
AX 38Ø  PRINT#3,Z$;Z$;
JF 39Ø  CLOSE 3
JE 4ØØ  CLOSE 2
FF 41Ø  CLOSE 15
```

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Atari P/M Graphics Toolkit

Tom R. Halfhill, Editor

If you're mystified by Atari player/missile graphics, this article is for you. With help from a toolkit of routines written in BASIC and machine language, you'll soon be writing your own programs that move shapes of your own design anywhere on the screen quickly and easily. For all 400/800, XL, and XE computers with Atari BASIC.

It's safe to say that no feature on Atari computers is as exciting and as frustrating as player/missile graphics.

Exciting: P/M graphics provides four larger objects called players and four smaller objects called missiles which can be displayed in almost any shape or color and animated on the screen. You can even achieve 3-D effects by making the objects pass above and beneath background graphics and each other.

Frustrating: Atari BASIC has no special commands for using P/M graphics, standard Atari manuals don't cover P/M graphics, you can't set up P/M graphics in a program without worrying about lots of POKEs and protecting memory, and Atari BASIC lacks a straightforward way to move a P/M object vertically or diagonally at speeds faster than a crawl. Furthermore, there's no easy method of designing player shapes without scribbling on graph paper and adding up binary bit values of bytes.

"Atari P/M Graphics Toolkit" solves all these problems and more. It's a package of routines written in BASIC and machine language that can form the core of your own programs. With the Toolkit, you can easily design your own shapes with a joystick, then write simple BASIC programs that automatically set up P/M graphics and instantly move your objects anywhere on the screen.

You've probably used or heard of similar programs in other magazines and books. In fact, several popular routines for animating P/M graphics appeared in early issues of COMPUTE! and are reprinted in various COMPUTE! books. But the P/M Graphics Toolkit offers these advantages:

Special Features

- The Toolkit setup/animation routine creates a true X-Y coordinate system for moving P/M objects to any horizontal-vertical position on the screen. This system is patterned after the X-Y coordinates in Atari BASIC graphics modes, so if you know how to use the PLOT, DRAWTO, LOCATE, or POSITION commands, you should have no trouble animating P/M objects with the Toolkit.

- A machine language subroutine automatically clears out the P/M memory area in a flash, so your programs initialize faster.

- The Toolkit routines work in single-resolution or double-resolution P/M graphics modes, and in any screen graphics mode.

- Unlike most other programs of this type, the Toolkit lets you move any of the four missile objects as easily as any of the four players.

- The Toolkit allows you to instantly change the shape or size of a P/M object by selecting from any number of previously designed shapes—even while the object is moving.

- Because all of its machine language is written to be completely relocatable, you can add the Toolkit setup/animation routine to any BASIC program without fear of memory conflicts with other ML routines you may be using.

- Best of all, using the Toolkit is a snap. Once the Toolkit setup/animation routine is added to your program, initializing P/M graphics requires only one line of BASIC, and all of the animation and shape-flipping can be done with just a single BASIC statement.

Getting Started

All of these features are contained in the setup/animation routine listed below as Program 1. This will be the basic building block of your own programs, so the line numbers start at 20000 to leave plenty of room for your own lines.

Be sure to type in Program 1 using COMPUTE!'s "Automatic Proofreader" utility, because the DATA statements in lines 20170–20590 are extremely critical—they encode the machine language for two ML subroutines. When you're done, store Program 1 on disk or tape with the LIST command, not SAVE or CSAVE:

```
LIST"D:filename.ext" for disk
LIST"C:" for cassette
```

This way, you can use the ENTER command (ENTER"D:*filename.ext*" or ENTER"C:") to merge the routine with another program already in memory, as we'll demonstrate in a moment.

A Single-Line Setup

To create a program that uses player/missile graphics, you only have to call this routine once. The call should be as near to the beginning of your program as possible; the first line is ideal. Here's the proper format:

```
10 GRMODE=0:PMMODE=1:GOSUB
  20050
```

Set the variable GRMODE to whatever graphics mode you desire. Any valid number or expression you'd use with the GRAPHICS statement will work. In the above example, we're asking the Toolkit routine to set up GRAPHICS 0. Set the variable PMMODE to the player/missile graphics mode you want: either 1 for single-line resolution or 2 for double-line resolution. (If you aren't familiar with P/M modes, see "Atari Animation with P/M Graphics," a three-part series beginning in the September 1985 issue of COMPUTE!. Even though the Toolkit routines automatically perform the memory allocation and animation chores discussed in this series, I strongly recommend acquiring some background on P/M graphics.)

The third statement in the sample line above actually calls the Toolkit setup/animation routine. Notice that it GOSUBs to line 20050 instead of 20000. Lines 20000–20040 are REM statements, and it's good programming practice to avoid a GOSUB or GOTO reference to a REM because some people delete REM statements from programs to save memory.

When you call the routine in this manner, there will be a pause of several seconds as it loads the machine language into memory. Then, in rapid sequence, the routine automatically protects the right amount of memory for the P/M mode you requested; instantly clears out any old data in that memory area; performs all the POKEs necessary to set up P/M graphics; assigns colors to all four players and missiles; and switches to the graphics mode you requested. In other words, it does all of the dirty work for you.

When the Toolkit routine is finished, a RETURN statement passes control back to whatever line follows the GOSUB. That's where the rest of your program should continue. Be sure to place an END statement at the end of your own program lines, but before line 20000, so the Toolkit routine doesn't accidentally execute more than once.

If you want to change the player colors from the colors assigned by the Toolkit routine, POKE your own color values into locations 704–707.

PMMOVE Magic

After this simple setup, all it takes is one BASIC statement to move any player or missile anywhere on the screen. Here's the format:

```
A=USR(PMMOVE,PLAYER#,SHAPE
,SIZE,X,Y)
```

Let's take a look at these parameters one at a time. We'll follow with a few examples.

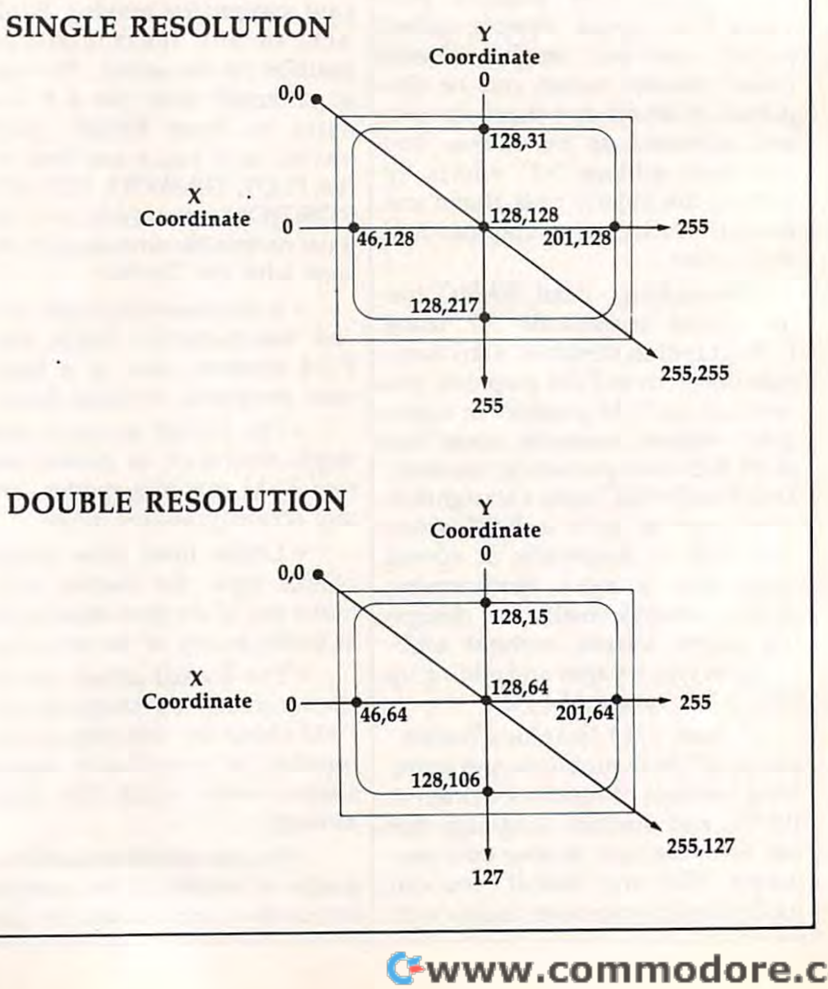
The variable A is a dummy variable required by the USR statement—with this routine, it returns no useful value. PMMOVE is the address of the machine language subroutine, and its value is automatically set when your program executes the GOSUB 20050 described above. (PMMOVE is actually the address of PMMOVE$, a string which holds the ML data.) Don't change the value of PMMOVE unless you enjoy watching your computer crash.

The remaining five parameters are under your control. You must assign values to these parameters yourself and always include them when calling the PMMOVE routine.

PLAYER# should be a number from 1 to 8 that specifies which P/M object will be affected by the statement. Numbers 1 to 4 specify the four players, and numbers 5 to 8 specify the four missiles.

SHAPE is the address of the shape data for the player or missile. The best way to use this parameter is to specify the address of a string which contains previously created shape data. For background on designing player shapes, see Part 2 of the three-part series mentioned above. In a moment, we'll discuss a Toolkit utility that lets you design your own shapes with a joystick and which calculates the shape data for you. The SHAPE parameter, incidentally, is what allows players to flip between different shapes even

PMMOVE SCREEN COORDINATES



SINGLE RESOLUTION

DOUBLE RESOLUTION

while they're moving. Each time you move a player or missile, the PMMOVE subroutine erases the object's entire memory area and replaces it with the new image you select with the SHAPE parameter. If you don't quite follow this explanation, the example programs will clarify things.

SIZE is the height of the player or missile in bytes. If the shape data referred to by SHAPE consists of eight bytes, you'd insert an 8 for this parameter. This makes it possible to store the data for numerous player shapes in a single string, then select just the shape you want by pointing SHAPE to its position within the string and specifying the substring's length with SIZE. Again, the example programs will demonstrate this technique.

The final two parameters determine the new position of the player or missile on the screen. X is the horizontal coordinate and Y is the vertical coordinate. Like the screen coordinates used by BASIC graphics commands such as PLOT and DRAWTO, position 0,0 refers to the upper-left corner. As the X coordinate increases, the P/M object moves from left to right; as the Y coordinate increases, the object moves from top to bottom. X values can range from 0 to 255. Y values can range from 0 to 255 in single-resolution P/M graphics or 0 to 128 in double-resolution P/M graphics. If the X or Y values exceed these ranges, the object eventually "wraps around" to the opposite side of the screen. But if you specify an X or Y value which is less than 0, an error results.

The accompanying figure shows the layout of these coordinates. Notice how some positions are off the visible screen area. A quick way to make an object disappear is to move it to one of these "invisible" positions. (Another way is to specify 0 for the SIZE parameter.)

Frame Flipping

Now for the fun stuff. The following examples show some typical ways to use the PMMOVE statement in your own programs.

Program 2 demonstrates how to store a player shape in a string. After typing Program 2, LIST it to disk or tape, then merge it in memory with Program 1 by using the ENTER command. When you type RUN, there's a pause as everything sets up, then a player in the form of a smiling face appears in the center of the screen. Here's how it works:

Line 10 calls the Toolkit setup routine (Program 1), specifying single-resolution P/M and graphics mode 0. Line 20 dimensions the string variable SHAPE$ to hold 11 characters, the size of the player (11 bytes tall). Next it uses BASIC's ADR function to set the variable SHAPE to the address of SHAPE$, and sets SIZE to 11. Then it uses a FOR-NEXT loop to read the 11 bytes of shape data in line 40 into SHAPE$.

Finally, the PMMOVE statement in line 30 makes the player appear at position 127,127 (the centerpoint in single-res P/M graphics). Note that the PLAYER# parameter is 1; simply by changing this number to 2, 3, or 4, you can display any of the other players using the same shape data—try it. (By the way, you should press SYSTEM RESET before rerunning this or any other program that uses player/missile graphics. Otherwise, the reserved P/M memory keeps growing until it consumes all the RAM in your computer.)

The technique of storing player shape data in strings has some interesting applications. By storing several shapes in a single string and flipping rapidly between them, you can make your players come alive as they move about the screen. Even a static player can seem to move as its shape continuously changes, much like frame animation in a cartoon. To see an example, type in Program 3. LIST it to disk or tape, then merge it in memory with Program 1 using the ENTER command. When you type RUN, the program initializes for a few seconds, then displays a small explosion in the middle of the screen, hurling fragments in all directions. Yet, throughout this animated sequence, the player object never moves.

The secret is BOOM$, a 64-character string filled with eight player shapes in line 30. Each shape is eight characters long, as seen in the DATA statements in lines 90–160. The PMMOVE statement in line 60 rapidly flips through all eight shapes in sequence because it is sandwiched within the FOR-NEXT loop between lines 40 and 80. (The loop serves double duty; it also fades the explosion sound into silence.) Another FOR-NEXT in line 70 is a simple delay loop. To slow down the explosion sequence for a better idea of what's going on, change the 35 in line 70 to a larger number—say, 150. Also notice how the final player shape in this sequence consists of nothing but zeroes. This is another way of making the player object seem to disappear without moving it off the screen.

Whirling Dervishes

Another fascinating application of this technique is to design players which change shape depending on which direction they're moving. To see an example, type in Program 4. As before, LIST the program to disk or tape, then merge it with Program 1 using ENTER.

When you type RUN, a red tank appears in the center of the screen. The low rumble of an idling engine can be heard in the background. Plug a joystick into port 1, then try moving the stick right or left. Notice how the tank rotates clockwise or counterclockwise. In fact, it spins so fast it's almost a blur.

The player isn't actually rotating or moving, of course; it's simply changing shape many times per second, thanks to the SHAPE parameter of the PMMOVE routine. The secret, again, is a string (SHAPE$) which contains shape data for eight tank images, one for each of the eight possible directions. Lines 40–80 read the joystick and determine which image should be displayed.

Now push the joystick forward. The engine revs up and the tank obediently moves in the direction it is pointed. You can drive the tank all over the screen. To see how this works, study lines 90–190. Notice how the ON-GOTO statement in line 90 passes control to one of the lines from 120 to 190, depending on which direction the tank is oriented. Each of these lines either increments or decrements the X and

Y coordinates to move the tank in one of the eight possible directions.

Notice, too, how this entire program contains only the one PMMOVE statement in line 80—a single statement controls both the player's shape and its movement.

Stepping On The Gas

To make the tank move twice as fast, change lines 120–190 so the X and Y coordinates are incremented or decremented by 2 instead of 1. For still more speed, you can even change these values to 3. However, keep in mind that the movement is not quite as smooth as these step values are increased; the object seems to jerk along at higher speeds. A step value of 2 or 3 is a reasonable compromise between speed and loss of grace.

Try changing the PLAYER# parameter in the PMMOVE statement to 2, 3, or 4 to see the other players in action.

For an example of missile animation, merge Program 5 with both Program 1 and Program 4. These lines let the tank fire a shot when you press the joystick button. The direction routine is very similar to the one in Program 4; in fact, it uses the same variable (DIR) to figure out which way the tank is pointing.

Note how the missile shape defined in line 25 is only one byte long—CHR$(3). Unlike player objects, which are eight bits wide, missiles are only two bits wide. You can't design a very fancy shape with only two bits to work with, so most programs use the missiles for such tiny shapes as projectiles, bullets, etc. A single byte is enough to define a missile shape for these purposes. Since all four missiles share the same memory area as a single player, defining missile shapes is a little different than defining player shapes.

Rather than getting into a confusing discussion about missiles and bit manipulation, just remember this: The shape bytes for the four missiles (accessed as PLAYER# 5, 6, 7, and 8 in the PMMOVE statement) should be 3, 12, 48, and 192, respectively. For instance, the PMMOVE statements in lines 1100 and 1110 refer to the first missile, PLAYER# 5, so its shape data in MISSILE$ is a 3. If you want to move the second missile, change the PLAYER# parameter to 6 and the shape byte in line 25 to CHR$(12). If you want to move the third missile, change the PLAYER# parameter to 7 and the shape byte to CHR$(48). And if you want to move the fourth missile, change the PLAYER# parameter to 8 and the shape byte to CHR$(192). These shape bytes will work with missiles in any of your own programs.

Designing Player Shapes

As a final touch, the P/M Graphics Toolkit includes a small utility for designing your own players. It's not very elaborate, but it's better than scribbling on graph paper and counting up "on" bits and "off" bits in your head.

Like the other example programs, the shape utility is based on the Toolkit setup/animation routine. To prepare it, type in Program 6 and merge it with Program 1. SAVE or CSAVE a copy of the merged program so you won't have to repeat these steps each time you want to use the utility.

After typing RUN, select single- or double-resolution player/missile graphics by pressing 1 or 2. The utility spends a few moments initializing, then displays a grid of dots along the left side of the screen. A cursor is at the upper-left corner; it's controlled by a joystick plugged into port 1.

The grid represents a magnified view of an eight-bit-wide player strip, with one dot for each bit. Each horizontal row of eight dots, therefore, represents one byte of the player strip. Player strips are really 255 bytes tall in single resolution or 128 bytes tall in double resolution, but there isn't room to display a grid that large on the screen. Still, the grid is tall enough to design player shapes for most purposes.

To design a shape, just move the cursor anywhere on the grid and press the joystick button to set a bit. The dot changes to inverse video, and an actual-size player begins taking form in the blank area on the right side of the screen. Simultaneously, a number representing the byte value for that row of bits appears. Try moving the cursor and setting more bits; the byte values keep changing. To erase a bit that you've set, position the cursor on it and press the joystick button again. With each change, the byte values are updated along with the actual-size player.

When you're satisfied with a player shape, jot down the byte values. (You can ignore the zeroes, if any, above and below the shape.) These byte values represent the shape data for your player. To display the player in your own programs, just read the numbers into a string as demonstrated in Programs 2, 3, and 4. Use the address of this string as the SHAPE parameter in the PMMOVE statement. The number of shape bytes becomes the value for the SIZE parameter.

If you mess things up too badly when designing a player, you can erase the entire grid by pressing the E key.

This is a bare-bones utility, but it's enough to get you started and take the bothersome paperwork out of defining player shapes. If you want, you can add more features of your own—commands to change player colors; to shift bit patterns left, right, up, or down; to flip the pattern as a mirror image; to automatically generate DATA statements of player shape bytes; and so on.

A Bonus Routine

Both machine language subroutines used by the Toolkit are designed to be as crashproof as possible. If you accidentally pass the wrong number of parameters in a USR statement, the routines immediately clear all faulty values off the 6502 stack and bounce back to BASIC. So if you call the PMMOVE routine and nothing happens, check the USR statement to make sure you included all of the parameters and that the parameters have legal values.

You may find one of the Toolkit machine language routines useful in other types of programs as well. PAGCLR is a general-purpose routine that rapidly clears a specified number of memory pages with zeroes. For P/M graphics, this routine erases any garbage data that may be cluttering the reserved memory area. But it's handy for any program that needs to clear out a large amount of memory in a split-second.

The ML data for PAGCLR can be found in the DATA statements in Program 1 at lines 20160–20240. Line 20060 reads this data into the string PAGCLR$, previously DIMensioned to 48 characters. The variable PAGCLR is set to the address of PAGCLR$.

Here's the format for calling the PAGCLR routine:

A=USR(PAGCLR,ADDRESS,PAGES)

where PAGCLR is the address of the ML routine, ADDRESS is the starting address (in decimal) of the memory area you want to clear, and PAGES is the number of memory pages to clear (a page equals 256 bytes). For example, the last statement in line 20130 clears either 1,024 or 2,048 bytes starting at the memory address PMBASE, depending on whether the variable PAGES is set to 4 or 8 for double- or single-resolution P/M graphics.

Caution: Don't use the PAGCLR routine for other purposes unless you understand exactly how it works. If misdirected, it can wipe out massive amounts of memory in an instant and crash your computer.

For instructions on entering these listings, please refer to "COMPUTE!'s Guide to Typing In Programs" published in this issue of COMPUTE!.

Program 1: P/M Toolkit Setup Routine

```
HF 20000 REM *** PLAYER/MISS
         ILE SETUP ***
DD 20010 REM DEFINE PMMODE &
          GRMODE BEFORE CALL
         ING THIS ROUTINE
JE 20020 REM PMMODE=1 FOR SI
         NGLE-RES P/M
IP 20030 REM PMMODE=2 FOR DO
         UBLE-RES P/M
EL 20040 REM GRMODE=GRAPHICS
          MODE
BE 20050 DIM PAGCLR$(48),PMM
         OVE$(202):PAGCLR=AD
         R(PAGCLR$):PMMOVE=A
         DR(PMMOVE$)
HL 20060 MT=0:RESTORE 20170:
         FOR X=1 TO 48:READ
         A:PAGCLR$(X)=CHR$(A
         )
OA 20065 MT=MT+A:NEXT X:IF M
         T=7484 THEN MT=0:GO
         TO 20070
KO 20066 PRINT "ERROR IN DAT
         A... LINES 20170-20
         240":STOP
BF 20070 FOR X=1 TO 202:READ
          A:PMMOVE$(X)=CHR$(
         A):MT=MT+A:NEXT X
JE 20075 IF MT<>23367 THEN P
         RINT "ERROR IN DATA
         ... LINES 20260-205
         90":STOP
OF 20080 IF PMMODE=1 THEN PA
         GES=8:DMA=62:GOTO 2
         0110
OF 20090 IF PMMODE=2 THEN PA
         GES=4:DMA=46:GOTO 2
         0110
ND 20100 RETURN
MK 20110 POKE 54279,PEEK(106
         )-PAGES:POKE 106,PE
         EK(106)-PAGES:POKE
         207,PMMODE
AE 20120 GRAPHICS GRMODE
OM 20130 PMBASE=PEEK(106)*25
         6:POKE 559,DMA:POKE
          53277,3:X=USR(PAGC
         LR,PMBASE,PAGES)
PN 20140 POKE 704,68:POKE 70
         5,78:POKE 706,88:PO
         KE 707,98:REM P/M C
         OLORS
NI 20150 RETURN
EJ 20160 REM PAGCLR ML DATA
NO 20170 DATA 104,201,2,240,
         16,133
CA 20180 DATA 206,162,0,228,
         206,208
PD 20190 DATA 1,96,104,104,2
         32,169
AM 20200 DATA 0,240,244,104,
         133,204
GN 20210 DATA 104,133,203,10
         4,104,133
CE 20220 DATA 205,169,0,168,
         170,145
HB 20230 DATA 203,200,208,25
         1,230,204
FL 20240 DATA 232,228,205,20
         8,244,96
GE 20250 REM PMMOVE ML DATA
OC 20260 DATA 104,201,5,240,
         18,141
OJ 20270 DATA 0,4,162,0,236,
         0
IK 20280 DATA 4,208,1,96,104
         ,104
BO 20290 DATA 232,169,0,240,
         243,104
LD 20300 DATA 104,201,9,144,
         9,104
GK 20310 DATA 104,104,104,10
         4,104,104
LA 20320 DATA 104,96,24,201,
         0,240
LA 20330 DATA 242,141,4,4,10
         4,133
HE 20340 DATA 206,104,133,20
         5,104,104
KP 20350 DATA 141,5,4,104,10
         4,141
EK 20360 DATA 2,4,104,104,14
         1,3
PH 20370 DATA 4,174,4,4,173,
         2
MG 20380 DATA 4,157,255,207,
         224,5
GC 20390 DATA 176,2,144,5,16
         9,0
LC 20400 DATA 141,4,4,165,20
         7,201
LI 20410 DATA 2,240,28,165,1
         06,24
FA 20420 DATA 105,3,109,4,4,
         133
CA 20430 DATA 204,169,0,133,
         203,168
HO 20440 DATA 145,203,200,20
         8,251,173
ID 20450 DATA 3,4,133,203,24
         ,144
LN 20460 DATA 65,165,106,24,
         105,1
IH 20470 DATA 133,204,169,12
         8,133,203
IJ 20480 DATA 173,4,4,240,21
         ,162
ON 20490 DATA 0,165,203,24,1
         05,128
BB 20500 DATA 133,203,165,20
         4,105,0
LF 20510 DATA 133,204,232,23
         6,4,4
BO 20520 DATA 208,237,160,0,
         152,145
IG 20530 DATA 203,200,192,12
         7,208,249
LK 20540 DATA 173,3,4,201,12
         8,144
OF 20550 DATA 1,96,101,203,1
         33,203
BI 20560 DATA 165,204,105,0,
         133,204
FA 20570 DATA 160,0,204,5,4,
         240
CE 20580 DATA 8,177,205,145,
         203,200
KF 20590 DATA 24,144,243,96
```

Program 2: Player Shape Demo

```
KH 10 PMMODE=1:GRMODE=0:GOSU
      B 20050
JL 20 DIM SHAPE$(11):SHAPE=A
      DR(SHAPE$):SIZE=11:RES
      TORE 40:FOR X=1 TO 11:
      READ A:SHAPE$(X)=CHR$(
      A):NEXT X
ON 30 A=USR(PMMOVE,1,SHAPE,S
      IZE,127,127)
NG 40 DATA 24,60,126,90,219,
      255,219,195,102,60,24
DM 50 END
```

Program 3: Explosion Animation Demo

```
KI 10 PMMODE=2:GRMODE=0:GOSU
      B 20050
FA 20 SETCOLOR 2,0,0:POKE 70
      4,72
IN 30 DIM BOOM$(64):BOOM=ADR
      (BOOM$):RESTORE 90:FOR
       X=1 TO 64:READ A:BOOM
      $(X)=CHR$(A):NEXT X
DD 40 FOR VOLUME=14 TO 0 STE
      P -2
CI 50 SOUND 0,90,0,VOLUME:SO
      UND 1,100,4,VOLUME
KN 60 A=USR(PMMOVE,1,BOOM,8,
      127,64):BOOM=BOOM+8
BO 70 FOR DELAY=1 TO 35:NEXT
       DELAY
HP 80 NEXT VOLUME
LL 90 DATA 0,0,8,28,28,8,0,0
EK 100 DATA 0,8,34,92,20,34,
       8,0
IL 110 DATA 8,65,4,168,20,1,
       64,8
AG 120 DATA 148,1,20,160,1,2
       0,1,136
IE 130 DATA 145,74,32,130,65
       ,2,84,137
HO 140 DATA 72,1,64,0,130,1,
       8,82
HI 150 DATA 129,0,0,0,0,128,
       1,66
GF 160 DATA 0,0,0,0,0,0,0,0
GP 170 END
```

Program 4: Tank Animation Demo

```
KI 1Ø  PMMODE=2:GRMODE=Ø:GOSU
       B 2ØØ5Ø
AL 2Ø  DIM SHAPE$(64):SIZE=8:
       RESTORE 21Ø:FOR X=1 TO
        64:READ A:SHAPE$(X)=C
       HR$(A):NEXT X
MM 3Ø  DIR=1:X=127:Y=64:SOUND
        Ø,18Ø,6,3
DB 4Ø  S=STICK(Ø):IF S=11 THE
       N DIR=DIR-1
EB 5Ø  IF S=7 THEN DIR=DIR+1
ME 6Ø  IF DIR<1 THEN DIR=8
MH 7Ø  IF DIR>8 THEN DIR=1
LB 8Ø  A=USR(PMMOVE,1,ADR(SHA
       PE$(DIR*8-7)),SIZE,X,Y
       )
DA 9Ø  IF S=14 THEN SOUND 1,1
       2Ø,6,6:ON DIR GOTO 12Ø
       ,13Ø,14Ø,15Ø,16Ø,17Ø,1
       8Ø,19Ø
FM 1ØØ  IF S=15 THEN SOUND 1,
        18Ø,6,3:GOTO 4Ø
CP 11Ø  GOTO 4Ø
LH 12Ø  Y=Y-1:GOTO 4Ø
DL 13Ø  X=X+1:Y=Y-1:GOTO 4Ø
LF 14Ø  X=X+1:GOTO 4Ø
DL 15Ø  X=X+1:Y=Y+1:GOTO 4Ø
LJ 16Ø  Y=Y+1:GOTO 4Ø
DP 17Ø  X=X-1:Y=Y+1:GOTO 4Ø
LL 18Ø  X=X-1:GOTO 4Ø
ED 19Ø  X=X-1:Y=Y-1:GOTO 4Ø
CC 2ØØ  REM *** TANK SHAPES (
        CLOCKWISE N-NE-E-SE-S
        -SW-W-NW ***
LO 21Ø  DATA 8,8,42,62,62,62,
        62,34
FB 22Ø  DATA 9,26,6Ø,127,254,
        6Ø,24,16
BF 23Ø  DATA Ø,252,12Ø,127,12
        Ø,252,Ø,Ø
FD 24Ø  DATA 16,24,6Ø,254,127
        ,6Ø,26,9
MC 25Ø  DATA 34,62,62,62,62,4
        2,8,8
IO 26Ø  DATA 8,24,6Ø,127,254,
        6Ø,88,144
KK 27Ø  DATA Ø,63,3Ø,254,3Ø,6
        3,Ø,Ø
JA 28Ø  DATA 144,88,6Ø,254,12
        7,6Ø,24,8
```

Program 5: Missile Demo

```
LF 25  DIM MISSILE$(1):MISSIL
       E$(1)=CHR$(3)
OD 85  IF STRIG(Ø)=Ø THEN GOS
       UB 1ØØØ
NB 1ØØØ  ON DIR GOTO 1Ø1Ø,1Ø2
         Ø,1Ø3Ø,1Ø4Ø,1Ø5Ø,1Ø6
         Ø,1Ø7Ø,1Ø8Ø
HL 1Ø1Ø  DX=Ø:DY=-2:GOTO 1Ø9Ø
HO 1Ø2Ø  DX=2:DY=-2:GOTO 1Ø9Ø
FA 1Ø3Ø  DX=2:DY=Ø:GOTO 1Ø9Ø
FD 1Ø4Ø  DX=2:DY=2:GOTO 1Ø9Ø
FC 1Ø5Ø  DX=Ø:DY=2:GOTO 1Ø9Ø
IC 1Ø6Ø  DX=-2:DY=2:GOTO 1Ø9Ø
IB 1Ø7Ø  DX=-2:DY=Ø:GOTO 1Ø9Ø
HE 1Ø8Ø  DX=-2:DY=-2
JP 1Ø9Ø  MX=X:MY=Y:FOR SHOOT=
         1 TO 15
BH 11ØØ  A=USR(PMMOVE,5,ADR(M
         ISSILE$),1,MX,MY):MX
         =MX+DX:MY=MY+DY:NEXT
          SHOOT
HN 111Ø  A=USR(PMMOVE,5,ADR(M
         ISSILE$),Ø,Ø,Ø):RETU
         RN
```

Program 6: P/M Shapemaker

```
BF 1Ø  GRAPHICS 2:SETCOLOR 2,
       Ø,Ø:POKE 752,1:POSITIO
       N 3,2:? #6;"P/M SHAPEM
       AKER"
KK 2Ø  ? "1 SINGLE RESOLUTION
       ":? "2 DOUBLE RESOLUTI
       ON"
CD 3Ø  OPEN #1,4,Ø,"K:":? "
       PRESS 1 OR 2";
PC 4Ø  GET #1,A:IF A=49 THEN
       PMMODE=1:GOTO 7Ø
BB 5Ø  IF A=5Ø THEN PMMODE=2:
       GOTO 7Ø
AD 6Ø  GOTO 4Ø
HJ 7Ø  ? "{3 SPACES}PLEASE WA
       IT...":GRMODE=Ø:GOSUB
       2ØØ5Ø
JL 8Ø  DIM CURSOR$(2),OLD$(2)
       ,BIT(8),BYTE$(24):CURS
       OR$(1,2)="■{LEFT}":OLD
       $(1,2)=".{LEFT}"
GK 9Ø  RESTORE 1ØØ:FOR N=1 TO
        8:READ A:BIT(N)=A:NEX
       T N
HP 1ØØ  DATA 128,64,32,16,8,4
        ,2,1
MM 11Ø  POKE 752,1:SETCOLOR 2
        ,Ø,Ø:FOR N=1 TO 24:?
        "........ Ø":BYTE$(N)
        =CHR$(Ø):NEXT N:CX=2:
        CY=Ø
EI 12Ø  A=USR(PMMOVE,2,ADR(BY
        TE$),24,17Ø,128/PMMOD
        E)
HH 13Ø  POSITION 24,2Ø:? "ERA
        SE PLAYER"
HE 14Ø  LOCATE CX,CY,A:OLD$(1
        )=CHR$(A):POSITION CX
        ,CY:? CURSOR$;
FE 15Ø  S=STICK(Ø):FOR N=1 TO
         25:NEXT N:IF S=14 TH
        EN 22Ø
LC 16Ø  IF S=7 THEN 24Ø
OC 17Ø  IF S=13 THEN 26Ø
OD 18Ø  IF S=11 THEN 28Ø
GC 19Ø  IF STRIG(Ø)=Ø THEN 3ØØ
AK 2ØØ  IF PEEK(764)=42 THEN
        POKE 764,255:? CHR$(1
        25):GOTO 11Ø
BC 21Ø  GOTO 15Ø
PB 22Ø  IF CY=Ø THEN 15Ø
CH 23Ø  ? OLD$;:CY=CY-1:GOTO
        14Ø
PL 24Ø  IF CX=9 THEN 15Ø
CF 25Ø  ? OLD$;:CX=CX+1:GOTO
        14Ø
CJ 26Ø  IF CY=22 THEN 15Ø
CJ 27Ø  ? OLD$;:CY=CY+1:GOTO
        14Ø
PI 28Ø  IF CX=2 THEN 15Ø
CL 29Ø  ? OLD$;:CX=CX-1:GOTO
        14Ø
OA 3ØØ  IF OLD$(1)="■" THEN O
        LD$(1)=".":BYTE$(CY+1
        ,CY+1)=CHR$(ASC(BYTE$
        (CY+1))-BIT(CX-1)):GO
        TO 32Ø
OF 31Ø  OLD$(1)="■":BYTE$(CY+
        1,CY+1)=CHR$(ASC(BYTE
        $(CY+1))+BIT(CX-1))
BO 32Ø  POSITION 11,CY:? "
        {4 SPACES}":POSITION
        11,CY:? ASC(BYTE$(CY+
        1)):POSITION CX,CY
EL 33Ø  A=USR(PMMOVE,2,ADR(BY
        TE$),24,17Ø,128/PMMOD
        E)
BD 34Ø  IF STRIG(Ø)=Ø THEN 34Ø
GH 35Ø  GOTO 15Ø
```

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The New Automatic Proofreader For Commodore

Philip I. Nelson, Assistant Editor

Now it's easier than ever to type in Commodore programs published in COMPUTE!. *This completely new version of the Automatic Proofreader is a significant improvement over the old Proofreader and catches almost any typing mistake that can be made. A single version now works on the Commodore 64, 128, VIC-20, Plus/4, and 16. Starting with this issue, all BASIC programs published in* COMPUTE! *for these computers are listed in the new Proofreader format. They cannot be checked with the old Proofreader.*

"The New Automatic Proofreader" is a short error-checking program that helps you type in COMPUTE! program listings without typing mistakes. The Proofreader conceals itself in memory and doesn't interfere with the program you're typing. Each time you press RETURN to enter a program line, the Proofreader displays a two-character value called a *checksum* in reverse video at the top of your screen. If you've typed the line correctly, the checksum on the screen matches the one in the printed listing—it's that simple. You don't have to use the Automatic Proofreader to enter COMPUTE!'s printed listings, but doing so greatly reduces your chances of making a typo.

Getting Started

First, type in the Automatic Proofreader program below *exactly* as it appears in the listing. Since the Proofreader can't check itself before it exists, type carefully to avoid mistakes. Don't omit any lines, even if they contain unfamiliar commands or you think they don't apply to your computer.

When you're finished, save at least two copies on disk or tape *before running it for the first time.* This is very important because the Proofreader erases the BASIC portion of itself when it runs, leaving only the machine language (ML) portion in memory.

When that's done, type RUN and press RETURN. After announcing which computer it's running on, the Proofreader installs the ML routine in memory, displays the message PROOFREADER ACTIVE, erases the BASIC portion of itself, and ends. If you type LIST and press RETURN, you'll see that no BASIC program remains in memory. The computer is ready for you to type in a new program listing.

Entering Programs

Once the Proofreader is active, you can begin typing in a BASIC program as usual. Every time you finish typing a line and press RETURN, the Proofreader displays the two-letter checksum in the upper-left corner of the screen. Compare this checksum with the two-letter checksum printed next to the corresponding line in the COMPUTE! program listing. If the letters match, you can be pretty certain the line is typed correctly. Otherwise, check for a mistake and correct the line.

The Proofreader ignores space characters that aren't enclosed in quotation marks, so you can omit spaces (or add extra ones) between keywords and still see a matching checksum. For example, these two lines generate the same checksum:

```
10 PRINT"THIS IS BASIC"
10 PRINT         "THIS IS BASIC"
```

However, since spaces inside quotation marks are generally significant, the Proofreader pays attention to them. For instance, these two lines generate different checksums:

```
10 PRINT"THIS IS BASIC"
10 PRINT"THIS ISBA       SIC"
```

A common typing mistake is transposition—typing two successive characters in the wrong order, like PIRNT instead of PRINT or 64378 instead of 64738. The old Commodore Proofreader couldn't detect transposition errors. Because the new Proofreader computes the checksum with a more sophisticated formula, it is sensitive to the *position* of each character within the line and thus catches transposition errors.

The Proofreader does not accept keyword abbreviations (for example, typing ? instead of PRINT). If you prefer to use abbreviations, you can still check the line with the Proofreader: Simply LIST the line after typing it, move the cursor back onto the line, and press RETURN. LISTing the line substitutes the full keyword for the abbreviation and allows the Proofreader to work properly. The same technique works for rechecking a program you've already typed in: Reload the program, LIST several lines on the screen, and press RETURN over them.

If you are using the Proofreader on the Commodore Plus/4, 16, or 128 (in 128 mode), *do not perform any GRAPHIC commands while the Proofreader is active*. When you perform a command like GRAPHIC 1, the computer moves everything at the start of BASIC program space—including the Proofreader—to another memory area, causing the Proofreader to crash. The same thing happens if you run any program that contains a GRAPHIC command. The Proofreader deallocates any graphic areas before installing itself in memory, but you are responsible for seeing that the computer remains in this configuration.

Though the Proofreader doesn't interfere with other BASIC operations, it's always a good idea to disable it before running any other program. Some programs may need the space occupied by the Proofreader's ML routine, or may create other memory conflicts. However, the Proofreader is purposely made difficult to dislodge: It's not affected by tape or disk operations, or by pressing RUN/STOP–RESTORE. The simplest way to disable it is to turn the computer off, then on again.

A gentler method to disable the Proofreader is to SYS to the computer's built-in reset routine. Here are the SYS statements required for various Commodore computers:

Computer	Reset Command
64	SYS 64738
128	SYS 65341
VIC-20	SYS 64802
Plus/4	SYS 65526
16	SYS 65526

Inside The Commodore Proofreader

Writing a machine language program that works on five different computers is no small task. The first hurdle is finding a safe place to put the code. Though the cassette buffer is an obvious choice, it's located in different places on various machines, and putting ML there creates problems for tape users. Instead, the Proofreader uses 256 bytes of BASIC programming space.

Before it installs the routine in memory, the Proofreader checks which computer you're using. Then it stores the ML at the bottom of BASIC memory and protects itself by moving the computer's start-of-BASIC pointer to a spot 256 bytes higher in memory. Once that's done, the Proofreader activates the ML routine and erases itself with NEW. Note that because the Proofreader overwrites its first few BASIC lines, it's critical not to delete anything from the first portion of the program.

The ML portion of the Proofreader wedges into one of the operating system's built-in routines (CRUNCH). The system calls CRUNCH every time you enter a line from the keyboard (it can be a numbered program line or a direct command without a line number). Before the computer digests the line, it uses CRUNCH to convert BASIC keywords like PRINT into *tokens*—one- or two-byte numbers that represent the keyword. By changing the CRUNCH vector to point to the ML checksum routine, we can make the computer figure the checksum before it tokenizes the line with CRUNCH.

The checksum routine initially sets the checksum to equal the low-byte and high-byte values of the current line number. Then it scans the line, multiplying the ASCII value of each character by its position in the line and adding the result to the two-byte checksum as it moves down the line. After scanning the whole line, the Proofreader performs an *exclusive or* operation on the two bytes of the checksum and displays the final result as two alphabetic characters in reverse video. Though the final checksum could have been displayed as a two-digit hexadecimal number, the Proofreader uses letters so that no harm will be done if you accidentally press RETURN over the line containing the checksum.

Once this is done, the Proofreader restores everything to normal and jumps to CRUNCH, which handles the line as usual.

Commodore Compatibility

If you own a Commodore 64, you may already have wondered whether the Proofreader works with other programming utilities. The answer is generally yes, if you are using a 64 and if you activate the Proofreader after installing the other utility. There's no way to promise, of course, that the Proofreader will work with any and every combination of utilities you might want to use. Any program that disturbs the CRUNCH vector or the memory area where the Proofreader resides will probably crash the system without delay.

When using the Proofreader with another utility, you should disable both programs before running a BASIC program.

The New Automatic Proofreader For Commodore

```
10 VEC=PEEK(772)+256*PEEK(773)
   :LO=43:HI=44
20 PRINT "AUTOMATIC PROOFREADE
   R FOR ";:IF VEC=42364 THEN
   {SPACE}PRINT "C-64"
30 IF VEC=50556 THEN PRINT "VI
   C-20"
40 IF VEC=35158 THEN GRAPHIC C
   LR:PRINT "PLUS/4 & 16"
50 IF VEC=17165 THEN LO=45:HI=
   46:GRAPHIC CLR:PRINT"128"
60 SA=(PEEK(LO)+256*PEEK(HI))+
   6:ADR=SA
70 FOR J=0 TO 166:READ BYT:POK
   E ADR,BYT:ADR=ADR+1:CHK=CHK
   +BYT:NEXT
80 IF CHK<>20570 THEN PRINT "*
    ERROR* CHECK TYPING IN DATA
    STATEMENTS":END
90 FOR J=1 TO 5:READ RF,LF,HF:
   RS=SA+RF:HB=INT(RS/256):LB=
   RS-(256*HB)
100 CHK=CHK+RF+LF+HF:POKE SA+L
   F,LB:POKE SA+HF,HB:NEXT
110 IF CHK<>22054 THEN PRINT "
   *ERROR* RELOAD PROGRAM AND
   {SPACE}CHECK FINAL LINE":EN
   D
120 POKE SA+149,PEEK(772):POKE
    SA+150,PEEK(773)
130 IF VEC=17165 THEN POKE SA+
   14,22:POKE SA+18,23:POKESA+
   29,224:POKESA+139,224
140 PRINT CHR$(147);CHR$(17);"
   PROOFREADER ACTIVE":SYS SA
150 POKE HI,PEEK(HI)+1:POKE (P
   EEK(LO)+256*PEEK(HI))-1,0:N
   EW
160 DATA 120,169,73,141,4,3,16
   9,3,141,5,3
170 DATA 88,96,165,20,133,167,
   165,21,133,168,169
180 DATA 0,141,0,255,162,31,18
   1,199,157,227,3
190 DATA 202,16,248,169,19,32,
   210,255,169,18,32
200 DATA 210,255,160,0,132,180
   ,132,176,136,230,180
210 DATA 200,185,0,2,240,46,20
   1,34,208,8,72
220 DATA 165,176,73,255,133,17
   6,104,72,201,32,208
230 DATA 7,165,176,208,3,104,2
   08,226,104,166,180
240 DATA 24,165,167,121,0,2,13
   3,167,165,168,105
250 DATA 0,133,168,202,208,239
   ,240,202,165,167,69
260 DATA 168,72,41,15,168,185,
   211,3,32,210,255
270 DATA 104,74,74,74,74,168,1
   85,211,3,32,210
280 DATA 255,162,31,189,227,3,
   149,199,202,16,248
290 DATA 169,146,32,210,255,76
   ,86,137,65,66,67
300 DATA 68,69,70,71,72,74,75,
   77,80,81,82,83,88
310 DATA 13,2,7,167,31,32,151,
   116,117,151,128,129,167,136
   ,137
```

©

MultiMemory

For Commodore 64 And Apple

Patrick Parrish, Programming Supervisor

This short utility partitions free memory so several BASIC programs can be loaded into your computer at once. Among other things, it's a great aid during program development—you can keep a couple of BASIC programming utilities at hand as you work, or test alternate versions of new routines before adding them to your main program. The Apple version works on all Apple II series computers with either DOS 3.3 or ProDOS.

The idea of partitioning memory into several modules 'which can contain separate programs is not new—Charles Brannon relied on BASIC pointers to split the PET into four 8K blocks with "Quadra-Pet" (COMPUTE!, June 1981), and Feeman Ng later partitioned the 64 into three 12K blocks with "Triple 64" (COMPUTE!'s GAZETTE, April 1985). Much like these earlier programs, "MultiMemory" divides free memory in your Commodore 64 or Apple into independent workspaces. Three partitions are set up in the 64, and four in the Apple. As before, you can load different BASIC programs into the computer at once. These could be utilities, applications, or games. And, once again, you can save and load programs from any of these areas without affecting the others.

But MultiMemory goes one step further. Not only are the BASIC programs in each module protected from one another, but the variables generated by each are protected as well. Any program can change a variable's value without affecting identically named variables that may exist in other partitions. That means there's even less chance of conflict between the programs, allowing you more flexibility when using MultiMemory.

Entering MultiMemory

The BASIC languages in the 64 and Apple were both written by Microsoft, Inc. and thus share numerous similarities. Nowhere is this more clearly seen than in a section of memory called *zero page* (locations 0–255), where many BASIC pointers are stored. If you compare detailed memory maps for these computers, you'll find that many zero-page pointers, though located at slightly different addresses, are the same on these two machines. MultiMemory takes advantage of this by using identical zero-page pointers in the 64 (locations 43–56) and in the Apple (locations 103–116) to split up free memory. As a result, the 64 and Apple versions of MultiMemory are alike in many ways.

Whether you have a 64 or an Apple II series computer, MultiMemory is entered in the same fashion. Both versions contain short machine language routines entered by a BASIC loader. Carefully type Program 1 for the 64 or Program 2 for the Apple and save a copy to disk or tape before running it for the first time.

When you run MultiMemory, line 100 sets the top of BASIC memory for the first partition. This is memory location 16384 (64*256) on the 64 and location 8192 on the Apple (we'll see why later).

Line 110 POKEs the machine language routine in lines 150–330 into a safe place in memory. On the 64, it's placed at the top of BASIC RAM (40769) just below BASIC ROM (40960). On the Apple, it resides at location 38251 just below DOS (38400). These areas are relatively safe from memory conflicts.

Line 120 checks to see if the machine language data has been correctly typed. Lines 130 and 140 place zeros in three sequential locations at the start of each memory module. The first zero is required to indicate the start of BASIC. The second and third zeros NEW each memory module. Finally, the NEW command in line 140 clears the BASIC loader from memory and leaves us in module 1.

Three Or Four Computers

To access any module on the 64, type SYS 40769 and press RETURN. The cursor will disappear. Now, pick a work area by typing 1, 2, or 3. For a test, let's choose partition number 2. A tone sounds as the partition number is displayed on the screen. That's all it takes to switch modules.

If you're using an Apple, type CALL 38251 and press RETURN. Choose among work areas 1 to 4. Again, for a test, specify number 2. A tone sounds, the partition number is displayed, and we're ready to program.

When you type LIST, you'll see that module 2 is empty. Now type PRINT FRE(0) to determine how much memory is available in this module. The 64 should show about 16K free, and the Apple about 8K. On either machine, there is plenty of room for a short BASIC program and its variables. To see that both a program and its variables remain intact within a particular module, let's enter and run a program in module 2 and then do the same in module 1.

While in module 2, type and run this program:

```
10 REM EXAMPLE 2
20 A$="MODULE #2"
30 FOR I=1 TO 20:NEXT I
```

After running this program, type PRINT A$,I and press RETURN. You should see this:

```
MODULE #2     21
```

Save this program to disk or tape with the filename "P2."

Now let's go to another module. Before we do this, list the program in module 2 so that it's at the bottom of the screen. Now type SYS 40769 on the 64 or CALL 38251 on the Apple and choose module 1.

Independent Variables

After entering module 1, type LIST to prove that our first program has been left behind in module 2. Again, if you wish, type PRINT FRE(0) to determine the amount memory available in this module. The 64 should show about 14K and the Apple approximately 6K.

Program "P2" should still be on the screen. Even though it was listed in module 1, it remains visible if you switch partitions without clearing the screen. This makes it possible to copy program lines from one module to another with the screen editor. Simply use the screen editing keys to cursor up to line 10. Change the 2 in this line to a 1 and hit RETURN to enter this line in memory (Apple useis must cursor to the end of the line before pressing RETURN, of course). Line 10 is now copied into memory in module 1 *without disturbing line 10 in module 2.*

If the BASIC screen prompts do not obscure the other program lines, you can copy them to module 1 in the same manner. At any rate, lines 20 and 30 should read:

```
20 A$="MODULE #1"
30 FOR I=1 TO 10:NEXT I
```

As you did before, run the program and then type PRINT A$,I. The result is:

```
MODULE #1     11
```

Save this program on disk or tape as "P1."

Now, go back to module 2 with SYS 40769 or CALL 38251 and type LIST. You should see program "P2" on the screen unchanged. Print the values for A$ and I. You'll see they still have the values they had when we left module 2.

Applications

As you can imagine, this process can be very valuable if you're writing and debugging your own programs. Suppose you're writing a program in module 1 and you need a subroutine from a BASIC program you have on disk. Maybe you aren't sure which disk the program is on. On the 64, normally you'd have to save the program currently in memory before looking at the disk directory, because the directory overwrites the BASIC workspace. (On the Apple, this wouldn't be a problem, since the disk catalog is not loaded into the BASIC workspace.)

With MultiMemory, you can nimbly jump to another module, load the directory there to find the program you need, and then load it into that module or the third module, leaving the directory intact. And, once you've found the subroutine you need from your earlier program, you can list it on the screen, shift back to the first partition, and copy the lines by RETURNing over them.

Now suppose that some bug in your program keeps the subroutine from working as you expected. Since variables retain their values within each program module, you can test each routine separately, compare the resulting variables, and make changes to your working version where needed.

With all this jumping from module to module, you might loose track of which partition you're in. To find out, you can type PRINT PEEK(40914) on the 64 or PRINT PEEK(38339) on the Apple.

In addition to aiding program development, MultiMemory can be used to hold a few BASIC programs that can be run individually. For instance, you might have a series of BASIC programs that, in sequence, manipulate data stored on disk. The first program could read in the data, manipulate it, and then write the results back to disk. In turn, a second or third program (or on the Apple, even a fourth) stored in the other workspaces could do the same. Or you could designate one BASIC workspace for data storage, much like a RAM disk.

Before undertaking any sophisticated programming applications with MultiMemory, however, you should consider how it works and keep in mind a few restrictions on its use.

Memory Ceilings

As mentioned earlier, MultiMemory uses a series of BASIC pointers in zero page to set up each workspace. The values required by these pointers for each module are stored in a lookup table at the end of the program. Whenever you SYS or CALL MultiMemory, it stores the current zero-page values in positions within this table which correspond to the current module. The program then waits for you to specify the next module.

When you pick a module, MultiMemory reads the zero-page pointer values for the module and places them in their proper zero page locations. The pointers transferred are the starting addresses for the location of the BASIC program, the array and nonarray variables, the string variables, and the top of BASIC memory.

The barriers separating the partitions were selected to keep MultiMemory compatible with most programs. On the 64, the first module runs from memory locations 2048–16383; the second, from 16384–32767; and the third, from 32768–40768. Partitions are placed on 16K boundaries because the 64's VIC-II chip can address only one 16K block at a time. The VIC-II chip is responsible for handling the 64's video display—such things as sprite shapes, screen memory, and character data.

On the Apple, the first module runs from memory locations 2048–8191; the second, from 8192– 16383; the third, from 16384–27317; and the fourth, from 27318–38250.

Note that the location of module 2 coincides with the Apple's first high-resolution graphics page. That means any programs which use the hi-res graphics page should be loaded into another module. And, of course, any programs loaded into module 2 will likely be erased if a program in another module uses the hi-res page.

Program 1: MultiMemory For Commodore 64

For instructions on entering this listing, please refer to "The New Automatic Proofreader for Commodore" in this issue of COMPUTE!.

```
XA 100 POKE56,64:CLR
CR 110 FORI=40769TO40959:READA
       :POKEI,A:X=X+A:NEXT
DH 120 IFX<>22456THENPRINT"ERR
       OR IN DATA STATEMENTS."
       :STOP
KA 130 POKE16384,Ø:POKE16385,Ø
       :POKE16386,Ø
RA 140 POKE32768,Ø:POKE32769,Ø
       :POKE32770,Ø:NEW
JD 150 DATA 174,210,159,189,21
       Ø,159,170,160,Ø,185
QJ 160 DATA 43,Ø,157,214,159,2
       32,200,192,14,208
SG 170 DATA 244,32,228,255,41,
       15,240,249,201,4
BA 180 DATA 176,245,72,72,169,
       35,32,210,255,104
QR 190 DATA 24,105,48,32,210,2
       55,169,13,32,210
BG 200 DATA 255,32,143,159,104
       ,170,142,210,159,189
CF 210 DATA 210,159,170,160,Ø,
       189,214,159,153,43
CR 220 DATA Ø,232,200,192,14,2
       Ø8,244,96,169,Ø
HS 230 DATA 168,153,Ø,212,200,
       192,25,144,248,169
PX 240 DATA 15,141,24,212,169,
       10,141,5,212,169
PK 250 DATA 84,141,15,212,169,
       39,141,1,212,169
MQ 260 DATA 20,141,4,212,169,2
       1,141,4,212,162
RA 270 DATA Ø,134,251,160,Ø,20
       Ø,208,253,232,208
XD 280 DATA 250,230,251,165,25
       1,201,4,208,242,169
DD 290 DATA Ø,141,4,212,96,1,Ø
       ,14,28,1
HJ 300 DATA 8,3,8,3,8,3,8,Ø,64
       ,Ø
JK 310 DATA 64,Ø,64,1,64,3,64,
       3,64,3
GE 320 DATA 64,Ø,128,Ø,128,Ø,1
       28,1,128,3
DR 330 DATA 128,3,128,3,128,65
       ,159,65,159,65,159
```

Program 2: MultiMemory For Apple

For instructions on entering this listing, please refer to "COMPUTE!'s Guide to Typing In Programs" in this issue of COMPUTE!.

```
B6 100 HIMEM: 8192
B3 110 FOR I = 38251 TO 38399: R
       EAD A: POKE I,A:X = X + A
       : NEXT
6B 120 IF X < > 16759 THEN PRINT
        "ERROR IN DATA STATEMENT
       S.": STOP
5F 130 POKE 8192,Ø: POKE 8193,Ø:
        POKE 8194,Ø
B6 140 POKE 16384,Ø: POKE 16385,
       Ø: POKE 16386,Ø: POKE 273
       18,Ø: POKE 27319,Ø: POKE
       27320,Ø: NEW
B3 150 DATA 174,195,149,189,195,
       149,170,160
C6 160 DATA Ø,185,103,Ø,157,200,
       149,232
2F 170 DATA 200,192,14,208,244,1
       73,Ø,192
52 180 DATA 201,128,144,249,141,
       16,192,170
AØ 190 DATA 41,15,240,241,201,5,
       176,237
14 200 DATA 72,32,58,255,169,163
       ,32,237
CØ 210 DATA 253,138,32,237,253,3
       2,142,253
B8 220 DATA 104,170,142,195,149,
       189,195,149
31 230 DATA 170,160,Ø,189,200,14
       9,153,103
49 240 DATA Ø,232,200,192,14,208
       ,244,165
C7 250 DATA 105,133,175,165,106,
       133,176,96
7Ø 260 DATA 1,Ø,14,28,42,1,8,3
2F 270 DATA 8,3,8,3,8,Ø,32,Ø
47 280 DATA 32,Ø,32,1,32,3,32,3
6E 290 DATA 32,3,32,Ø,64,Ø,64,Ø
Ø1 300 DATA 64,1,64,3,64,3,64,3
BE 310 DATA 64,182,106,182,106,1
       82,106,183
5Ø 320 DATA 106,185,106,185,106,
       185,106,107
Ø9 330 DATA 149,107,149,107,149
```

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Experimenting With SID Sound

Mark A. Currie

This versatile program for the Commodore 64 lets you experiment with a wide variety of sound effects and listen to how they sound in a preprogrammed song.

The Commodore 64's SID (Sound Interface Device) chip offers the ability to create a great number of rich, distinctive sounds. But sound programming involves so many different parameters (controlling values) that testing even a few different combinations can consume a lot of time. This program lets you change and experiment with any of the SID parameters quickly and easily. Once you have designed a sound, you can test its actual effect by playing it in a preprogrammed song.

Type in and save a copy of the program before running it for the first time. When you type RUN, the main menu displays 12 choices:

```
 1 WAVEFORM              2 PULSE WIDTH
 3 ATTACK/DECAY          4 SUSTAIN/RELEASE
 5 LOUDNESS              6 SYNCHRONIZE V1 to V3
 7 RING MODULATION       8 FILTERS
 9 PLAY MUSIC           10 ZERO VARIABLES
11 QUIT                 12 LIST OF EFFECTS
```

The first eight options let you design a sound by changing one or more of the SID chip's parameters. In each case, the computer tells you what range of values is allowed and prevents you from entering illegal values. If you select an option and decide not to change anything, press RETURN without entering any value. Let's look at each option in turn.

Option 1 lets you select one of four different SID waveforms—triangle, sawtooth, pulse, or noise. Each has its own distinctive tone. If you select the pulse waveform you must also set the pulse width to some nonzero value with Option 2. Options 3 and 4 permit you to adjust the ADSR (attack/decay/sustain/release) envelope of the sound. Each of the four ADSR parameters can be set separately to any number from 0–15.

Attack controls the rate at which the sound rises from zero to full volume. *Decay* controls the rate at which it falls from the level it reached at the end of the attack cycle to the volume level set by the sustain setting. *Sustain* sets the volume level the note will maintain from the end of the decay cycle until the note is turned off. And *release* controls how fast the note fades away after it's turned off. Since all four ADSR settings contribute to the ultimate result, it may take some experimenting to find exactly the envelope you want. Option 5 sets the SID's master volume control, accepting values from 0 (silence) to 15.

As you may know, the SID chip has three separate voices or tone generators. Option 6 permits you to synchronize two of these voices (1 and 3), producing effects which neither voice could produce alone. Note that voice 3's frequency must be set to some nonzero value before synchronization can work. This program lets you set voice 3's frequency to an unchanging value or to values that vary along with voice 1's frequency changes. Option 7 selects ring modulation: This effect is generated much like synchronization, but produces quite different effects. Again, you must set voice 3's frequency to a static value or an offset of the frequency for voice 1.

Note that while this program uses only voices 3 and 1 for synchronization and ring modulation, you may use these effects with other voice combinations in your own programs. In this case, voice 3's frequency affects voice 1. With the same techniques, you can affect voice 2 by voice 1's frequency, or affect voice 3 by voice 2's frequency. No matter which combination is used, you must supply frequency values for both of the voices involved.

Option 8 controls the filter, allowing you to change six different parameters. You may turn four different types of filters on or off and set the overall cutoff frequency and resonance for the filters. Filtering permits only certain specified frequencies to pass unchanged. Frequencies outside the specified range are much quieter or inaudible. You can choose from four types of filters: low-pass, band-pass, high-pass, and notch-reject. When a filter is on, you can also choose an overall filter resonance value.

Resonance emphasizes frequencies near the cutoff frequency of the filter.

Customized Music

When you select Option 9, the program plays a song using the sound you have designed. Don't be discouraged if the results aren't exactly what you expect at first. Sometimes a minor change in only one or two parameters (particularly those controlling the ADSR envelope) makes a big difference in the ultimate effect.

Option 10 clears all sound parameters to zero to clear the slate for a new sound. Note that the SID chip produces silence when every parameter is zero: The least you must do to produce a sound is turn on a waveform, set the volume to a nonzero level, and define some sort of ADSR envelope. To help you get started, this program begins by choosing maximum volume, a pulse waveform (with pulsewidth of 2048), an attack value of 1, and a decay of 9.

After designing a sound that you like, you may wish to use it in a program of your own. Option 12 generates two lists for that purpose. The first list summarizes the sound parameters currently in effect. The second list includes all the SID control locations and indicates which values to POKE into each register to reproduce the current sound. Although this program makes only one voice audible, you can achieve even more interesting effects by activating more than one voice at a time.

Sound Experimenter

For instructions on entering this listing, please refer to "The New Automatic Proofreader for Commodore" in this issue of COMPUTE!.

```
DA 100 POKE53280,6:PRINT"{CLR}
       {7 DOWN}"SPC(9)"C64 SOU
       ND EXPERIMENTS":FORT=1T
       O1300:NEXT
GG 110 L1=15:W1=65:A1=25:D1=9:
       S1=0:W2$="PULSE":P1=204
       8:L2=15:F1$="NO":P2%=8
JK 120 PRINT"{CLR}{DOWN}
       {5 SPACES}{RVS}
       {5 SPACES}SOUND EFFECT
       {SPACE}MENU{5 SPACES}
       {OFF}{4 DOWN}"
GE 130 PRINT" {RVS}1{OFF} WAVE
       FORM{9 SPACES}{RVS}2
       {OFF} PULSE WIDTH
       {DOWN}
KK 140 PRINT" {RVS}3{OFF} ATTA
       CK/DECAY{5 SPACES}{RVS}
       4{OFF} SUSTAIN/RELEASE
       {SPACE}{DOWN}
PD 150 PRINT" {RVS}5{OFF} LOUD
       NESS{9 SPACES}{RVS}6
       {OFF} SYNCHRONIZE V1TOV
       3
QC 160 PRINT" {RVS}7{OFF} RING
        MODULATION{2 SPACES}
       {RVS}8{OFF} FILTER/RESO
       NANCE{DOWN}
BK 170 PRINT" {RVS}9{OFF} MUSI
       C PLAYER{5 SPACES}{RVS}
       10{OFF} ZERO VARAIABLES
        {DOWN}
QX 180 PRINT" {RVS}11{OFF} QUI
       T{12 SPACES}{RVS}12
       {OFF} LIST OF EFFECTS
       {DOWN}"
KB 190 INPUT"{2 DOWN}ENTER NUM
       BER OF YOUR SELECTION";
       A
QA 200 ON A GOTO520,340,220,28
       0,790,370,630,820,1370,
       1030,1670,1040
FS 210 GOTO120
RQ 220 PRINT"{CLR}{2 DOWN}SET
       {SPACE}ATTACK VALUE BET
       WEEN 0 & 15"
BS 230 PRINT"{DOWN}CURRENT VAL
       UE OF ATTACK IS";(A1-D1
       )/16
PB 240 INPUT"{DOWN}";A3:A2=A3*
       16
SX 250 PRINT"{2 DOWN}SET DECAY
        VALUE BETWEEN 0 & 15"
XS 260 PRINT"{DOWN}CURRENT VAL
       UE OF DECAY IS";D1
HS 270 INPUT"{DOWN}";D1:A1=A2+
       D1:GOTO120
FC 280 PRINT"{CLR}{2 DOWN}SET
       {SPACE}SUSTAIN VALUE BE
       TWEEN 0 & 15"
QK 290 PRINT"{DOWN}CURRENT VAL
       UE OF SUSTAIN IS";(S1-R
       1)/16
DJ 300 INPUT"{DOWN}";S3:S2=S3*
       16
XX 310 PRINT"{2 DOWN}SET RELEA
       SE VALUE BETWEEN 0 & 15
       "
GE 320 PRINT"{DOWN}CURRENT VAL
       UE OF RELEASE IS";R1
BF 330 INPUT"{DOWN}";R1:S1=S2+
       R1:GOTO120
EE 340 PRINT"{CLR}{3 DOWN}SELE
       CT A PULSE WIDTH BETWEE
       N 0 & 4095"
HS 350 PRINT"{2 DOWN}CURRENT P
       ULSE WIDTH IS";P1
EX 360 INPUT"{DOWN}";P1:P2%=P1
       /256:P3%=P1-256*P2%:GOT
       O120
DA 370 PRINT"{CLR}{3 DOWN}DO Y
       OU WANT SYNCHRONIZING?"
FX 380 INPUT"TYPE Y OR N ";B$
FC 390 IFB$="N"THENW1=W1AND253
       :S2=0:GOTO120
JH 400 IFB$="Y"THENW1=(W1AND25
       1)OR2:GOTO420
GX 410 GOTO380
AE 420 PRINT"{2 DOWN}PRESENT F
       REQUENCY OF V3(VOICE3)I
       S";V4
PC 430 INPUT"{2 DOWN}ENTER FRE
       QUENCY FOR V3";V4:V3=IN
       T(V4*16.4)
QK 440 V4%=V3/256:V5%=V3-(256*
       V4%)
FD 450 PRINT"{2 DOWN}DO YOU WA
       NT V3 TO BE OFFSET
RG 460 PRINT"FROM FREQUENCY OF
        V1 BY"
SM 470 PRINT"AMOUNT YOU JUST E
       NTERED?"
XX 480 INPUT"{DOWN}TYPE Y OR N
        ";C$
BE 490 IFC$="N"THENS2=0:GOTO12
       0
CM 500 IFC$="Y"THENS2=1
JB 510 GOTO120
JP 520 REM SET UP WAVEFORM TYP
       E
GG 530 PRINT"{CLR}{2 DOWN}ENTE
       R THE FIRST LETTER OF T
       HE":PRINT"TYPE OF WAVEF
       ORM YOU WANT:
PP 540 PRINT"{DOWN}TRIANGLE, S
       AWTOOTH, PULSE, NOISE."
MX 550 PRINT"{DOWN}WAVEFORM IS
        NOW SET TO ";W2$
SE 560 INPUT"{DOWN}";W$
BF 570 IFW$="T"THENW1=17:W2$="
       TRIANGLE"
SM 580 IFW$="S"THENW1=33:W2$="
       SAWTOOTH"
RH 590 IFW$="P"THENW1=65:W2$="
       PULSE"
XC 600 IFW$="N"THENW1=129:W2$=
       "NOISE"
KD 610 IFW1=65GOTO340
HJ 620 GOTO120
FH 630 PRINT"{CLR}{2 DOWN}IF Y
       OU SELECT RING MODULATI
       ON THEN"
HA 640 PRINT"WAVEFORM WILL BE
       {SPACE}SET TO TRIANGLE
AQ 650 INPUT"{2 DOWN}DO YOU WA
       NT RING MOD? TYPE Y OR
       {SPACE}N";R$
FB 660 IFR$="N"THENW1=W1AND113
       :S2=0:GOTO120
QQ 670 IFR$="Y"THENW1=21:W2$="
       TRIANGLE":GOTO690
BB 680 GOTO630
KD 690 PRINT"{DOWN}FREQUENCY O
       F V3(VOICE 3) IS NOW SE
       T AT ";V4
SS 700 INPUT"{DOWN}SET FREQUEN
       CY OF V3 ";V4:V3=INT(V4
       *16.4)
XG 710 V4%=V3/256:V5%=V3-(256*
       V4%)
FE 720 PRINT"{2 DOWN}DO YOU WA
       NT FREQ. OF V3 TO"
RA 730 PRINT"TO BE OFFSET FROM
        V1 BY"
QE 740 PRINT"AMOUNT YOU JUST E
       NTERED"
CC 750 INPUT"{2 DOWN}TYPE Y OR
        N ";O$
BB 760 IF O$="N"THEN S2=0:GOTO
       120
KQ 770 IF O$="Y"THEN S2=1
FC 780 GOTO120
SR 790 PRINT"{CLR}{2 DOWN}LOUD
       NESS IS NOW SET AT";L1A
       ND15
RE 800 INPUT"{2 DOWN}SET LOUDN
       ESS BETWEEN 0 & 15";L2
PE 810 L1=L1AND240:L1=L2+L1:GO
       TO120
DS 820 PRINT"{CLR}{2 DOWN}ENTE
       R FIRST LETTER OF TYPE"
       :PRINT"OF FILTERING YOU
        WANT:
GJ 830 PRINT"{DOWN}LOWPASS, BA
       NDPASS, HIGHPASS,
XG 840 PRINT"OR NOTCH FILTER
       {DOWN}"
DC 850 PRINTF1$;" FILTERING IS
        BEING USED NOW.
FG 860 INPUT"{DOWN}TO TURN FIL
       TERING OFF ENTER 0";F$
```

```
HS 870  IFF$="Ø"THENL1=L1AND15:
        R2=Ø:F1$="NO":R6=Ø
QB 880  IFF$="N"THENL1=L2+80:R2
        =1:F1$="NOTCH"
PJ 890  IFF$="L"THEN L1=L2+16:R
        2=1:F1$="LOWPASS"
CG 900  IFF$="B"THEN L1=L2+32:R
        2=1:F1$="BANDPASS"
BC 910  IFF$="H"THEN L1=L2+64:R
        2=1:F1$="HIGHPASS"
QR 920  PRINT"{CLR}{2 DOWN}CUTO
        FF FREQUENCY IS NOW SET
         AT";F
MB 930  PRINT"{2 DOWN}INPUT CUT
        OFF FREQUENCY
AB 940  INPUT"BETWEEN Ø & 2047
        {SPACE}CYCLES";F
AG 950  F1%=F/8:F2%=F-(8*F1%):F
        $="?"
HE 960  PRINT"{2 DOWN}DO YOU WA
        NT TO SET RESONANCE
FF 970  INPUT"TYPE Y OR N";R$
BH 980  IFR$="Y"GOTO1000
FJ 990  R6=1:R5=Ø:GOTO12Ø
CH 1000 PRINT"{DOWN}RESONANCE
        {SPACE}IS NOW SET AT";
        R5
KC 1010 PRINT"{2 DOWN}SET RESO
        NANCE BETWEEN Ø & 15
KG 1020 INPUTR5:R6=R5*16+1:GOT
        O12Ø
PR 1030 CLR:F1$="NO":GOTO12Ø
ER 1040 REM PRINT LIST OF SOUN
        D EFFECTS
JG 1050 PRINT"{CLR}{DOWN}WAVEF
        ORM TYPE IS ";W2$
SX 1060 IF W2$="PULSE"THEN PRI
        NT"PULSEWIDTH IS ";P1
JC 1070 PRINT"{DOWN}ATTACK IS
        {SPACE}";(A1-D1)/16;"
        {2 SPACES}DECAY IS ";D
        1
KE 1080 PRINT"{DOWN}SUSTAIN IS
         ";(S1-R1)/16;" RELEAS
        E IS ";R1
QP 1090 PRINT"{DOWN}LOUDNESS I
        S SET TO ";L1AND15
AA 1100 IFR2=ØGOTO114Ø
HP 1110 PRINT"{DOWN}"F1$" FILT
        ER BEING USED WITH
EM 1120 PRINT "CUTOFF FREQUENC
        Y OF ";F
JJ 1130 PRINT"{DOWN}RESONANCE
        {SPACE}IS ";R5
MF 1140 IFW1AND2THENPRINT"
        {DOWN}SYNCHRONIZING IS
         ON":GOTO117Ø
CS 1150 IFW1AND4THENPRINT"
        {DOWN}RING MODULATION
        {SPACE}IS ON":GOTO117Ø
CQ 1160 GOTO119Ø
BH 1170 PRINT"POKE54286 WITH";
        V5%;"& POKE54287 WITH"
        ;V4%;
PP 1180 PRINT"{4 SPACES}TO SET
         V3 FREQ TO";V4;"HZ
JK 1190 IFS2=1THENPRINT"FREQUE
        NCY OFFSET IS BEING US
        ED.
KH 1200 IFS2=1THENPRINT"SEE PR
        OGRAM LINES 1640-166Ø
GS 1210 INPUT"{DOWN}PRESS RETU
        RN TO CONTINUE";R8
EE 1220 PRINT"{CLR}{DOWN}VOICE
         1{3 RIGHT}VOICE 2
        {3 RIGHT}VOICE 3
        {3 RIGHT}VALUE TO
        {DOWN}"
JQ 1230 PRINT"REGISTER
        {2 RIGHT}REGISTER
        {2 RIGHT}REGISTER
        {2 RIGHT}BE POKED
        {DOWN}"
SC 1240 S(Ø)=P3%:S(1)=P2%:S(2)
        =W1:S(3)=A1:S(4)=S1
BQ 1250 FORS=ØTO4
KH 1260 PRINT 54274+S,54281+S,
        54288+S,S(S):NEXT
DQ 1270 PRINT"{2 DOWN}FILTERIN
        G & LOUDNESS"
EK 1280 PRINT 54293;TAB(3Ø);F2
        %
MK 1290 PRINT 54294;TAB(3Ø);F1
        %
QS 1300 PRINT 54296;TAB(3Ø);L1
EP 1310 PRINT"{DOWN}RESONANCE
        {SPACE}& VOICE TO BE F
        ILTERED
HH 1320 PRINT"54295";TAB(3Ø);
        {SPACE}R6AND24Ø
KD 1330 PRINT"ADD 1 TO 54295 F
        OR FILTERING VOICE 1
DG 1340 PRJNT"ADD 2 TO 54295 F
        OR FILTERING VOICE 2
MR 1350 PR:NT"ADD 4 TO 54295 F
        OR FILTERING VOICE 3
SA 1360 IN UT"PRESS RETURN TO
        {S'ACE}CONTINUE ";R8:G
        OTO12Ø
SK 1370 RE=54272:RESTORE
GB 1380 FORR=54272 TO 54296: P
        OKER,Ø: NEXT
SD 1390 REM ENTER SOUND EFFECT
        S INTO SID
BD 1400 POKERE+2,P3%:POKERE+3,
        P2%
BB 1410 POKERE+5,A1:POKERE+6,S
        1:POKERE+14,V5%
JF 1420 POKERE+15,V4%:POKERE+2
        1,F2%:POKERE+22,F1%
KQ 1430 POKERE+23,R2:POKERE+24
        ,L1
CG 1440 READN,D:IFN=ØTHENPOKER
        E+24,Ø:GOTO12Ø:REM PLA
        Y MUSIC
DP 1450 H=INT(N/256):L=N-(256*
        H):DUR=16ØØ/D
AA 1460 POKERE+1,H:POKERE,L:PO
        KERE+4,W1
FC 1470 IF S2=1 GOTO163Ø
EM 1480 FOR T=1TODUR:NEXT
DR 1490 IFW1<1GOTO151Ø
JB 1500 POKERE+4,W1-1
SQ 1510 FORT=1TO2Ø:NEXT:GOTO14
        4Ø
JE 1520 DATA1Ø814,8,11457,8
DF 1530 DATA1286Ø,4,1286Ø,16,1
        4435,8,17167,8,1Ø814,4
        ,11457,8,1Ø814,8
RQ 1540 DATA9634,4,9634,16,114
        57,8,81Ø1,8,8583,4
DM 1550 DATA1Ø814,8,11457,8
MG 1560 DATA1286Ø,4,1286Ø,16,1
        4435,8,17167,8,1Ø814,4
        ,11457,8,1Ø814,8
GS 1570 DATA9634,4,9634,16,114
        57,8,81Ø1,8,8583,4
KB 1580 DATA1286Ø,4,17167,16
QR 1590 DATA21269,4,21269,16,2
        1269,8,19269,8,17167,4
        ,1286Ø,8,1286Ø,8
HR 1600 DATA14435,4,17167,16,1
        7167,8,14435,8,1286Ø,4
        ,1Ø814,4
GH 1610 DATA1Ø814,4,1Ø814,16,1
        Ø814,8,9634,8,1Ø814,4,
        1286Ø,8,1Ø814,8
SC 1620 DATA9634,4,9634,16,114
        57,8,81Ø1,8,8583,4,Ø,Ø
MM 1630 REM DEVELOP OFFSET FRE
        QUENCY
KM 1640 F1=H*256+L:F1=F1-V3:IF
        F1<ØTHENF1=Ø
RA 1650 V4%=F1/256: V5%=F1-(25
        6*V4%)
QQ 1660 POKERE+14,V5%:POKERE+1
        5,V4%:GOTO148Ø
QK 1670 END
```

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