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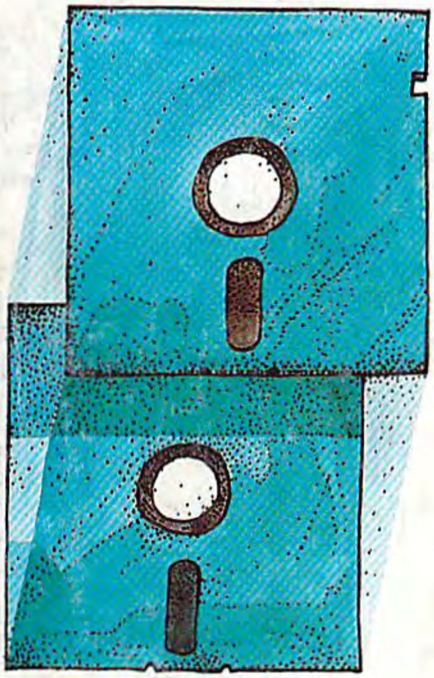

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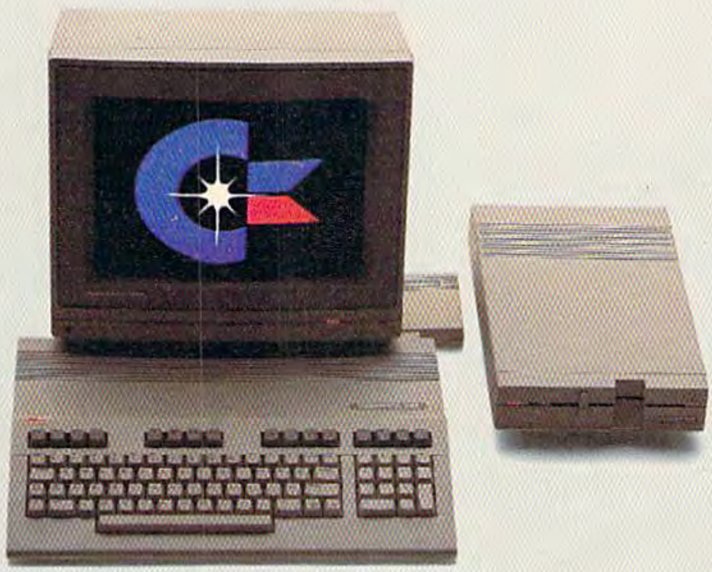

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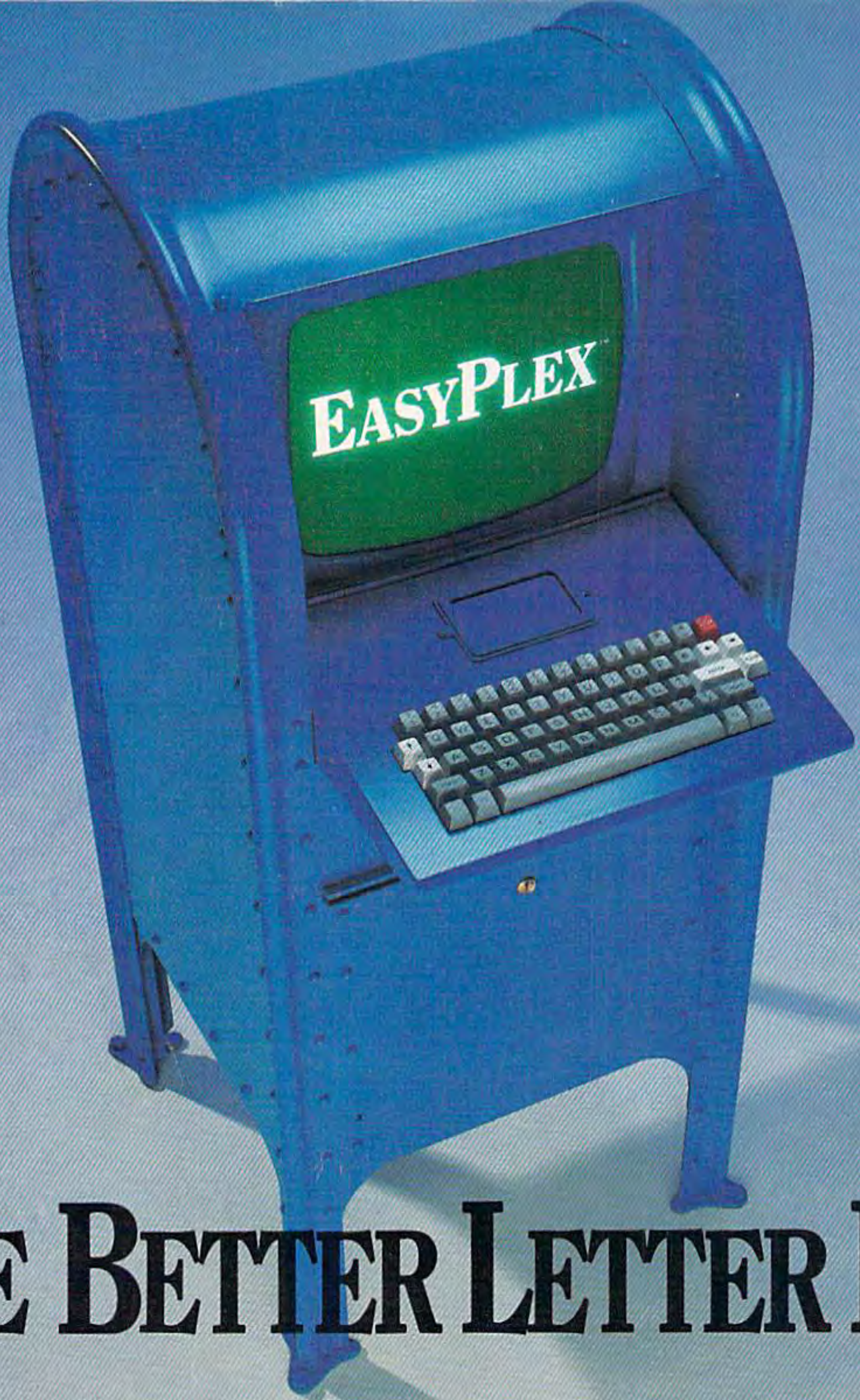

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* =General, **V**=VIC-20, **64**=Commodore 64, +**4**=Plus/4, **16**=Commodore 16.

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THE EDITOR'S *notes*

Many of you will be a bit disappointed with the quantity of contents in this issue. In truth, this is the smallest issue, pagewise, in the history of COMPUTE!'s GAZETTE. What does it mean? Should we collectively grow concerned? No! Shrinkage continues in the personal computing marketplace. As if that weren't enough of a problem, August is traditionally the slowest month for publication advertising. These events have combined to lead us to this 96-page issue. As those of you who've been with us for very long are well aware, quantity isn't everything. Within these 96 pages you'll find the best value, the best quality of content available in the Commodore-only marketplace. Articles such as "Crunch" and "Zounds!," columns such as "Machine Language for Beginners," and a great deal more, contribute to the continuing level of quality we present in each monthly issue.

As we proceed into the fall issues, we'll regain pages in the magazine and sectors on the disk.

In spite of this, some of you will be disappointed with the size of the issue. We ask simply that you view each issue as cumulative month after month, providing you with an excellent value. And we thank you for your continued support and endorsement.

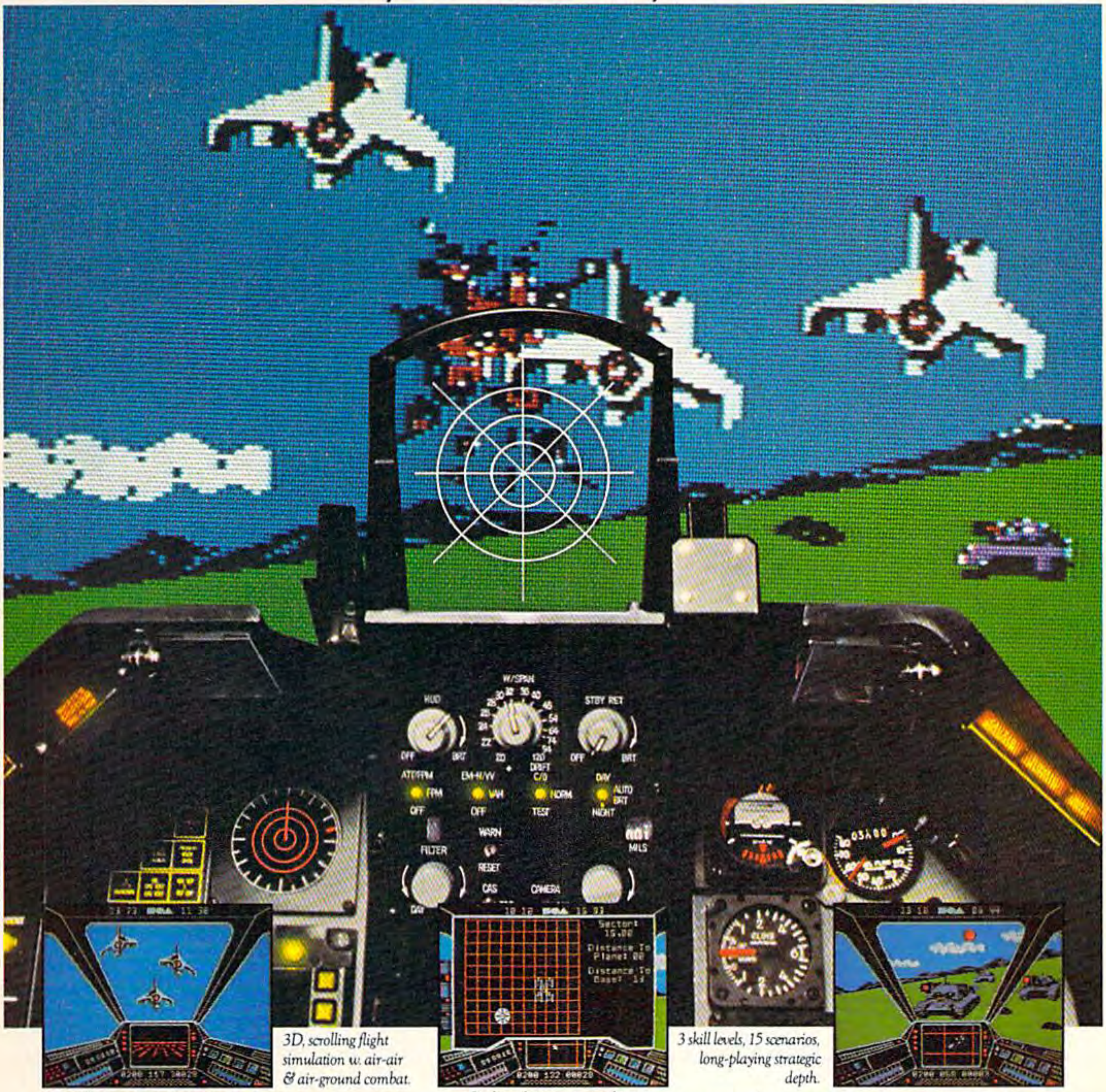
Mr. Mansfield has suggested that I write about the industry as a whole in this column—or perhaps he meant to suggest "hole," as in "black hole." Seriously, we remain, while subdued, confident. In these editorial pages, some many months ago we argued against the notion that personal computers would ever go the way of the CB radio craze of the seventies. From the present state of the marketplace, one must wonder whether or not we missed the boat on this particular call. We maintain that this is not the case. The personal computer market is alive, and if not particularly well, at least steadfastly alive.

We hear continued rumblings of a reawakening—if not from the direction of Commodore and the Amiga, then perhaps Atari. More probably both, plus Apple, IBM, and past or future players such as RCA or Sony or others. Will the resurgence come from a demand for home-based entertainment clusters? Combination VCR-compact disc programmable units? We think this may become a part of what the industry seems to be seeking. Surely though, intelligent appliances won't be the solution. We think they'll be one manifestation of our ability to integrate machine-level intelligence with human access. That is the key, in our opinion. Perhaps the solution will lie in a Topsy-like creation that combines the robot hotel of Fred D'Ignazio's fantasies with the technical austerity of one of Mr. Mansfield's machine language treatises. The offspring, while awesome to contemplate, will be truly functional and will have real-world utility. Will the next generation of personal computers please hurry forward? The industry, we fear, badly misses you.

Robert C. Lock

Editor in Chief

Fly the unfriendly skies.



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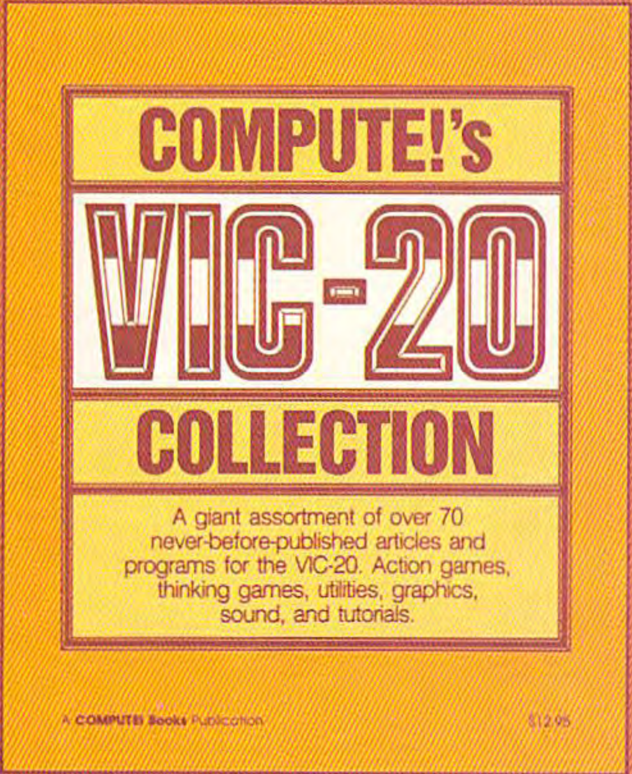

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GAZETTE FEEDBACK

Editors And Readers

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

Automatic Proofreader

In most of your program listings, you put a colon and a one-to-three digit number after each line. What's the reason for this?

Paul Gremel

COMPUTE!'s GAZETTE *frequently (usually every other month) publishes a program called "Automatic Proofreader." When you type it in and run it, it prints a number at the top of the screen every time you press RETURN.*

If you load and run the Proofreader before typing a GAZETTE *program, you can check the number on the screen against the rem number after each line of the program listing. If they don't match, you've made a typing mistake. It's not completely foolproof, however. The checksum comes from adding up the ASCII values of the characters you type (every character has a corresponding ASCII value—"A," for example, is character number 65), and if you transpose two characters (PRITN instead of PRINT, for example), the number appears to be correct even though the line is entered incorrectly. And the Proofreader ignores spaces because Commodore BASIC allows you to enter either PRINTA (no space) or PRINT A (with a space). Spaces inside quotation marks can be important, though, so be careful when typing lines containing "strings." And if you accidentally forget a line, Proofreader can't tell you that a line is missing.*

When you're checking a program that doesn't work, watch for spaces, missing lines, and transpositions (especially if the program has a lot of DATA statements containing numbers). To find missing lines, look at the magazine listing first, then check the screen, rather than looking at the screen first. If you've forgotten to type a line, everything you see on the screen will be in the listing, but not everything in the listing will be on the screen.

Preventing Disk Drive Heat Buildup

Many of us worry about disk errors caused by overheating of the drive. Even after just half an hour, my 1541 becomes quite warm. An external fan works well, but it should be turned on when the disk drive is first turned on. If you wait until the heat has already built up, much of the heat will be blown toward the disk and the read/write head, thus causing the problem you're trying to avoid by using a fan.

Joseph T. Malloy

Thanks for the tip. Some 1541s (and a few 64s as well) suffer from heat buildup, especially in the middle of summer. Muffin fans, available at electronics stores, can help prevent overheating.

Running Part Of A Program

Is there a program or routine that will allow me to run only a certain amount of lines? I know I can type RUN 1140 and it will start at line 1140, but I can't get the computer to run only a segment.

Andy Harvey

*Either RUN 1140 or GOTO 1140 will start up a program at that line. The difference is that GOTO preserves variables, while RUN erases them. You can define variables before a GOTO—***X=5:N$="SAMPLE STRING":GOTO410***. This technique is useful when you're testing subroutines or sections of a program.*

To stop the program at a certain line, insert a STOP or END. Or press the RUN/STOP key. You can then examine variables by printing them. Type CONT to make the program continue.

Double Meanings

"Disk Merge" in January appears to have an error. Line 340 says QUIT=FC$="*" and from what I've read about converting programs to the 64, you have to rewrite lines like A=B=C.

Richard D. Evans

Some versions of BASIC allow multiple assignments, like A=B=15, which would have to be translated

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APROTEK

1071-A Avenida Acaso, Camarillo, CA 93010 *to A=15:B=15 on a Commodore computer. Putting a number into a variable (called assignment) is one of the functions of the equals sign.*

But "=" has a second meaning. The equals sign in IF A=15 THEN PRINT "FIFTEEN" causes the computer to compare the current value of A against 15, and if A=15 is true then print something. There is already a value in A, and the equals sign is not assigning, but comparing. The computer marks a true statement with −1; a false statement with 0. In line 340 from Disk Merge, the first equals sign assigns, the second compares. The variable QUIT is given a value of 0 or −1 depending on the truth of FC$="".*

Try typing the following lines to see the difference between assignment and comparison:

```
A=5:B=A=5:C=A=6
PRINT A,B,C
PRINT A=5,A=6
```

One Key Disk Load

I own a Plus/4 and have found a way to load programs from the directory. First, type this:

```
KEY 1, "DLOAD"+"{19 RIGHT}"+"
{3 SPACES}"+CHR$(13)+"{CLR}"
```

Next, list the directory by pressing f3, move the cursor to the line where the program is, and press f1. The program loads and the screen clears.

Juan Sanchez

It certainly helps to have definable function keys. This shortcut should help our readers who own a Plus/4 or 16.

Throwing Out Garbage Strings

I have a program that works fine most of the time, but during some operations it stops in the middle of a routine and takes a few seconds to start again. I know the variables are stored at the end of the program and was wondering if they may be interfering with the program. Could I put the variables elsewhere?

N.L Jonker

A numeric variable takes up a certain amount of memory, no matter what number you assign to it. String variables, though, need different amounts of memory according to how many characters they hold. Type in the following program:

```
10 GETG$:IFG$=""THEN10
20 IFG$<>CHR$(13)THENPRINTG$;:A$=A$+G$:GO
   TO10
30 PRINT:FORJ=(PEEK(51)+256*PEEK(52))TO(P
   EEK(55)+256*PEEK(56)-1)
40 PRINTCHR$(PEEK(J));:NEXT
```

This is a short program, leaving a lot of room for variables. Run it and type ABC followed by RETURN. You should see ABCCABBAA. The first three letters (ABC) are the current value of A$, while the fourth (C) is the most recent value of G$. Everything else is garbage—old values of A$ and G$. (First G$ held an "A," so A$ held an "A." Next, G$ was "B," and A$ equaled "AB.") Dynamic string variables are stored at the end of available memory with new strings added underneath. Try running the program and typing "TUVWXYZ," to see how much garbage is generated.

At some point in your program, the computer is running out of memory for new strings, so it has to get rid of the unused characters in a process called "garbage collection." It searches through memory for invalid strings and erases them. This may take a minute or so, depending on how many string variables you've defined. You can't avoid garbage collection, although you can force it to happen by defining a variable as FRE(0)—the amount of free memory remaining. For more about this subject, see "Debugging BASIC, Part 2" in February.

Another reason you may see pauses is related to how variables are stored in memory. A BASIC program is stored at the beginning of available memory. It is followed by simple variables, then array variables. If you DIMension a very large array, then define a simple (nonarray) variable, it takes some time to move the whole array up a few bytes in memory (about half a second for a 5000-element array). The solution is to define all nonarray variables at the beginning of your program.

Smooth Paper For The Okimate

We've found an alternate source of paper smooth enough for the Okimate 10 printer. The only disadvantage is that it comes in single sheets rather than fanfold. It can be found at Sears, catalog number 3A5470, $5.99 for 500 sheets.

Thomas Parady

Smooth paper gives the best results on the Okimate and judging from the print quality of your letter, you've discovered a good alternative to ordinary bond paper. Thanks for the information.

Turning Off The Cursor Keys

Is there a way to disable the cursor keys? I'm writing a program and don't want anyone moving the cursor around in an INPUT statement.

Kyle Chow

There are several methods to prevent cursor movement during INPUT. The simplest is to **POKE198,1: POKE631,34** *before each INPUT. The first POKE tells the program one key has been pressed, the second puts a quotation mark in the keyboard buffer. This forces the computer into quote mode, and the cursor keys will appear as reversed graphic characters. You're not really disabling the cursor keys, just*

preventing them from moving the cursor around the screen.

Or you can give up INPUT and use GET instead. After GETing a character, if it's not a cursor key, print it on the screen and add it to the string. If the user presses RETURN, a CHR$(13), then continue the program. You'd also have to check for the INST/DEL key. This is a little more complicated, but effectively disables the cursor keys.

Here's another method, a short machine language program that completely disables the cursor keys, both inside and outside of a program. Type it in, save it, and then run it.

```
10 FORA=710TO758:READB:POKEA,B:NEXT:END
20 DATA 169,229,141,143,2,169
30 DATA 2,141,144,2,173,246
40 DATA 2,73,1,141,246,2
50 DATA 208,10,169,72,141,143
60 DATA 2,169,235,141,144,2
70 DATA 96,165,203,201,7,240
80 DATA 4,201,2,208,4,169
90 DATA 64,133,203,76,72,235,0
```

SYS710 turns off cursor keys if they're on, and it turns them back on if they're disabled. The program inserts a machine language wedge into the keyboard table vector at $028F. For more details about this technique, see Mapping the Commodore 64 *from COMPUTE! Books.*

Flippy Update

We would like to clarify a comment regarding potential read/write head damage (June '85) caused by using both sides of a single-sided disk. Someone who uses the second side of a single-sided disk risks data loss because the flip side may not have passed error-free testing. Some vendors do certify "flippies" that have passed such testing. While there may be some concern about potential damage induced by debris trapped in the disk liner (and then released when the reverse side is used), it appears that this is not, in fact, a threat to the read/write head of the disk drive.

A Hardware Fix For Jumpy TV Screens

My 64 works fine with our RCA television, but when hooked up to a Zenith the screen skips up and down a quarter inch every second or two. The Zenith works fine with a VIC, but can't be used with a 64. Turning off the automatic fine tuning has no effect. Is there a hardware or software fix available?

Joe Tomanic

Jittery screens can often be fixed with a single POKE on a VIC (POKE 36864,133). But there's no simple fix for vibrating 64 screens.

Several readers have written about this problem. We called an authorized Zenith repair shop and a repairman asked if the television was an older model. Apparently, certain older TVs (not just Zeniths) have jumpy screens when hooked up to a computer. Zenith has sent technical bulletins about how to solve the problem to their repair shops. A jumper wire inside the TV must be cut, but it's not a job for an amateur. Contact a local TV service shop and have them take care of it.

Will It Fit On The Disk?

I have disks almost completely full and like to fill them up as much as possible.

Is there any way to figure out how many blocks a program is from its listing? Also, I've seen that many commercial games are exactly 66 blocks long. Any reason for this?

Afshin Livian

There's nothing really wrong with filling up disks, unless a disk is physically or magnetically destroyed and you have no backups of the programs or files. Also, the disk save-with-replace command has problems handling nearly full disks.

Each disk sector holds 256 bytes. The first two point to the next track and sector, leaving 254 for your own use. If you know how many bytes your program takes up, you can divide by 254 to find the number of disk blocks it will use.

FRE(0) returns the number of bytes not *being used for the program and its variables. You can clear out the variables with the CLR command—type the letters C-L-R, rather than pressing SHIFT–CLR/HOME. The following line tells you how much memory is not being used by the program:*

```
CLR:PRINT FRE(0)
```

If you own a 64 and the result is negative, add 65536. Once you know the amount of free memory, subtract it from the amount of BASIC memory. A Commodore 64, for example, when just turned on says 38911 BASIC BYTES FREE.

Let's say you have a Commodore 64 program in memory and CLR:PRINT FRE(0)+65536 results in 37192. Subtract from 38911 to get 1719. That's how many bytes your program uses. Divide that number by 254 and the result is between 6 and 7. Thus, your program will use seven blocks.

*Your second question is a puzzler: 16K is a nice even number in machine language, exactly a quarter of 64K, but calculating (16*1024)/254 returns 64 and a fraction. A 16K program should use 65 blocks, not 66.*

Moving Messages

I own a 64 and would like some information on how to get a message to scroll across the screen. I've seen this done in games I've bought.

Kurt Kunert

For Commodore 64™ Computers

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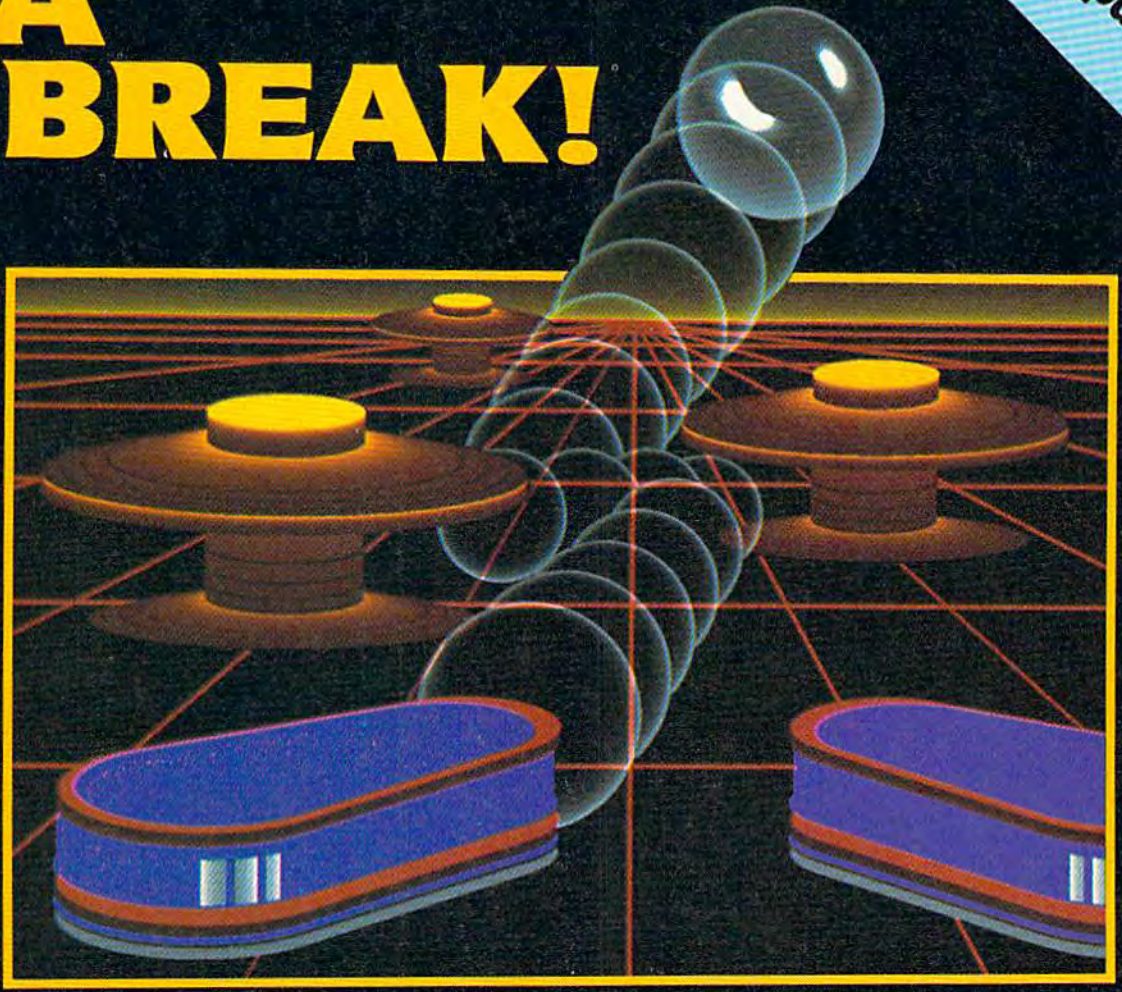

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Coarse scrolling, moving characters a character at a time, would be one answer. Position the cursor, print a CHR$(20) to delete the character to the left of the cursor, and you'll see the rest of the line scroll to the left. To move a line of characters to the right, print a CHR$(148), the insert control character.

Moving characters a pixel at a time, smooth scrolling, is a little more difficult. You can use custom characters or the smooth scrolling registers, but a somewhat easier method would be to use sprites.

Sprites don't have to be limited to players or objects in a game; you can just as easily define their shapes to look like words or phrases. You can create your own library of characters, or PEEK character ROM for the shape of each letter.

Like A Telephone Call

What in the world is an interrupt?

Brian Weese

Its name provides a hint—an interrupt is like an interruption. For example, if the telephone rings while you're reading a book, you would save your place with a bookmark and answer the phone. When the call (interrupt) is finished, you return to the book.

In a 64, a timing chip pulses a million times a second. The chip that runs the show, the 6510, listens to the clock and follows ML instructions, which may take two or more clock cycles to complete. This central processor talks to memory chips, fetching instructions for calculations and moving numbers around in memory.

There's another chip (the Complex Interface Adapter #1, or CIA for short) that spends most of its time doing nothing. When 1/60 second has gone by, it sends an interrupt request (IRQ) to the 6510. The main processing chip then marks its place in the program (with a sort of computer bookmark) and does some important work like checking to see if a key has been pressed and clicking the jiffy clock.

There's one more kind of interrupt, not a request, but a demand. A nonmaskable interrupt (NMI) is similar to a phone call that requires you to drop your book and leave the house for an emergency. Pressing RUN/STOP–RESTORE is an example. The computer doesn't go back to the program, it drops everything, stopping the program.

Using advanced techniques, you can insert your own short ML programs (wedges) in the interrupt routines. You can also trigger interrupts to happen when sprites collide or when a light pen sees a blip on the screen.

A Shortcut For Ending Disk Chatter

"An End to Disk Drive Chatter" from "Gazette Feedback" (December 1984) is one of the most important tips you have printed. If used consistently, it solves the problem of the disk drive banging when commercial software is loaded. But it's inconvenient to enter the line every time you load a program. Is there a simpler way to make it run?

Charles C. Badeau

The line that stops disk chatter is fairly short; all it does is write a 133 to memory location 106 inside the disk drive. But, yes, there is a shortcut:

```
10 OPEN1,8,2,"&C,U,W"
20 FORJ=1TO9
30 READK:PRINT#1,CHR$(K);
40 NEXT:PRINT#1:CLOSE1
50 DATA1,6,6,169,133,133,106,96,128
```

First, insert one of your own disks (do not try this with a commercial disk). Enter and save this program. Next, type RUN. A USR file with the name "&C" is created on the disk; think of it as short for "et cetera." Before loading a commercial program, insert your disk and type **OPEN 15,8,15,"&C"** *and then remove your disk and load the commercial software.*

If a file begins with an ampersand (&) and is written correctly, OPEN 15,8,15,"&filename" loads the machine language program from the file into the disk drive memory and automatically runs it. Ampersand files are an undocumented feature of the 1541 disk drive.

Why Machine Language?

A year ago I retired from an aircraft company where I worked on engineering programs for mainframe computers. I translated a program from FORTRAN to Commodore BASIC and it worked fine. But sometimes it took half an hour to finish the calculations.

I got interested in machine language, but realized that it would take a long time to learn enough to make the program run faster. Then I bought a BASIC compiler from Abacus. It compiled my BASIC to a machine language program that ran in four minutes.

If the compiler will make BASIC that fast, is there any reason to continue learning machine language?

George D. Johnson

There's no simple answer to your question. A compiled BASIC program is like a bicycle with a motor. You reach your destination much faster, but it's still not as fast as an automobile. If 30 minutes in BASIC is unacceptable, but four minutes after compiling is fine, you may not need to learn machine language. It depends on your goals.

With machine language, the time could probably be reduced to less than a minute, especially if you write a program from scratch, rather than translating from FORTRAN to BASIC to ML. But you might spend hours of programming and debugging time to gain the additional three minutes.


Commodore-64 Screen Picture

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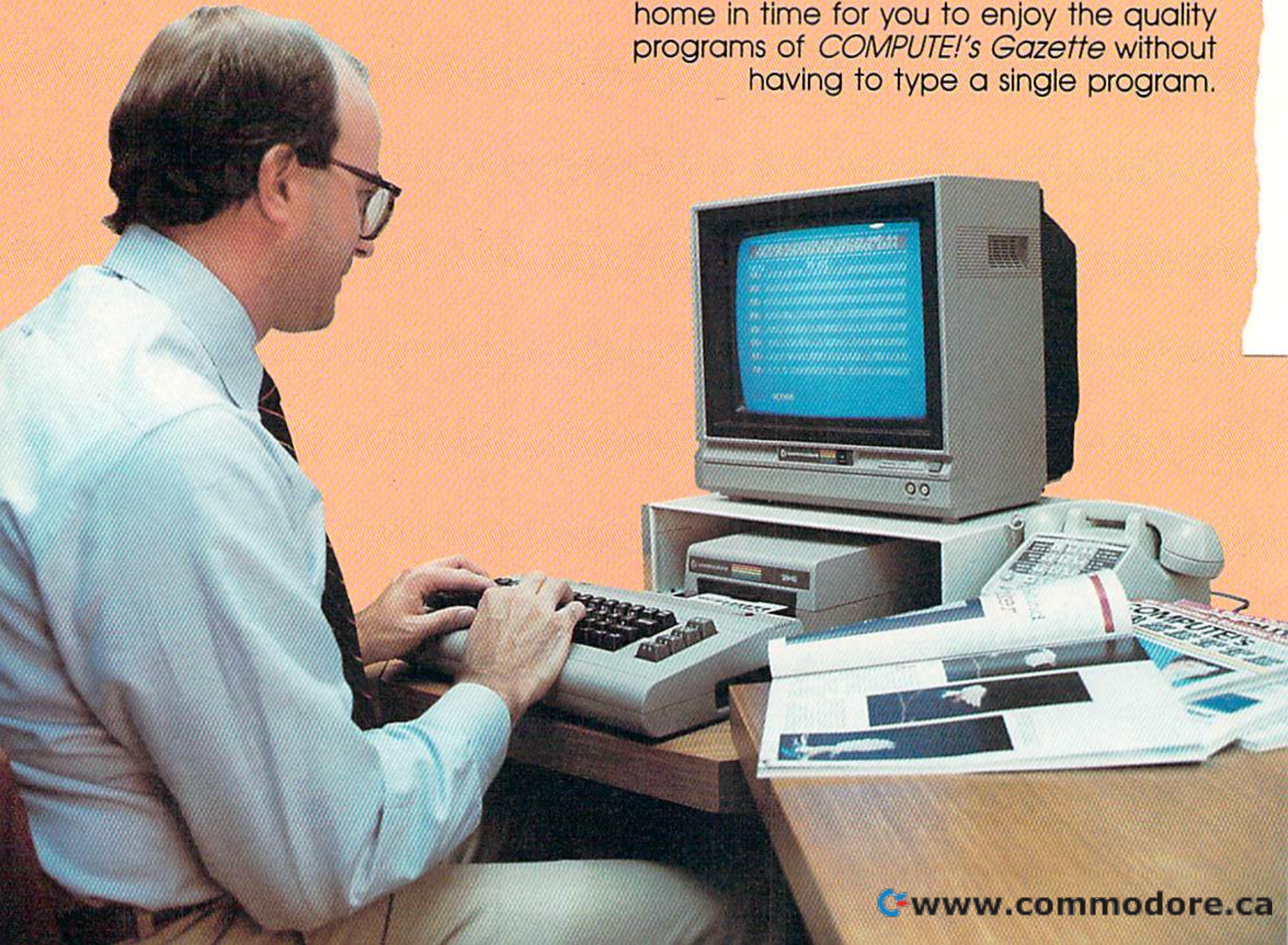

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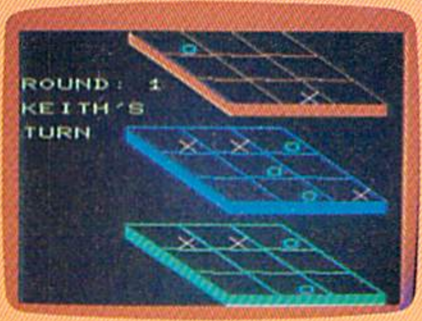

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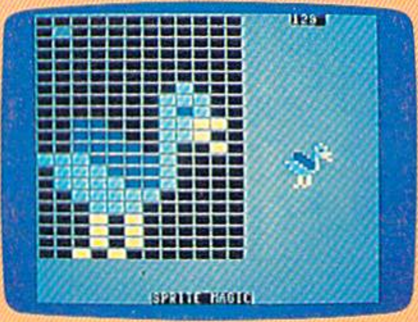

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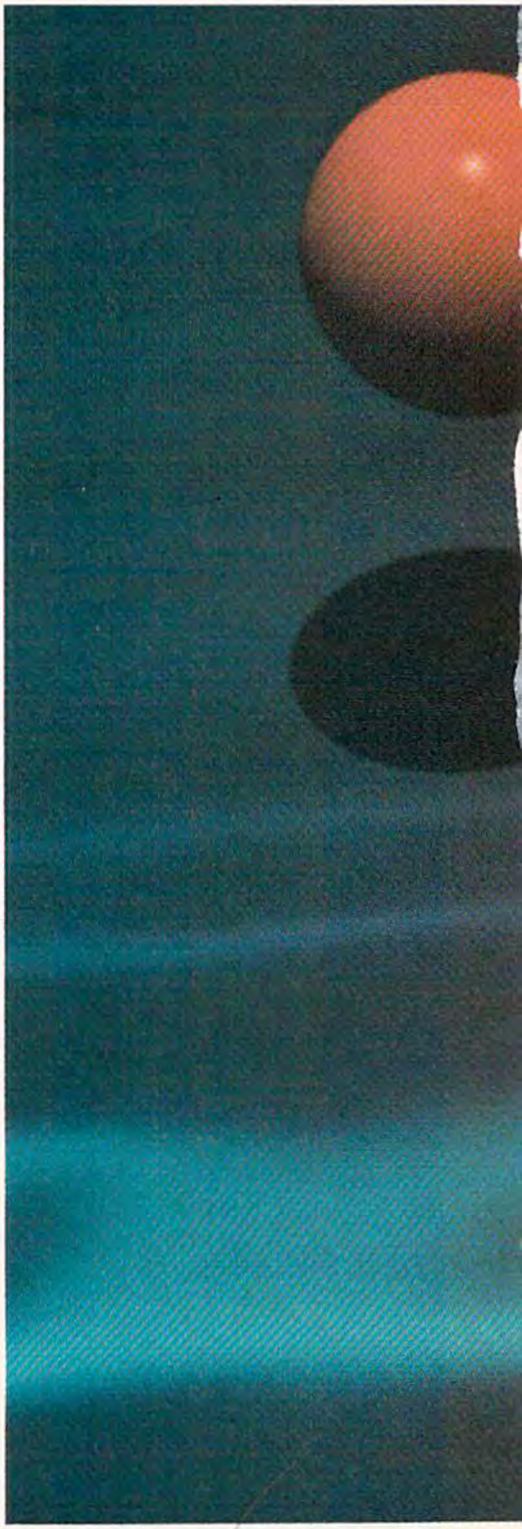
DIGITAL DESIGNS

The Evolution Of Computer Graphics

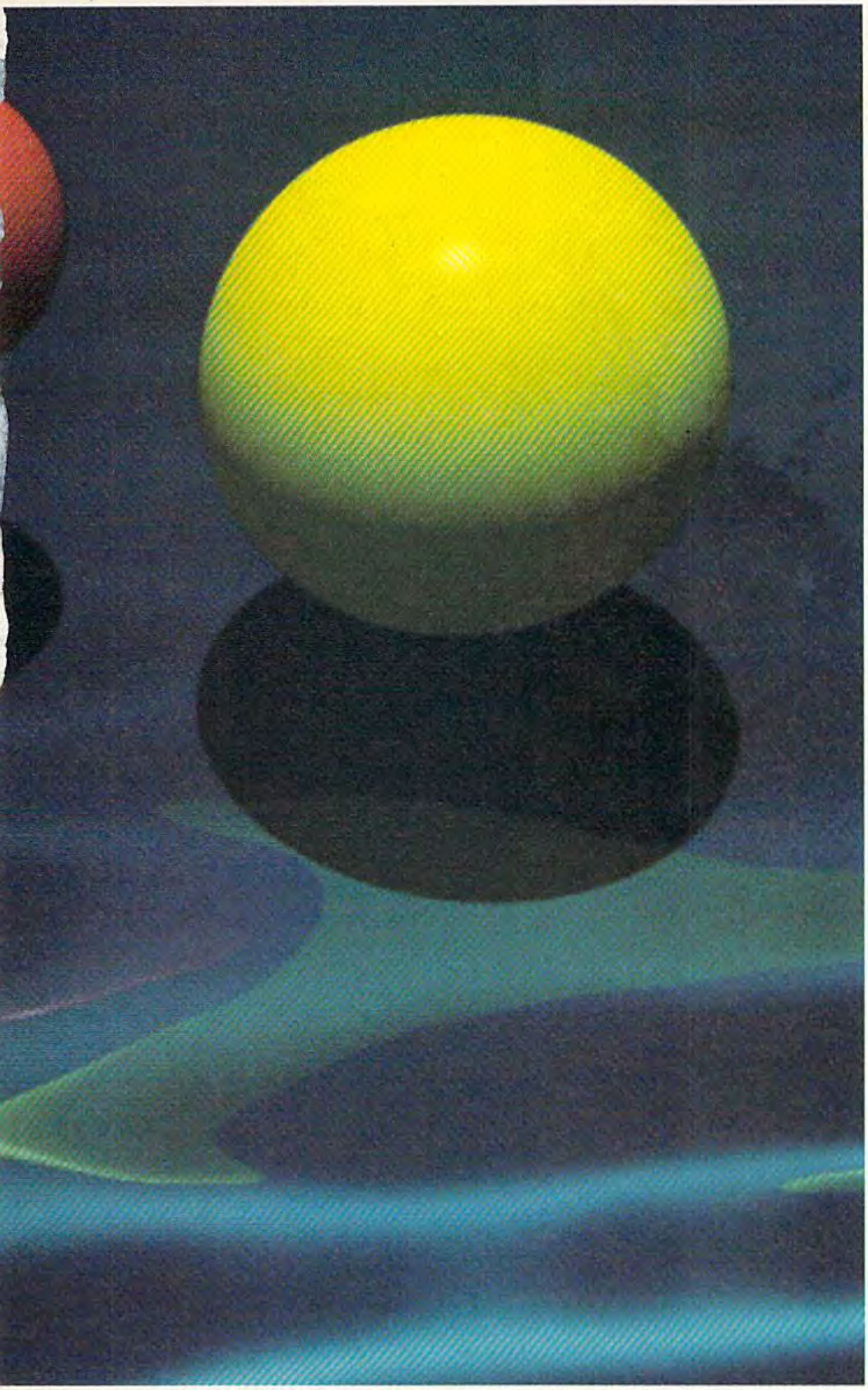
Kathy Yakal, Feature Writer

We've come a long way since Pong, the first computer videogame. Computer-generated graphics are making today's games look much more realistic. And they're revolutionizing imagery in art, science, television, and many other fields. In the next decade, with the help of new hardware—and the vision of those exploring new ways to expand existing technologies—we'll see this evolution continue.



Probably a day doesn't go by in your life when you don't see computer-generated images. Computer-enhanced pictures are used to predict the weather and find oil. They're used extensively in medicine to help cure disease and better understand the way the human body works. Filmmakers use them to create images that weren't possible before and, more recently, artists are using them to create comic books. Computer-generated graphics are allowing people in almost every field to better understand—and in some cases, to alter—the world around us.

Research on the uses of computer graphics in these areas has been going on since the days when computers filled entire rooms. But in the late sixties, young employees at electronics companies, as well as students at major American universities, were creating graphics for another purpose: games.



The earliest video entertainment available to the masses was Nolan Bushnell's *Pong*, a simple ping-pong style arcade action game. Players simply used an onscreen paddle to bounce a white "blip" back and forth. Bushnell built the game into a single-purpose console and asked permission to put it in a pizza parlor to test public reaction. As the story goes, the machine broke after a week. When it was taken apart for repair, the problem was obvious: the coin box was too full of quarters to accept any more.

Bushnell founded Atari to start mass-producing the game machines. As microprocessors became less expensive and easier to obtain, videogames moved into homes in the form of the videogame machine. As they were replaced by multipurpose home computers, thousands of software developers began to stretch the graphics capabilities of the tiny chips.

At about the same time that Nolan Bushnell was readying his new invention, nuclear physicist Melvin Prueitt was writing his dissertation on molecular dynamics. He needed a way to remove extraneous lines from some of his drawings, and his knowledge of computers allowed him to write programs that would do that.

But as he continued his work at Los Alamos National Laboratory, he found himself drawn more and more to experimenting with computer graphics to produce theoretical designs. And when some of those pictures started popping up on book covers, he decided to devote himself to that kind of work full time.

Prueitt had realized that scientific data—properly displayed—can be quite aesthetically pleasing. A young scientist was being lauded as an artist, a pioneer in the field of computer art.

Several of Prueitt's creations, along with those of other artists and scientists, were recently compiled in *Art and the Computer* (1984, McGraw-Hill), a collection of computer-generated designs which shows the range and vision of today's computer graphics pioneers.

Though a few of the book's pictures were produced on home computers, mini- and mainframe machines are required for sophisticated state-of-the-art graphics. "The main problem is not really the software in this case, but the hardware," says Prueitt. "The home

Designers at Raster Technologies, manufacturers of color graphics controllers, created these pictures using a Prime 750 (a minicomputer). *Spheres in a Warped Pool* (on previous page) and *Ocean* (top photo) were done by David P. Kirk. *A Study in Surfaces* (bottom photo) by Olin G. Lathrop. (Photos courtesy of Raster Technologies, Inc.)

computers don't usually have good enough resolution to produce the kinds of pictures you want. But as that improves, you'll see people doing some pretty fantastic things on their home computers.

"If you can close your eyes and imagine a beautiful scene, the question is, *How do you produce that scene so that someone else can see it?* If you're talented with a paintbrush, you get out your brush and spend several weeks trying to create that scene. If you're not that kind of artist, then you just keep it inside.

"But if you can conceive of pictures and also do the mathematics, then you can program a computer to produce that picture so other people can see it. I guess if you're just a pure mathematician and don't have any artistic feeling for anything, then you probably wouldn't be able to create a mental image. So you need to both be able to conceive of something, and then reduce it to a computer program that can produce the picture."

Which is not to say that you must necessarily be a talented programmer to create computer art. Graphics software—even digitizing systems—are available for home computers. Jack Nichols, art director for software publisher Mindscape, believes those tools make computers acceptable to artists who have an aversion to the machines.

"I don't think of them as computers. I think about them like I would a stick of charcoal or an oil paint brush or an acrylic medium. The more I'm around them, the more I find they're just a plastic box you can beat on."

Filmmakers have been expanding frontiers of computer graphics for years to create visual effects never before possible. It's not surprising, then, to see movie studios getting into the videogame business.

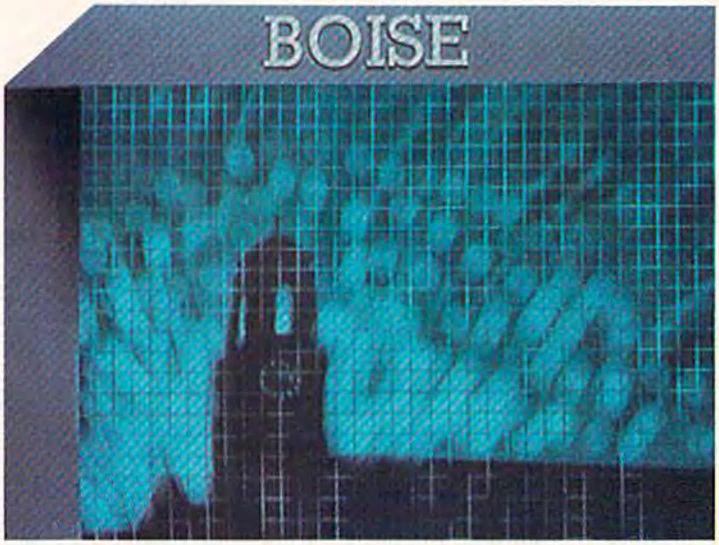
David Fox joined the newly formed games division of movie studio Lucasfilm in 1982. "We started experimenting with the Atari, the idea being to just create throwaway games," Fox recalls. "Partway through the project, we realized the games were too good to throw away."

Fox was sharing an office at the time with Loren Carpenter, who had extensive experience with computer graphics. Carpenter thought they might get some interesting results by using *fractals*—a mathematical principle not yet exploited by software authors—to develop the game's landscape. The result was *Rescue on Fractalus* (published by Epyx).

The theory of fractals isn't new. "It's just that no one had done it before," says Fox. But it's an example of the kind of research being done to move one step closer to even more realistic computer graphics. The next big step, though, is already here: the new generation of computers, the 16/32-bit machines based on Motorola's 68000 microprocessor (Apple's Macintosh, Commodore's Amiga, and Atari's ST).

"With the 16-bit machines, we can take what's been done before and make it run with a faster frame rate, more colors, and higher resolution," says Fox.

But that doesn't mean we have to reinvent the wheel, according to Jack Nichols of Mindscape. "We don't have to do another *Space Invaders*, or any of those other things that captivated audiences."



All photos courtesy of The Weather Channel. Artists: Mike Scearce (upper two photos, lower left) and Paul S. Newman (lower center and right).

The Weather Channel uses computers for creating more than weather maps and satellite photos. About 95 percent of its images are electronically produced, says art director Eddie Terrill. Using state-of-the-art graphics systems like the Quantel *Paintbox* has resulted in numerous broadcast awards for superior design. Beyond that, automating many of the station's functions allows meteorologists to concentrate more on something else: predicting the weather.

Rather, the new computers will move us closer to being able to do at home what Melvin Prueitt does on his computers at Los Alamos—and beyond. "Already, in fact, I see paint systems and things emulating systems that I've spent $150,000 for," says Nichols.

"I'm very selfish on this order. I want all the resolution I can get, all the colors I can get. I see these new machines giving me definable palettes, and not restricting me to the number of colors they give me."

And that kind of flexibility makes the computer medium more acceptable to him as an artist. "That freedom lets me just get in and zip around. I don't care if they want me to do it with a mouse or a joystick or a tablet or by talking into a microphone. I don't care how they get me there because I'll draw with my foot if that's what it's going to take me to do it."

By providing such artistic satisfaction and maneuverability to the designers of software, the consumer ultimately benefits. "What we're aiming for is an experience that people can have when they play a game that makes them feel like they're really in the environment. I know *I* want something in my house that can do that," says Lucasfilm's Fox.

So how long will it be before we see images on computer screens that make us think we're watching television? That can be done now, says Fox, but not in realtime. To create a picture like that on a fairly large computer can take hours. And it could be another ten years, and a few more generations of microprocessors, before people can do that in their homes.

One thing it takes to make pictures look real is a process called *anti-aliasing*, a blending of the boundaries wherever two colors meet on a design. If a computer cannot generate enough shades of each color to do that, edges look stair-stepped instead of smooth. Fox looks for computers to contain specific chips for just that function.

Another boon would be the use of *CD ROM's* in future computers. A CD ROM is a read-only memory device that uses a compact disc format for digital information. Currently, CD machines are available as music systems. If a home computer were interfaced with a compact

disc player, it would add over 500 megabytes of storage space. (Most CD players have jacks labeled "For future expansion"; this is one possible use.)

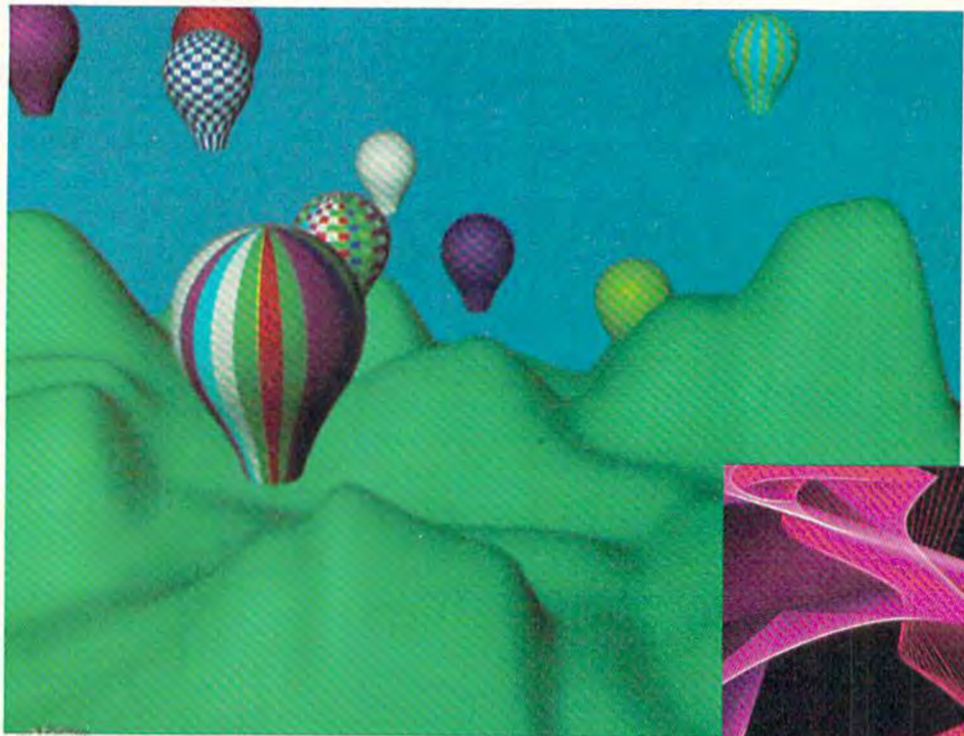
Besides the obvious advantage of that much extra storage space (you could literally store encyclopedias on disks), the entertainment possibilities are tremendous. "You could store precomputed images—the ones that take hours to produce—and then bring them up in a game so you get really nice images," says Fox. "It's a way to force the small computers to do more."

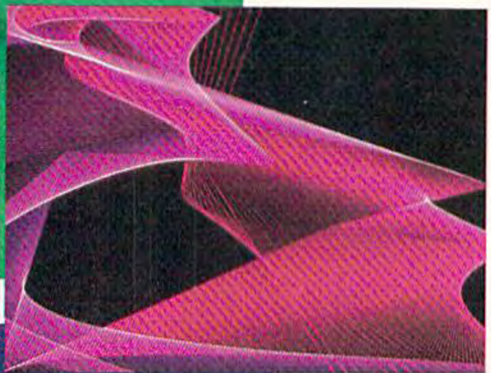
Another popular form of home entertainment may also become a part of your computer system: the video cassette recorder (VCR). "When these machines talk to my VCR at home—and I'm sure they will—I see me being able to freeze a frame and grab it from my VCR, and my computer will understand that," says Nichols. "I see that as setting up horizons that I can ram around in."

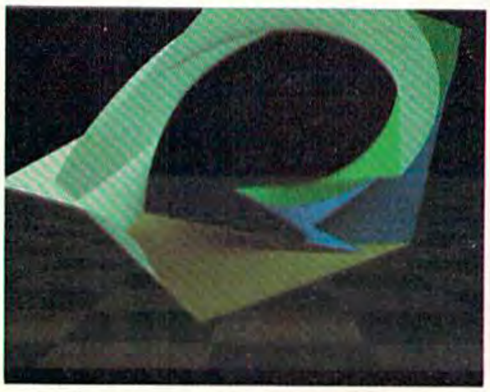
All of these new, powerful tools may bring forth hidden talents from unexpected sources, says Prueitt. "I think that what you're going to see is that people who are, by nature, let's call it spiritually artistic, the kind of person who appreciates beauty, who likes to see beautiful landscapes or spend hours in museums looking at pictures...maybe those people don't have the coordination to be able to produce that on a piece of canvas, but it's inside of them...this is the kind of person who I think will be brought forth by computers. Whether they're traditional kinds of artists or not, they're artistic inside and they'll be able to produce art."

Science Becomes Art

All photos courtesy of Melvin L. Prueitt, Motion Picture Group, Los Alamos National Laboratory







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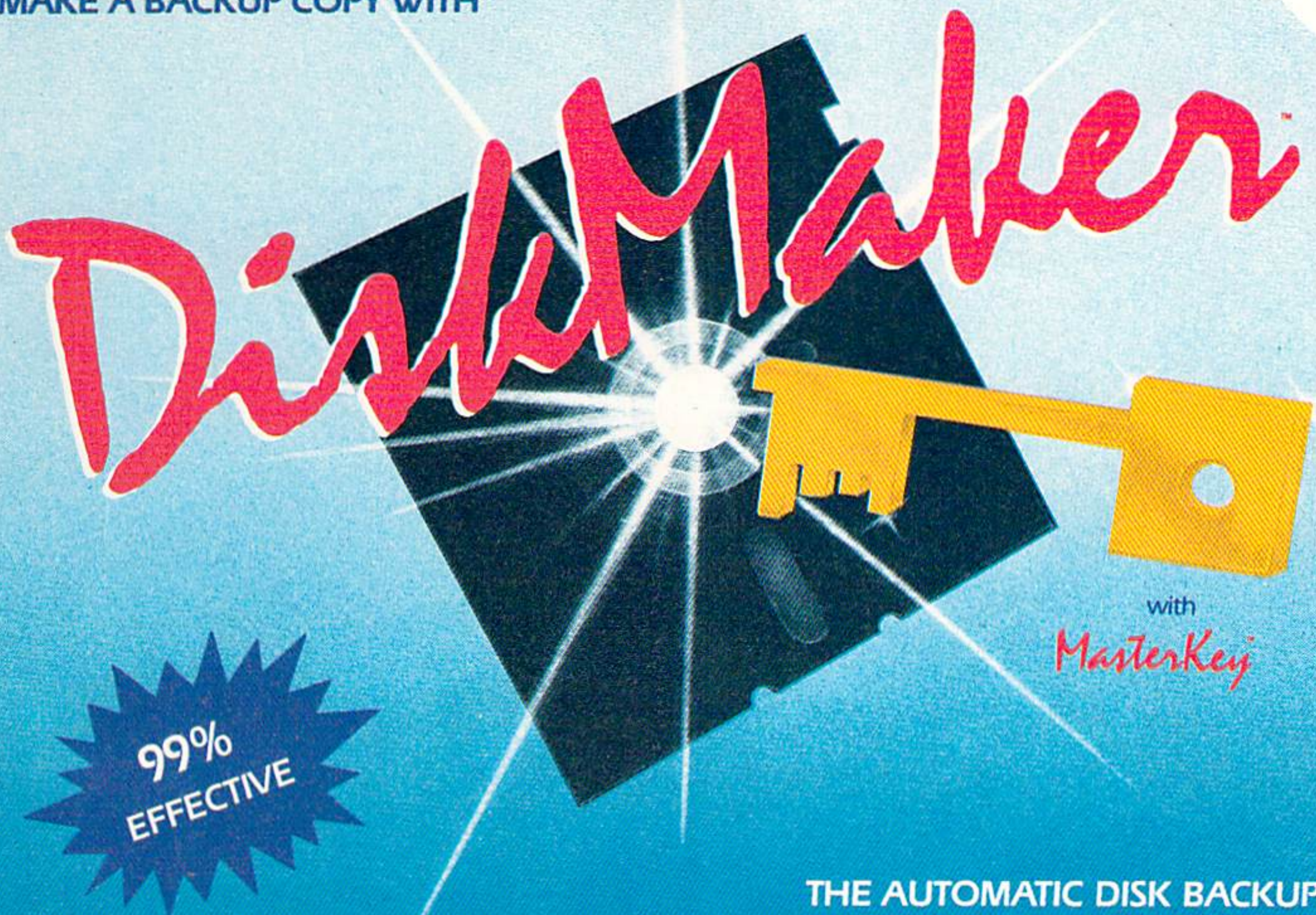

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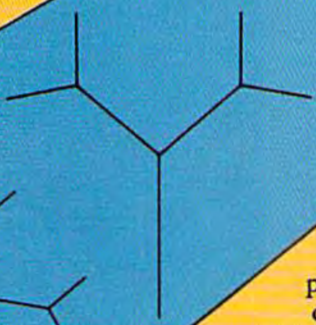
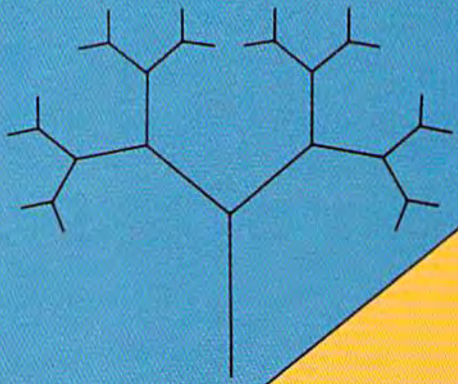
Funnies of the future? First Comics, of Evanston, Illinois, has produced the first comic book created on a microcomputer. Artist Michael Saenz drew *Shatter* on an Apple Macintosh, then added color to each frame.

The Macintosh represents a major step in the evolution of computer graphics, says First Comics' Michael Gold, because of its affordability, ease of use, and high-resolution graphics capabilities. "The Macintosh is a very easy machine to use," he says. "For artists, who want to minimize interference, that's very important."

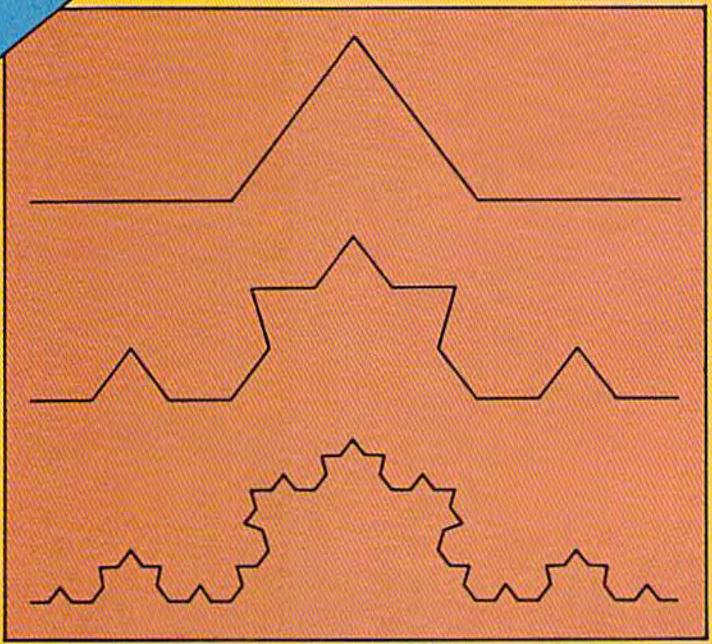
Fractals

These figures illustrate how fractals work. Line A branches off at a 50-degree angle to form a Y intersection (the two shorter lines are 2/3 the length of A). By continuing the pattern, a tree-like structure is formed.
(Fractals created by staff artist Lee Noel.)





The lacy coastline pictured below was created by breaking a line segment into four equal parts, then letting that pattern continue in each of the parts. Though you can still make out the original shape in the fourth drawing, further steps would make it harder to distinguish.



Fractals were used in the development of *Rescue on Fractalus* to generate the constantly changing landscape. Had the design team at Lucasfilm Games used more traditional programming methods, the program would have taken up more memory, and each individual change in scenery would have had to be painstakingly plotted—which means the resulting graphics may have been much cruder.

HINTS&TIPS

BASIC Shortcuts

If you've discovered a clever timesaving technique or a brief but effective programming shortcut, send it to "Hints & Tips," c/o COMPUTE!'s GAZETTE. If we use it, we'll pay you $35. Due to the volume of items submitted, we regret that we cannot always reply individually to submissions.

Some Ideas For Beginners

Christophe Robin

To make a program run faster: • use NEXT rather than NEXTX or NEXTR; • don't put REMs inside FOR-NEXT loops; • use variable names of one letter, the more characters in a variable name, the slower the program runs; • write several statements on the same line, separated by colons; • when doing a lot of calculations, use variables rather than numbers (X=Y*Z instead of X=5*130).

If you're writing a program that contains POKEs or SYSes, save it to tape or disk before running it. If used improperly, these commands can lock up the computer and you'll lose the program.

When a disk drive makes crackling sounds and the red light is blinking, you may have a disk that's stuck in its envelope. Remove the disk, put a couple of fingers in the middle, and gently rotate it a turn or two. You may loosen the disk enough to make it work.

A long name for a disk program, like "DISKREADWRITE" gives you more information about what the program does, but may be difficult to remember. A shortcut is to use an asterisk (*) as a wildcard. LOAD "DI*",8 will load the first program that starts with the letters "DI." If there are other programs beginning with "DI" use something like LOAD "DISK*",8 or LOAD "DISKREAD*",8.

To reset your computer as if it had been turned off and then turned on, type SYS64738 on a 64, or SYS64802 on a VIC.

It's a good idea to validate heavily used disks once in a while, especially after you've scratched several files. Enter OPEN 15,8,15,"V0" and (on a separate line) CLOSE 15. This causes the drive to look through the directory and mark which blocks are being used for programs and files.

Taping Before Typing

Milton A. Young

Here's a tip for people who type in programs from magazines. To minimize errors, dictate the program first into a cassette player. Read slowly enough so that you can keep pace while typing. Include the line number, program line, and checksum number for "Automatic Proofreader." Then listen to the tape while you enter the program. It helps to have a pause button on the tape player. To keep from getting bored, I usually do 20 to 30 lines at one sitting and then take a break.

Overall, this method may take a little more time, but it has several advantages. First, you nearly eliminate typing errors, which means much less time spent looking for mistakes. And when you do mistype something, you can listen to the tape while you check the lines on the screen. It's even a good way to learn programming. For some reason, listening to yourself reading program lines gives you a better understanding of how the program works.

Defined Equations

Paul Shaughnessy

The DEF FN command allows you to define a complex calculation as a function with a short name. DEF is short for DEFine and FN means function, so it's actually a function that creates a brand new function, like establishing a new keyword in BASIC:

```
10 DEF FN A(X)=(5*X)-10
```

If you place this function definition at the beginning of a program, you can later multiply by five and subtract ten, with function "A"—**PRINT FN A(20)** or **K=FN A(J)**, for example. In this simple function, one number comes in and another goes out, although it's possible to define functions that operate on more than one value.

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Now, to add a little twist to DEF FN, we can add another equals sign and a number:

```
10 DEF FN A(X)=(5*X)-10=20
```

All of a sudden, we have a defined equation. The first equals sign is part of the DEF FN command, the second equals sign says we're going to compare the left half against the right half of the equation. The function will return a zero if the equation is false, minus one if it's true, as you can see in this example. (The answer to this simple equation is 6.)

```
10 DEF FN A(X)=(5*X)-10=20
20 FOR J=1 TO 10:PRINT J,FN A(J):NEXT
```

There are several variations you can use to make defined equations more flexible. First, you don't have to limit the equation to one variable; you can insert additional variables, or PEEKs or other defined functions. And the second equals sign could be a less-than, greater-than, or both. With several such functions, you could loop through possible answers until you find one number that's too high, another that's too low. Then loop through that range, using a smaller STEP size, until you find the answer or an approximation. You can also use this technique to solve diophantine equations (as in math problems like "I have four coins that add up to 37 cents; what are the coins?").

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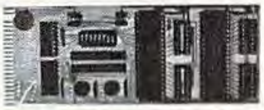

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No. of Windows	2	8	9
Built-in Functions	21	39	33
Link Spreadsheets	NO	YES	NO
Sort	NO	YES	YES
Program Mode	NO	NO	YES
Money-back Guarantee	NO	NO	YES
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SIMPLE ANSWERS TO COMMON QUESTIONS

Tom R. Halfhill, Staff Editor

QA

Each month, COMPUTE!'s GAZETTE *tackles some questions commonly asked by Commodore users and by people shopping for their first home computer. If you have a question you'd like to see answered here, send it to this column, c/o* COMPUTE!'s GAZETTE, *P.O. Box 5406, Greensboro, NC 27403.*

Q. You often publish programs which require special POKEs to "protect BASIC" or "move the top of BASIC." Why do you have to do this?

A. Usually this is necessary to make room in memory for a machine language program without interfering with BASIC. Let's back up a bit to explain the problem in more detail.

When you write a program in BASIC, the computer takes care of a lot of picky details for you. Among these details is *memory management*—the process of making sure that memory conflicts are avoided. For instance, you might get upset if the computer suddenly decides that it needs a chunk of memory for some reason and appropriates a piece of the BASIC program you've been typing in for the last hour. Your program would be a jumbled mess.

To prevent things like that from happening, the computer keeps track of how much memory is available for BASIC programs. In effect, it draws an imaginary boundary between the end of BASIC memory and the beginning of remaining memory. This boundary is often referred to as the "top of BASIC." The computer also draws another boundary at the point in memory where your BASIC program starts—the "bottom of BASIC." Then the computer does everything it can to protect the BASIC program between these boundaries against internal interference.

If you stick to programs written completely in BASIC, you shouldn't have to worry about interference. But things get a little more complicated when you start working with machine language. Suddenly you're forced to accept responsibility for some memory management yourself. The computer doesn't automatically reserve memory for a machine language program in the way it does for a BASIC program. Furthermore, it is oblivious to any memory conflicts the machine language program may create—at least until a severe conflict causes the machine to "crash" or lock up.

Machine language programs that don't have to share memory with BASIC programs have more freedom. With BASIC out of the way, there's plenty of room in memory. However, some machine language programs are designed to work as subroutines of BASIC programs or to enhance BASIC itself (by adding new commands, for example). To coexist, the BASIC program and machine language must be protected against encroaching on each other. At the same time, room must be found in memory for the machine language. Often the solution is to "move the top of BASIC."

The top of BASIC boundary is controlled by two memory locations in the computer. A pair of numbers stored in these locations tells the computer where the boundary should be drawn. By changing these numbers with POKE statements in BASIC or equivalent commands in machine language, the top of BASIC can be moved at will—but only after careful calculations insure that a conflict won't result. Two other locations point to the bottom of BASIC; the beginning of BASIC memory can be moved up with POKEs to these locations.

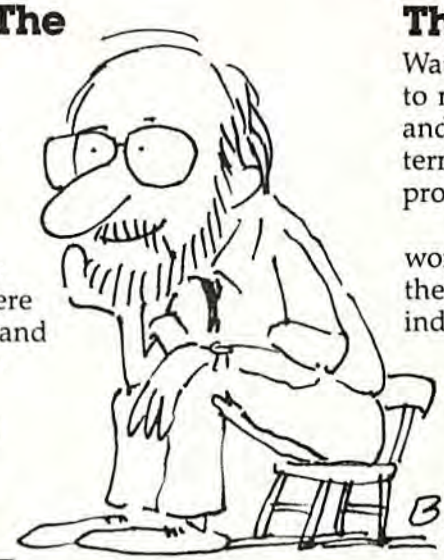
A typical example of moving the top of BASIC is when you type in certain machine language program listings with the MLX utility published frequently in COMPUTE!'s GAZETTE. MLX is designed to make it easier to enter machine language programs. However, since MLX is written in BASIC, some machine language programs can overwrite MLX in memory. The reverse can also happen: MLX can overwrite some machine language programs it's supposed to be helping you enter. To avert these disasters, sometimes the top of BASIC has to be moved downward, or the bottom of BASIC has to be moved upward. That's why the MLX instructions in some articles include a few POKEs you have to type before loading MLX.

Occasionally the top of BASIC is moved for other reasons than to make room for machine language. For instance, high-resolution screens, custom character sets, and sprites need memory for their data tables, and moving up the beginning of BASIC boundary to free up some extra memory is a common solution.

A Visit To Eric's Classroom

Fred D'Ignazio, Associate Editor

The Land Of The Lilliputians



Recently, I visited the classroom where my son Eric will begin the first grade this fall. Parents of this year's kindergarten class were encouraged to come and see how first graders spend their day.

The first thing I noticed in the classroom was how big I was and how little everything else was—people, chairs, tables, drinking fountains, and bookshelves. I'm a small person, so it was kind of a shock to feel like Gulliver in the wee land of the Lilliputians.

When I sat down in one of the tiny chairs recommended by the teacher, I sat down cautiously and nervously, fearing that I would crush the puny thing with my gigantic five foot seven body.

After a few minutes of acute discomfort, however, I began to relax. It wasn't long before I overcame my shyness and began roaming around the room, asking children what they were doing, examining work materials, and peeping over the teacher's shoulders as she conducted her reading groups.

I've often thought of schools as "learning factories." I saw kids going to school in massive numbers across our country, to process huge quantities of facts and basic skills.

When I visited Eric's school, I found out that I was right! Schools are factories. I was amazed, in the short time we were there, at the amount of material—the number of pieces of paper—those kids processed. It was exhausting just watching them.

The Paperless Classroom

Watching all those kids process paper, it occurred to me how neat it would be—both for students and teacher—to have little networked computer terminals at every table for the kids to do all this processing on.

I noticed that the kids already had their own workstations and were encouraged to work at their own pace. Computers could augment this independence and self-paced learning. Instant feedback, with helpful suggestions, encouragement, and a review of the lesson only a keystroke away.

And what a boon this would be for the kids' teacher who, I noticed, was accumulating stacks of paper. Instead of spending hours correcting papers, she would have time to look at summary statistics of the children's progress, or recall a transcript of each child's work, in any subject, and examine what was especially hard for the child to master.

What Software Is Available Now?

Is this fantasy of mine even close to happening in real classrooms with real teachers and children?

The right kind of software (drill-and-practice) *is* available. According to the 1985 edition of *TESS (The Educational Software Selector)* published by EPIE (Educational Products Information Exchange) and the Consumers Union, of the 7000 educational programs on the market, almost 70 percent are drill-and-practice. (For more about TESS, write: EPIE, P.O. Box 839, Water Mill, NY 11976; or call 516-283-4922.)

And it looks like teachers (and parents) are responding. A recent issue of *Billboard* shows that eight of the top ten best-selling educational programs were drill-and-practice. (The other two were learning games.)

But does this mean, then, that we're close to the paperless classroom?

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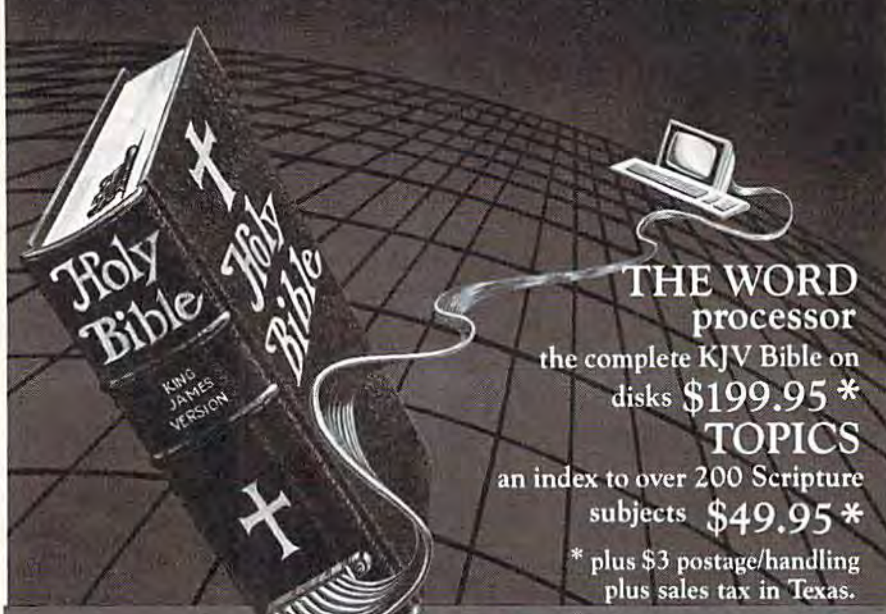

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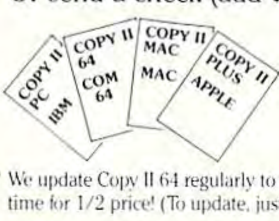

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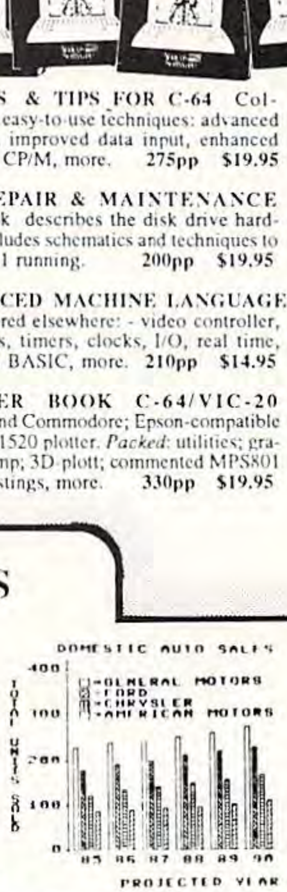

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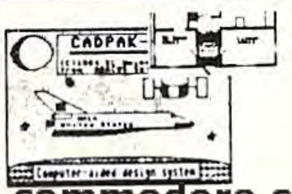

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            ;      /* skip white space */
        sign = 1;
        if (s[i] == '+' || s[i] == '-')    /* sign */
            sign = (s[i++]=='+') ? 1 : -1;
        for (n = 0; s[i] >= '0' && s[i] <= '9'; i++)
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}
```

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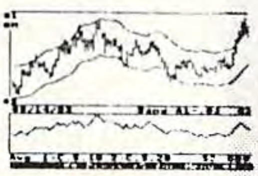

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this software (as journalists and educators so widely lament) is mostly very low. According to *TESS*, only four of ten educational programs are even worth buying, and one or two of these are simulation or problem-solving programs, not drill-and-practice.

Second, and perhaps more important, very little of the drill-and-practice software fits the teachers's or child's needs. Most programs on the market exist as one-shot products that drill children in a very narrow area. When a teacher looks at educational programs, it seems she's faced with an array of mediocre products that cannot easily be integrated into her curriculum. So what is she to do?

It looks to me like she has three choices. First, she can experiment and try to squeeze available programs into her curriculum, while recognizing that in most cases they'll be a poor fit. Second, she can wait until software and educational publishers link forces and produce quality software that's fully integrated into her curriculum. Or third, she can develop her own materials.

Available Programs

Fortunately, software on the market is improving. The CBS Success with Math Series, the Davidson & Associates programs, Scarborough's *MasterType*, Simon & Schuster's *Typing Tutor III*, and Springboard's *Early Games* are examples of quality software that make the computer a learning medium. Although these are basically narrow, one-skill programs, they are well-designed, pedagogically sound, and quite appealing. Also, they offer ways to custom-fit the lessons to a teacher's needs, and they offer limited evaluation and progress-report facilities for each learner.

In addition, a new generation of powerful, yet easy-to-use productivity software for children is available: word processors like *Quill* from D.C. Heath, *Magic Slate* from Sunburst, the productivity series from Grolier (*Friendly Filer, EduCalc,* and *Easy Graph*), and Scarborough's *MasterType's Writer* and *MasterType's Filer* are examples of this new generation.

Computers In The Curriculum

However, even if software quality improves, we still need to see an explicit connection between a teacher's curriculum and the programs she has available.

As a start, textbooks should refer to specific software and vice versa. Computer disks and computer-learning units should be included in every textbook. A teacher won't be forced to use these, but if she chooses to, they should enable her advanced students to explore a topic in more depth, and provide self-paced practice for those who need more work.

On the other hand, new curriculum-based (or at least, curriculum-supportive) programs are appearing on the market. One of the best is the family of "Intelligent Tutor" programs produced by Intelligent Software (9609 Cypress, Munster, IN 46321; 219-923-6166), which include five math programs targeted to older children: *Algebra I, Geometry, Algebra II,* and *Trigonometry* parallel the standard high-school math curriculum; and *SAT Math* helps students prepare for the math portion of the SAT exam.

A Successful Alternative

More and more teachers are also choosing the third route and creating their own software and materials for integration into their curriculum. This is not as simple as it sounds. Few teachers, alone, have the time or expertise to develop a battery of materials or programs and then plug them into their daily schedule.

But an entire school system—in a city, a county, a state, or province—can do this. I found this out when I visited the city school system in Vancouver, British Columbia. Under the active guidance of Mike Northy, the District Elementary Computer Consultant, the school system is developing a rich library of programs, books, and other materials to feed into the city's elementary schools. (For more information, write to Michael L. Northy, Education Services Group, Board of School Trustees of School District No. 39 [Vancouver], 1595 W. 10th Avenue, Vancouver, B.C. V6J 1Z8 CANADA; or call 604-731-1131.)

The Teacher: The Real Key

The Vancouver program is successful because Mike has patiently worked with individual schools and parent-teacher associations to develop grass-roots support, and because the city is big enough to provide a pool of talented teachers who can jointly develop the materials and enough classrooms, teachers, and students to make it all worthwhile.

But the real key to Vancouver's success, I believe, is the teachers themselves. My old image of the "factory classroom" placed the teacher as supervisor or foreman. She does act as a fact-and-skill-processing manager, but there are other things she does that far transcend this role and make her an invaluable part of my son Eric's (and all children's) school experience. Most important of all is her style of teaching and the warm, person-to-person attention I saw one of the teachers lavish on each child in her class when I visited Eric's school. Now, after visiting Eric's classroom and seeing his future teachers in action, I'm convinced that a teacher is much, much more.

Michael S. Tomczyk

The Art Of Repetition In BASIC

Michael S. Tomczyk is a former Commodore marketing executive and product designer. His recent book, The Home Computer Wars, *describes the rise of Commodore and is published by COMPUTE! Books.*

This month we're going to look at some of the many ways to repeat actions in BASIC programs. And choosing the right way can be an art.

You might notice that I often repeat a particular programming tip in different forms to help explain it better. In BASIC, you can use repetition in a lot of different ways:

Repeating certain graphics symbols makes a long line across the screen.

Repeating the use of a variable allows you to use it in different ways.

Repeating an action a specified number of times is easy with FOR-NEXT.

Repeating a complex action or calculation can be used with a GOSUB.

Repeating, The Hard Way

The clumsiest way to repeat an action in BASIC is to type the command over and over. But this wastes memory and also makes you do a lot of unnecessary typing. You could type the following program like this:

```
10 PRINT "****************************************"
20 PRINT "COMPUTE!'S GAZETTE"
30 PRINT "****************************************"
40 PRINT "COMPUTE!'S GAZETTE"
50 PRINT "****************************************"
60 PRINT "COMPUTE!'S GAZETTE"
70 PRINT "****************************************"
80 PRINT "COMPUTE!'S GAZETTE"
```

Lines 10, 30, 50, and 70 print 40 SHIFTed asterisks. VIC users should type only 22 SHIFTed asterisks.

You could do the same thing by doing this (VIC users should change 40 to 22 in this and subsequent examples):

```
10 FOR X=1 TO 4
20 FOR G=1 TO 40: PRINT "*";: NEXT
30 PRINT "COMPUTE!'S GAZETTE"
40 NEXT
```

One program looks clumsy and takes eight lines. The second program does the same thing in only four lines and with a lot less typing. We'll come back to this example in a moment. First, here's a quick list of the most common methods to repeat actions in BASIC:

1. Type the command over and over.
2. Use a GOTO to move to a line and repeat it.
3. Wrap an action you want to repeat in a FOR-NEXT loop.
4. Use a GOSUB to insert the action where you want it.

GOTO And The "Infinite" Repeat

Most of you will be familiar with the following example, which displays a message over and over again. Enter the program, then type RUN and press RETURN:

```
10 PRINT "ALBERT EINSTEIN"
20 GOTO 10
```

Line 10 displays the message, in this case the name of our century's most famous scientist, and line 20 tells the computer to go back to line 10 and print it again. This program is called a *loop* because it keeps "looping" back to do the same thing over and over again. To break out of

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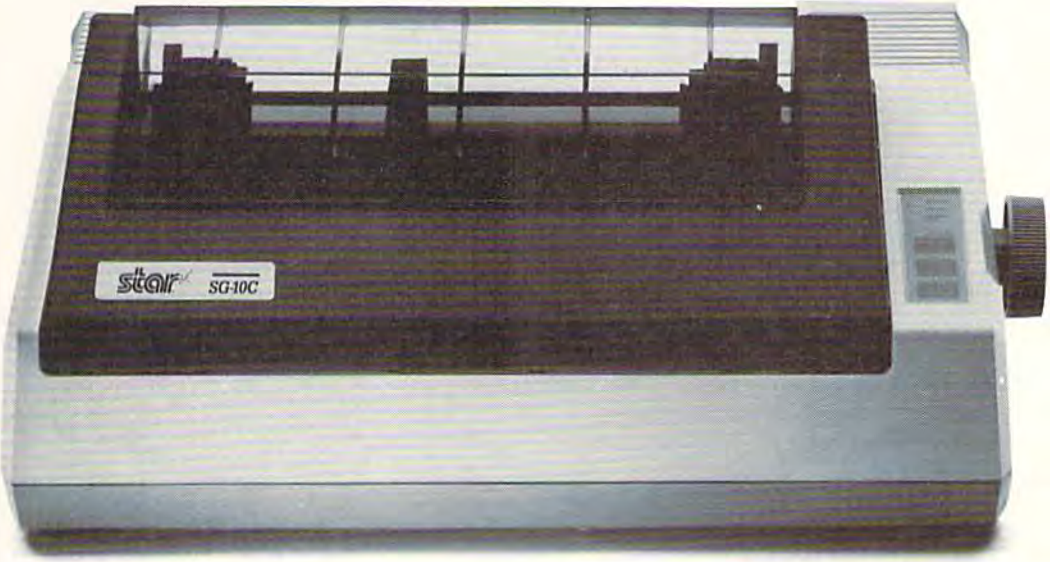

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the loop you have to press the RUN/STOP key. The program displays the message in a vertical column because each new PRINT statement is automatically put on a new line, *unless* you add a semicolon at the end of line 10. The semicolon (;) is like "glue." It makes printed messages occur right after each other, in a running stream.

You can put a GOTO on the same line as the command you want to repeat. Here's the same example on one line (with the semicolon inserted):

```
10 PRINT "ALBERT EINSTEIN ";: GOTO 10
```

Using the GOTO command to go back to the same line has some special uses. For example, you can use it to make the computer stop and wait until a key is pressed, like this:

```
10 PRINT "{CLR}ALBERT EINSTEIN": PRINT: P
   RINT "PRESS ANY KEY TO GO ON."
20 GET K$: IF K$="" THEN GOTO 20
30 PRINT "ALBERT EINSTEIN ";: GOTO 30
```

Line 10 clears the screen and displays Einstein's name. The PRINT command all by itself puts a blank line on the screen (in other words, skips a line). Then we print an instruction to the user.

Line 20 uses the GET command to tell the computer to look for a key to be pressed. The IF-THEN statement sets up a condition which tells the computer IF no key is pressed ("" in this case means "no key"), THEN keep going back to the same line and check to see if a key is pressed. The trick here is that if any key on the keyboard *is* pressed, line 20 stops going back to itself and the program "falls through" to the next line. Remember, if no key is pressed, the program stops and waits. If *any* key is pressed, the program drops through to the next line.

Line 30 displays Einstein's name over and over. Press RUN/STOP to break out of the "loop," then type NEW and press RETURN to erase this example and get ready for the next one.

Repeating Actions With FOR-NEXT

The FOR-NEXT command is the most common way to repeat actions, especially when you want to specify exactly how many times an action should repeat. The important thing to remember about this command is that everything *between* the FOR and the NEXT command will be repeated as many times as you specify. Here's a simple example:

```
10 FOR X=1 TO 10:PRINT"ALBERT EINSTEIN":
   NEXT
```

Type RUN and press RETURN. The first part of the command tells the computer it's going to do something ten times. Then we insert the command we want to repeat—in this case printing Einstein's name—followed by the NEXT command.

The way this works inside the computer is that the variable X starts out with a value of 1 and prints Einstein's name. When the computer reaches the NEXT command, X is increased to 2, and Einstein's name is printed again, and so on until X reaches its upper limit—in this case, 10. Then, X becomes 11, the computer realizes that 11 is beyond the limit (10) we gave it, and the program continues. Try changing the numbers 1 and 10 and run the program again to see what happens.

The variable X can be named anything you choose: a letter (A,B,C), two letters (AB,AX,XY), or a letter and a number (A1,X4,M2). The range of numbers can also be changed. If you type FOR X=6 TO 15, Einstein's name will still print ten times. If you type FOR X=41 TO 60, Einstein's name will print 20 times.

REM: *The STEP command lets you skip numbers in a FOR-NEXT sequence, and also lets you "step" backwards through a number sequence. Here are some examples to try:*

```
10 FOR X=1 TO 20 STEP 2:PRINT"EINSTEIN":NEXT
10 FOR X=1 TO 20 STEP 2:PRINT X:NEXT
10 FOR X=20 TO 1 STEP −2:PRINT X:NEXT
10 FOR X=20 TO 1 STEP −1:PRINT X:NEXT
```

This is especially useful when going up or down a musical scale or in creating a sound effect which pops up or down through the scale of notes, by STEPing 2, 5, 10 or however many notes at a time—either up from a low note to a high note, or down from a high to a low note. When you go down from a higher number to a lower number, STEP a negative number like STEP −1, STEP −5, and so on.

You can also use FOR-NEXT to repeat a graphics symbol, like this:

```
10 FOR G=1 TO 40: PRINT "*";: NEXT
```

This is a convenient way to draw a horizontal line across the screen. It simply prints the single short line symbol 40 times (22 if you have a VIC) to make a long line across the screen.

You can also wrap several program lines in a FOR-NEXT loop, like this example which we used at the beginning of the column:

```
10 FOR X=1 TO 4
20 FOR G=1 TO 40: PRINT "*";: NEXT G
30 PRINT "COMPUTE!'S GAZETTE"
```

```
40 NEXT
50 PRINT: PRINT "CONTINUE REST OF PROGRAM
   "
```

Line 10 starts the FOR-NEXT loop. Everything between this line and the NEXT command in line 40 is repeated four times.

Line 20 contains our graphics line loop, which puts a long line across the screen. Line 30 prints the message.

Line 40 tells the computer to increase the variable X by one and run through the program again. When the X becomes 4, and the fourth cycle is completed, the program continues to line 50 and goes on to the rest of your program.

Using FOR-NEXT Variables To Count

As we've learned so far, the FOR-NEXT loop makes program actions repeat because the computer increases the variable each time it cycles through the loop. You can make use of this variable in many ways, just like any number. Try this example:

```
10 FOR N=1 TO 10:PRINT N:NEXT
```

Here, we define the variable N as a range of numbers from 1 to 10. We can use this to print the value of N. Since the value of N changes, from 1 to 10, the computer prints the value and counts from 1 to 10. You can also use this method for calculations, like this:

```
10 FOR N=1 TO 5:PRINT"2 TIMES"N" EQUALS"
  2*N:NEXT
```

Here, we print the message "2 TIMES" inside quotes, then go outside quotes to print the value of N (which is 1, 2, 3, 4, and 5), then the word "EQUALS" inside quotes, and finally we go outside quotes to print the result of a calculation (1*5, 2*5, 3*5, 4*5, and 5*5).

Here's another variation:

```
10 FOR N=40000 TO 100000 STEP 10000:PRINT"12
  TIMES"N" EQUALS "12*N:NEXT
```

Here's another variation which combines a PRINT message with the use of the FOR-NEXT variable:

```
10 FOR N=1 TO 10:PRINT" {CLR} EINSTEIN...
  REPETITION"N:NEXT
```

Using GOSUB To Repeat Actions

What if you want to repeat an action several times, but in different parts of your program? Here's where the GOSUB command comes in handy. Try the following short example:

```
10 PRINT "{CLR}EINSTEIN OUTDATED NEWTON..
   .": GOSUB 100
20 PRINT "BUT WHO WILL": GOSUB 100
30 PRINT "OUTDATE EINSTEIN...?": GOSUB 10
   0
40 GOSUB 100: GOSUB 100: GOSUB 100
50 END
100 FOR G=1 TO 40: PRINT "*";: NEXT: RETU
    RN
```

Here we want to print three short messages on the screen and separate them with horizontal lines, but instead of typing the "line-making" line over and over again, we use a GOSUB to jump down to line 100 and use it over and over again.

Line 10 clears the screen, prints our message, and GOSUBs to line 100. Line 100 displays a horizontal line on the screen, and the RETURN command sends the computer back where it came from—the end of line 10—so it continues on to line 20.

Line 20 prints another message, GOSUBs to line 100 to print the horizontal line, returns to the end of line 20, and continues on to line 30, which does the same thing.

Line 40 is included to show you that you could use the GOSUBs by themselves to put several lines on the screen.

A GOSUB can be used for many different purposes. In this next example, we use it to make the computer choose six random numbers from 1 to 40. We'll call this program a "lottery."

```
10 FOR L=1 TO 6: GOSUB 100: PRINT "LOTTER
   Y NUMBER"L"IS"R
20 NEXT
50 END
100 R=INT((RND(1)*40)+1): RETURN
```

Line 10 is a FOR-NEXT loop which counts from 1 to 6. The GOSUB is inserted here so the random number in line 100 is chosen before we have to use it. The random number (R) is printed at the end of the message. Line 100 chooses a random number from 1 to 40 and RETURNs.

Line 20 contains our NEXT command.

Line 50 ends the program.

REM: *If you put subroutines at the end of a program, you should separate them from the main program with an END statement. Otherwise, the program "falls through" to the subroutine and executes it once. Then, the RETURN causes a RETURN WITHOUT GOSUB error. Try deleting line 50 to see how this can happen.*

Repeating actions are fundamental to nearly every program. As we've seen here, there are various ways to accomplish the same thing, but some are more efficient than others.

Richard Mansfield, Senior Editor

Crossing

If you're already good at BASIC, then you've seen the wall that prevents you from getting better. There's only so much you can do to improve the speed of your programs in BASIC—and it can be a considerable effort to squeeze a little extra efficiency out of a language which has very definite limits.

That's one of the main arguments for making the leap and crossing over to machine language. ML can be a hundred times faster than BASIC. But what only ML programmers know is that ML isn't really that difficult or that mysterious. It just seems obscure at first because it uses different command words and builds programs a different way. However, once you know the few underlying rules that distinguish ML from BASIC, you'll wonder why you put off learning ML. It's not hard and it's the only way to take your programming to the max.

If You Know BASIC

If you know how to communicate with your computer in BASIC, you know how to construct loops and branches and variables. ML, too, is based on loops and branches and variables. ML does the same things that BASIC does, you just write the program instructions differently.

Let's take a simple BASIC program that defines four variables, prints a prompt message, gets input from the user, branches to print out the correct response message, and then loops back for more input. This is pretty simple, but it illustrates how variables, input, output, looping, and branching are accomplished in both BASIC and ML. By comparing the methods, you'll learn a good deal about how ML works and begin to see that there's nothing inherently difficult about ML.

Program 1: BASIC Version

```
10 NE$ = "MESSAGE #1"
20 TWO$ = "MESSAGE #2"
30 THREE$ = "MESSAGE #3"
40 PROMPT$ = "PLEASE ENTER A NUMBER BETWEEN
   1 AND 3.  HOWEVER, EXIT THIS
50 P1$ = "ROUTINE WITH ANY OTHER NUMBER."
100 PRINT PROMPT$;P1$
110 INPUT A
120 IF A = 1 THEN PRINT NE$:GOTO 100
130 IF A = 2 THEN PRINT TWO$:GOTO 100
140 IF A = 3 THEN PRINT THREE$:GOTO 100
```

Now let's see what the ML program would look like. To write ML, you can write a series of instructions, much the way you would write a BASIC program. You can even use colons to separate instructions just as BASIC does (see line 100 in Program 2).

There's one extra step to ML, however, that you must take after you've written the program. The ML you write has to be translated from your instructions (called *source code*) into a real, runnable ML program (called *object code*). This translation is done for you by a program called an *assembler*. That's a special program which doesn't come with the computer; it's not inside waiting for you to type RUN the way BASIC is. Instead, you must buy an assembler. There are several available for Commodore computers, but I'll use the LADS assembler from my *Second Book of Machine Language* in the following example.

Here's the ML equivalent to the above BASIC program:

Program 2: Machine Language Version

```
10 *= 828
20 .O
30 ;
35 ;                    --- LABEL ASSIGNMENTS ---
36 ;
```

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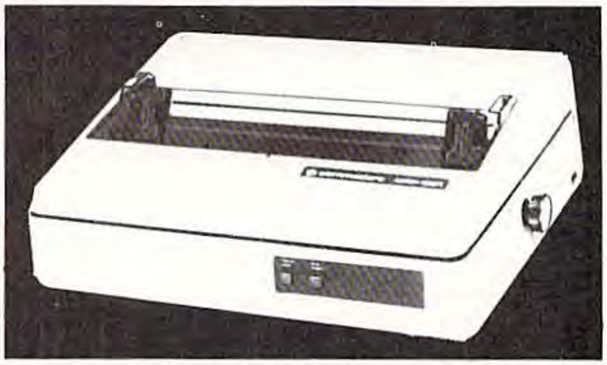

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```
40 PRINTSTRING = $AB1E;                     A-LOW, Y-HIGH...($CB1E ON THE VIC)
50 GETKEY = $FFCF;                          PULLS IN ONE BYTE
60 PRINT = $FFD2;                           PRINTS ONE BYTE
70 ;
75 ;                   --- MAIN PROGRAM ---
76 ;
100 LOOP LDA #<PROMPT:LDY #>PROMPT:JSR PRINTSTRING;   PRINT PROMPT MESSAGE
105 JSR GETKEY:AND #$0F;                        INPUT A NUMBER AND STRIP IT
106 JSR CR;                                     PRINT A CARRIAGE RETURN
110 CMP #1:BNE TWOPRINT;                        IS IT #1....
120 LDA #<ONE:LDY #>ONE:JSR PRINTSTRING:JMP LOOP;   IF SO PRINT THAT MESSAGE
130 TWOPRINT CMP #2:BNE THREEPRINT;                   CONTINUE TESTING
140 LDA #<TWO:LDY #>TWO:JSR PRINTSTRING:JMP LOOP
150 THREEPRINT CMP #3:BNE END;      (IF NOT 3, WE'VE TRIED EVERY POSSIBILITY)
155 ;                                (SO WE CAN GO DIRECTLY TO THE EXIT.)
160 LDA #<THREE:LDY #>THREE:JSR PRINTSTRING:JMP LOOP;  IF 3, PRINT THAT.
170 END RTS
400 ;
410 ;                   --- SUBROUTINES ---
420 ;
430 CR PHA:LDA #13:JSR PRINT:PLA:RTS;      PRINT CARRIAGE RETURN (SAVE A)
500 ;
502 ;               --- DATA & VARIABLES ---
503 ;
510 ONE .BYTE "MESSAGE #1"
520 .BYTE 13 0
530 TWO .BYTE "MESSAGE #2"
540 .BYTE 13 0
550 THREE .BYTE "MESSAGE #3"
560 .BYTE 13 0
565 ;
566 ;          (INPUT PROMPT)
570 PROMPT .BYTE "PLEASE ENTER A NUMBER BETWEEN 1 AND 3. "
580 .BYTE "HOWEVER, EXIT THIS ROUTINE WITH ANY OTHER NUMBER."
590 .BYTE 13 0
```

Notice first that in BASIC you need to define your variables at the start of the program. BASIC has to know what these variable names NE$, TWO$, and THREE$ mean before it can use them. (By the way, because the variable name ONE$ would confuse the computer since the command word ON is embedded, we had to shorten the name to NE$.)

More Intimate Terms

As you see, it's not necessary to assign variables at the start of an ML program. In practice, most ML programmers put all their data at the end of the ML program. And variables are just another kind of data in ML.

With ML, we're on more intimate terms with the computer. We're more in charge of managing the data and the variables than we are in BASIC. This requires that we do things a little differently, but we have far more control over how things are formatted and manipulated. We give a variable a name by assigning a label to it as in line 510 of Program 2. Just type in the label as the first thing after the line number. Next, the .BYTE is a command to the assembler (such commands are called *pseudo-ops*) to insert the following characters into RAM at the address where the label ONE starts. The string starts and ends with quotes, just as in BASIC.

What if it's a numeric variable? Simple. Line 520 stores the numbers 13 and 0 in RAM right after the message in line 510. We could have given a label to line 520, but we didn't need to since we're going to consider the 13 0 as part of the message (we'll see why in a minute).

Likewise, all the rest of our strings are stored following the first one. They don't need to be in any particular order—they'll be referenced by their label. But messages and data shouldn't be stored *within* the actual ML program (at line 125, say) since messages are not proper instructions to the computer and the 6502 chip wouldn't be able to understand what to do. So put messages at the end.

There's Less Than Meets The Eye

By the way, there's a lot more in Program 2 than ever gets POKEd into the computer as runnable object code. Labels, line numbers, comments, pseudo-ops like .BYTE—none of these things will end up in the finished program. They are conveniences to the programmer, they make writing ML simpler, but the assembler will strip off all these things when it transforms the source code (Program 2) into the object code (Program 3). It's the object code that you SYS to when running an

ML program. And it's only object code that the computer itself can understand.

How do you insert REMarks into an ML program? It works just like REM, except you use the semicolon (;) with LADS and some other assemblers. Anything following the semicolon on a line is ignored by the assembler.

What are those variable-looking items up in lines 40–60? They aren't actual data like messages to be printed out. They're a different kind of label assignment, but they do assist the programmer. There are many built-in routines in BASIC, in the ROM memory, which are easy to use from ML. After all, BASIC itself is written in ML. Rather than reinvent the wheel, an ML programmer will freqently use built-in routines by simply JSRing (Jump to SubRoutine) to them as he would to any other subroutine. Some of these activities, like printing and disk I/O can get pretty complex. It's convenient to "borrow" routines from BASIC from time to time.

Thus, a routine which prints a string (after you first put its address in the Accumulator and the Y register) is located at $AB1E in the 64. So at the start of the program, we define the label PRINTSTRING to mean the address of that routine. Then, anywhere in the program (see line 120) that you want to access this routine, you just type JSR PRINTSTRING. You don't need to remember specific addresses this way, and the programming becomes more BASIC-like, with real words for commands.

The ML program proper starts at line 100 with the label LOOP. LOOP identifies the address where the command LDA on that line is located in memory and the address to which we can later JMP (JuMP) to the LOOP. As when naming variables in BASIC, you can use any words you want for labels. You just can't use the same word twice. (If you do, LADS will ring a bell and print "Duplicated Label" to let you know.)

There's another interesting thing in line 100: the #< pseudo-op. To satisfy the needs of the PRINTSTRING routine, we need to divide the address of the string we want printed into two bytes and then put the high byte into the Y register and the low byte into the Accumulator. You break an address in half like this: #<PROMPT, which gives you the low byte, and #>PROMPT, which gives you the high byte.

How Does It Know When To Stop?

How, you might ask, does the PRINTSTRING routine in BASIC know when to stop, know when it has reached the end of a message? That's where those bytes 13 0 we spoke of earlier come in. PRINTSTRING stops printing to the screen when it comes upon a 0. The 13 is the symbol for the carriage return and that's an easy way to print one: Just add it to a string you want printed.

GETKEY is another BASIC subroutine and so is PRINT which prints one character—whatever is in the Accumulator—at the time you JSR to it.

GETKEY acts like BASIC's INPUT command and the character typed will be left in the Accumulator when we return to our ML program from GETKEY. Thus, we can transform the ASCII code for numbers into actual numbers by using the AND #$0F in line 105. ASCII for 1 is $31, for example. After $31 AND $0F, we're left with a 1 in the Accumulator. It's not important for now that you understand how this or GETKEY or PRINTSTRING accomplish their tasks. Just learn what they do and how useful they can be when programming.

In fact, we didn't really need to strip off the $3 from $31. We could have constructed the branch test in line 110 to CMP $31, but it's easier to visualize what's happening if we test the real numbers instead of their ASCII code. The BNE (Branch if Not Equal) in line 110 will send the program down to line 130 (for another IF-THEN test) if the number in the Accumulator is not equal to 1.

However, if the number *is* 1, we "fall through" the BNE to line 120, which prints out our message for keypress 1 and then jumps back up to start the loop over again and prompt the user for more input.

The only subroutine we've written for this program is one which prints a carriage return just after we've detected a keypress with GETKEY. Obviously, we want to save what's in the Accumulator after GETKEY because we need to use it to test for 1, 2, or 3. To save the Accumulator, we PHA (PusH Accumulator onto the stack) and then print a 13 and then PLA (PuLl Accumulator from the stack) so that we can preserve the original GETKEY value. We needed to use the Accumulator briefly, and without saving whatever was in it, we would have lost it. In ML there are many ways to save the Accumulator, many ways to print string variables, many ways to do most anything. But the techniques illustrated here work well.

One final observation: The source code in Program 2 illustrates the general structure used by most ML programmers. It separates the program into four fundamental sections: the Definitions and Initialization (lines 35–60); the Main Loop (100–170); the Subroutines (430); and, last, the Data 510–590). There are no fixed rules about this in ML, but most programmers find this arrangement is the most efficient.

REVIEWS

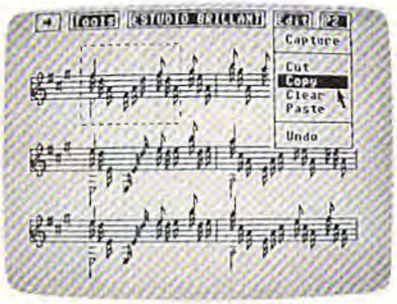
The Music Shop

"The Music Shop," written by Don Williams for Brøderbund, is a powerful, thoughtfully designed music editor for the Commodore 64. If you've never tried programming a computer to make music, it's hard to appreciate just how much *The Music Shop* simplifies the process: It works in such a natural, intuitive way that you can start making "real" music within minutes of booting it up. This is due in large part to the program's intelligent use of Macintosh-style visuals.

Nearly every *Music Shop* function can be performed with a joystick (keyboard controls are also available), guiding an arrow-shaped cursor around a screen display that looks like a sheet of music paper. For instance, to choose a note, you open the "Notes Box" and take what you want from a wide selection of musical symbols. Press the button and the box disappears, putting you back on the music paper. Now the cursor is "carrying" the selected note, which plays at the proper pitch when you place it on the musical staff.

After you've placed a few different notes, you can use your own composition like the Notes Box, picking up new notes from existing ones without disturbing the originals. Thus, you need only to go back to the Notes Box for something that's not already on the screen.

The rest of the program has the same visual orientation, letting you move around in the composition to add, delete, or revise small details or large passages with equal ease. Compositions can be saved or loaded from disk, or sent to a Commodore-compatible printer. The program disk also contains an impressive selection of demonstration musical pieces.



The Music Shop provides 16 predefined instruments, and you can switch any of the 64's three independent voices from one instrument to another at will. But the real fun is in making your own customized musical instruments. This is done with "Adjust Sound," a full-featured sound effects editor that lets you adjust the sound of an instrument *while your composition plays in the background.*

Besides being lots of fun, it's intriguing to listen to the same song played by a variety of different instruments, switching from one to another with the touch of a button. Once you've defined a new instrument, you can use it at any point in the composition, just like one of the presets. And the instrument definitions are automatically saved as part of the composition.

On the negative side, if you're one of those who dislikes icons and pull-down window menus (some people find them obtrusive and irritating), this program may not be for you. After a while you may tire of moving the cursor all the way across the screen to select new options. Though it's possible to choose options with shorthand keyboard commands (pressing f2 puts you in the Adjust Sound option, and so on), there's no way to escape the omnipresent windows. In addition, since it's designed for writing fairly conventional music, the program is not suitable for creating sound effects. But for most people, these are likely to be insignificant drawbacks to a generally exceptional product.

The Music Shop includes an excellent instruction manual containing step-by-step tutorials as well as a quick reference card. For those who need to brush up on fundamentals, there's even a section on basic music theory.

—Philip I. Nelson

Brøderbund
17 Paul Drive
San Rafael, CA 94903
$44.95 (disk)

Felony

Once again it's time for you, in the role of a master detective, to take to the city streets. Your job is to solve the 12 crimes which make up *Felony,* the second scenario in CBS Software's Mystery Master Series.

Like its successful predecessor, *Murder by the Dozen, Felony* is an attractive, intriguing, and challenging software package that contains all the paraphernalia needed to crack each of the cases. Unlike *Murder by the Dozen,* in which all the cases centered on murders, the cases in *Felony* vary considerably, necessitating that your investigative techniques vary accordingly. Motives for theft, for example, can differ considerably from motives for murder, and your methods of investigation will reflect the type of case you're trying to solve.

Less convoluted than some other mystery games, *Felony* is no less enjoyable and often just as diabolical in its logic. Each crime is supported by a Case History that provides you with the necessary data to begin working on the case. Players (up to four detectives on each case, more if you wish to play in teams) may interview people, examine physical evidence, or move to another location on each game turn. Each option carries with it certain advantages and disadvantages, and it takes a top-notch sleuth to know when to do what, sift through the red herrings, and make good use of time.

While there is no time limit on solving each case, your final detective rating is based in part on how long it took to solve the case. To meet the objectives of each case (as stipulated in the Case History), you must be sure that you've spent enough time gathering evidence that will support your solution, yet not so much time that you've bankrupted the city with your overtime pay.

The computer acts as your crime lab, the map of the city (there are functional graphics), and option generator. It not only does the busy work of keeping track of whose turn it is, but also the necessary work of analyzing the evidence you've sent to the lab. Most importantly, it sends you to the proper section of the Clues Booklet, which contains the information necessary for building your case and eventually solving the crime.

Felony is an excellent example of an educationally sound game. Players exercise logic and reasoning skills, learn to both take and organize notes, and to employ other problem-solving skills. The cases are well thought-out, each as difficult in its own way as the next, and they accurately reflect the problems and anxiety that must accompany painstaking detective work. The competitive factor, brought on by working against rival detectives trying to solve the same crime, adds another dimension to *Felony*, though the game is equally enjoyable when played alone. This is a good one for all the would-be Sherlocks out there.

—*James Trunzo*

CBS Software
One Fawcett Place
Greenwich, CT 06836
$34.95 (disk)

Mixing Text And Hi-Res Graphics

James R. Chambers

You've created the perfect graph in hi-res, but how are you going to label it? Here's a program that allows you to put standard text characters on the hi-res screen of the 64. Also, it's compatible with "Hi-Res Toolbox."

Once you start writing hi-res programs, you may find yourself wishing for just a few regular characters. Perhaps you want some labels for a detailed graph or a player's score display for a game with a hi-res screen. I've read about creating text windows using a raster interrupt vector routine written in machine language. I haven't tried this, but apparently the text is limited to certain portions of the split screen—you can't mix characters and hi-res graphics.

One solution is to create a brand new character set, but why do all that work when there's a character set already in memory? And because of the organization of hi-res memory, we can put character shapes there without a lot of complex math.

Eight Byte Chunks

In some important ways, a hi-res screen is similar to a regular screen (see "Creating Hi-Res Graphics On The 64" in this issue). Each character on a normal screen is made up of eight lines of eight pixels. Information about letter shapes is stored in character ROM—eight bytes per character. Not so coincidentally, the memory used for hi-res bitmapping is divided into 1000 groups of eight bytes.

So, if you were to go through character ROM and PEEK the shapes of the letters C, A, and T, and then POKE the 24 numbers into the first 24 bytes of hi-res memory, the word CAT would appear. This is the principle behind the program offered here, "Text Print."

Instructions And Modifications

Enter the program and save it to tape or disk. Make sure the numbers in the DATA statements are all typed correctly.

When you run the program, you see a horizontal, a vertical, and a diagonal hi-res line. Next, the words describing each line are printed. There are also examples of Commodore graphics characters. This simple demonstration screen illustrates the purpose of the program: mixing standard characters with hi-res. To add the routine to your own program:

1. Remove lines 2580–2670. This part of the program draws the hi-res lines. Also, add a line: **2580 RETURN**.

2. Remove lines 2740–2910, the section from the demo routine where the words HORIZONTAL, VERTICAL, and so on are printed.

3. At the beginning of your program, insert a GOSUB2500. This subroutine POKEs some ML routines into memory and turns on the hi-res screen (the bitmap starts at 8192, hi-res color memory at 1024).

Using Text Print

If you want to turn on a single pixel, set the X and Y values and GOSUB 2920. The X (horizontal) value should be in the range 0–319 and Y should be between 0 and 199.

To put characters on the screen, you'll have to define some variables first:

TEXT$—the words which will appear on the hi-res screen.

TX—the X value (0–319) of where the first letter will appear. It should be a multiple of eight. An easy way to calculate TX is to imagine a normal screen with room for 40 columns numbered 0–39. Multiply the column number by eight and assign it to TX.

TY—the Y value (0–199), which must also be a multiple of eight. Take the row number (0–24) and multiply by eight.

TCOL—the color of the letters (foreground color 0–15 multiplied by 16, added to background color).

D—the direction of printing. Because of the way hi-res screen memory is organized, left to right is direction 8, downward printing is 320, and diagonal printing (down and to the left) is 328.

After the variables are defined, add GOSUB 2960 to the program and your words or characters appear on the screen. For example, if you wanted to label the left side of a graph with the numbers 1–9 in blue on white, you could put this line in your program:

```
50 TEXT$="987654321": TX=0: TY=13*8:
   TCOL=6*16+1: D=320: GOSUB2960
```

Machine Language For Speed

The main section of Text Print is written in BASIC, but there are also some machine language routines. Their functions could have been written in BASIC, but BASIC is fairly slow when there are a lot of POKEs to be done. They work as follows:

SYS 828 copies the first 128 shapes from character ROM down to 50176 and following. Interrupts must be turned off and the I/O bank switched out before this routine will work. This is taken care of in lines 2690–2730. This ML routine transfers the uppercase/graphics characters down to RAM. If you'd prefer the upper/lowercase letters, change these two lines:

```
3130 DATA234,72,138,72,152,72,160,0,185,0
     ,216,153,0,196,185,0,217,153,0,197,1
     85                                :rem 96
3140 DATA0,218,153,0,198,185,0,219,153,0,
     199,200,208,229,104,168,104,170,104,
     96                                :rem 96
```

SYS 869 clears the hi-res screen at 8192. In a matter of seconds, machine language does what would take BASIC half a minute.

SYS 923 fills color memory with the foreground and background colors you've chosen. Before calling this routine, POKE 251 with a number from 0 to 255 (foreground × 16 + background).

If you choose to append Text Print to Hi-Res Toolbox (elsewhere in this issue), you won't need the clear screen or color fill routines, although you can include them. You can also delete the BASIC routine (lines 2920–2950) that turns pixels on.

See program listing on page 75.

Space Dock

Aaron Bobick

Do you have the steady hand and quick eye it takes to land at a busy spaceport? Watch out for the other ships, they won't slow down or get out of your way. For the unexpanded VIC and 64. Joystick required.

You've taken your Class 3 OC-88DL mining ship to the asteroid belts and back. The cargo bays are brimming with valuable ore, as well as a few strange crystals you discovered. Six months in space is a long time; all you want is to dock the ship, collect your pay, and find a room with a hot bath.

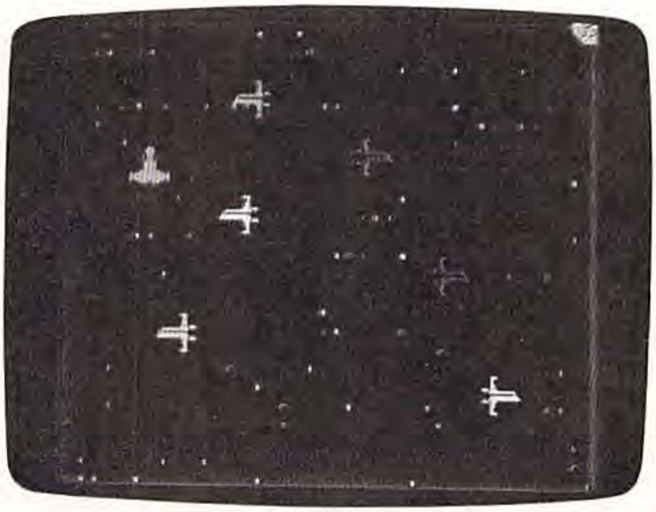
But the traffic is heavy today. On arrival at the Lincoln International Spaceport, you were asked to go into a holding pattern. Finally, after three hours of flying in circles, you've been cleared for landing. You accelerate toward the landing bay and suddenly realize that every ship in the sector must be here, and they're all blocking your path. You hear an angry voice on the radio, "Hey, noodlebrain, where'd you learn to fly? Get out of my way." So you turn off the radio.

Limited Fuel

In "Space Dock," you have only one chance to reach the landing bay, because the fuel is nearly gone. And since the ship is completely full of ore, it can't change course very quickly. Use the joystick to move forward, left, and right. And avoid the other spaceships that are waiting to land. If you miss the landing bay, your ship is lost. You must touch down in the middle of the spaceport; if you miss slightly, it counts as a crash.

In the VIC version, you start with three ships. You get an extra (bonus) ship each time you dock successfully.

The 64 version is slightly different. You have five chances to dock, but are not given any bonus for success. At the beginning of the game, move the joystick up or down to choose level 1, 2, or 3. (Level 1 is the easiest.) Then press the fire button to begin. Push forward to accelerate, pull back to decelerate. You cannot stop completely, but you can adjust the speed somewhat.



Position and timing are essential. Here, the ship waits for the spaceport (partly visible in the upper right) to wrap around to the left (64 version).

Typing Instructions

The VIC version is written in BASIC. Remove or disable any extra memory, type in the program, and save it to tape or disk.

The 64 version is a little longer than 1K of machine language, and you'll need the MLX machine language editor, published regularly in the GAZETTE, to enter it. Load MLX, and answer the prompts as follows:

Starting Address: 49152
Ending Address: 50597

Enter the program and save it to tape or disk. When you load it back, you must use a secondary address of one: **LOAD"SPACEDOCK",8,1** (disk) or **LOAD"SPACEDOCK",1,1** (tape). To start, SYS49152.

See program listings on page 69.

Crunch

James A. Ledger

There are a number of advantages to crunching your programs: execution speed, efficiency, and more memory, to name the most obvious. This utility is one that every programmer should have in his toolbox. For the 64 and VIC-20.

One of the first skills a beginning programmer learns is how to "crunch" a BASIC program, reducing it to the smallest size possible by removing all spaces, shortening variable names, combining lines, and so on. It's usually quite tedious and time-consuming, and becomes even more so as the programmer writes longer programs. A lot of people have developed the bad habit of crunching their program as they type it in, with the result being hard to read and difficult to debug.

Why Crunch?

Why bother to crunch in the first place? For one thing, it allows your program to run faster and more efficiently. However, in some cases, especially on the VIC-20 with little or no memory expansion, it's the only way a program will run. But even the 64, with its relatively large RAM memory, occasionally runs into this problem. This can occur, for instance, in a lengthy program which uses large arrays. Every byte saved by reducing the program length can be used for string and variable storage.

With "Crunch" you can let your computer do the tedious work for you. After all, that's what computers are best at. In fact, this program will not only crunch your program in a matter of seconds, but the result will be much more compact than would be possible by hand. Originally written for the 64 and requiring a little over 1.5K of memory, I've added a version for the VIC-20 which retains the power of the 64 version while using only 880 bytes.

Eight Ways To Crunch

Combining Of Lines. One of the most remarkable things that Crunch can do is combine as many statements onto one line as possible. And you're not limited to 80 or 88 characters as you would be using the keyboard. In fact, it will use up to 255 bytes per line, or any lower limit you select (BASIC doesn't like lines longer than 255 bytes). That's bytes, not characters, and it can result in a line even longer than 255 characters. This is because BASIC keywords are stored as one byte tokens but are printed out using full length words.

Not every line can be combined with another one. BASIC keywords such as GOTO, GOSUB, IF-THEN, RUN, and LIST may be followed by a line number. The line they refer to is called a *referenced* or *target* line. Such a line cannot have its line number removed by combining it with the previous line.

Another special case is the IF-THEN statement. Any statement that follows an IF-THEN on the same line is executed only when the condition is true. Therefore, no additional lines can be added to the end without changing the logic of the program.

Spaces. All spaces within a program are removed except those within a string inside quotes and certain spaces within DATA statements as described below.

DATA Statements. If you group all of your DATA statements together, Crunch will combine them in a special way. Instead of just adding a colon and concatenating, a comma is added and the DATA token is dropped. For example:

```
10 DATA ABC,DEF
20 DATA GHI,JKL
```

would become:

```
10 DATAABC,DEF,GHI,JKL
```

This will continue up to the maximum number of bytes selected per line.

Spaces are also treated differently within a DATA statement. This is because BASIC allows you to define strings within a DATA statement without using quote marks. For example, the statement:

10 DATA JOHN DOE , 123 OAK LANE

would become:

10 DATAJOHN DOE ,123 OAK LANE

Notice that only leading spaces are deleted, while those within and trailing the data string are preserved. This is exactly how your computer would treat them. And since Crunch cannot tell whether a number within a DATA statement is meant to be used as a number or a string, all items are treated as strings. If you enclose your string data items within quote marks, as is sometimes necessary when using punctuation, then spaces trailing after the quote mark are also removed.

REMarks. Remarks are nearly always completely removed. However, if the remark is on a line by itself and is referenced by another statement (a bad practice, by the way), then the line following the remark is checked to see if it's referenced. If it's not, then its line number is changed to that of the referenced remark and the remark is completely dropped. If the next line is referenced, then only the text of the remark is removed. The REM token and its line number are preserved.

Variable Names. With Crunch, there's no reason why you can't use descriptive variable names such as AMOUNT and NAME$. Crunch will truncate all of them to the first two characters, since that's all your computer recognizes anyway. Just remember to keep the first two characters unique for each variable.

FOR-NEXT Statements. Whenever you terminate a loop with a NEXT command, it's not necessary that it be followed with a variable name such as NEXT J. Therefore, Crunch will remove all variables following NEXT. If you've used nested loops and terminate them with something like NEXT J1,J2, Crunch will transform it into NEXT:NEXT. This may look longer, but remember that BASIC keywords are stored as one byte tokens, so for the example given, three bytes are actually saved. If you've nested your loops properly, the computer will remember which loop to perform, and your program will run the same, actually, a little faster since it does not have to verify that the variable matches the one it was expecting.

End Quotes. Whenever the last thing on a BASIC line is a literal string within quotes, it's not necessary to include the final closing quote mark. This is because the carriage return at the end of the line terminates the quote mode. So whenever this occurs on the newly crunched line, the final quote mark is dropped.

On the other hand, if the programmer has already dropped the end quote, Crunch will tack it back on before concatenating the next line.

LET tokens. Few programmers use the LET command. (A=B+1 is the same as LET A=B+1). However, LET often adds a little clarity, especially for the beginning programmer. Crunch removes all LETs because they're not necessary.

Typing It In

The 64 version of Crunch is written entirely in machine language, so you'll need to use MLX, the machine language entry program published frequently in the GAZETTE. Here's the information you need to use Crunch with MLX:

Starting address = 49152
Ending address = 50795

After you've finished typing, save the program to tape or disk.

The VIC version of Crunch is also in machine language, but in order to allow it to be used with any size VIC memory, a compact BASIC loader is used. You should use the "Automatic Proofreader" (also published regularly in the GAZETTE) to type it in. The VIC version barely fits in an unexpanded VIC. The machine language portion, represented by the letters and numbers in the DATA statements, is not relocatable, but the loader program changes it as necessary in order to load it into the highest available memory. Be sure to save it before using it because the loader erases itself after hiding the machine language in top of memory.

How To Use Crunch

The 64 and VIC-20 versions have the same crunching power, but their directions for use are greatly different. Owners of both computers should read the directions for the 64, and then the differences for the VIC will be explained.

To load the 64 version you must use a secondary address of 1. Type **LOAD"filename",1,1** for tape or **LOAD"filename",8,1** for disk, then type **NEW** to reset various pointers. Crunch-64 resides in a portion of RAM not utilized by BASIC. It's also compatible with Commodore's DOS wedge program included on the Test/Demo disk. (Actually, the two programs are not compatible, but Crunch will disable it before starting and restore it when it's through.)

Next, load in the BASIC program you wish to crunch and type SYS 49152. The screen will clear and change colors, and you'll be asked to select the maximum number of bytes desired per line: 255, 80, or original line length. Ordinarily, you should choose 255 since this will give you the maximum reduction in program size. The resulting program can be listed, saved, loaded, and relocated just like any other program. However, it is difficult to edit, since any line longer than 80 characters will have to be broken up and rewritten as several lines before the screen editor will accept them. This is not really a problem, however. You should save your uncrunched program for editing purposes since it contains all of the explanatory remarks, sensible variable names, and short, easy to read lines.

If you select 80 bytes per line, the resulting program will be a little easier to edit but at the cost of more memory. Most lines will then be 80 characters or less, and the few that do spill over 80 characters can be broken up into two lines.

If for some reason you do not want any line concatenation, select original line length. If a program has been crunched with a short line length selected, it can always be recrunched using a longer line length. However, the reverse is not true. Crunch will not break up a line to form a smaller line.

Crunch takes only seconds to completely rewrite your program. If there were no errors, you'll then see a summary showing the old program length, new program length, and number of bytes saved. The new program should now be saved using a new name. Or, you might want to keep the old name for the crunched program, since that's the one you'll use the most, and add an extension to the name of the uncrunched program such as ".S" for "source".

Before crunching, your program is first checked for nonexistent line numbers. For example, if your program contains a line that reads "100 GOTO 500", and there is no line 500, then you'll get this message:

```
100 LINE #500 DOES NOT EXIST
```

and your program will not be crunched.

To use the VIC-20 version of Crunch, first turn your computer off, then on, to completely clear memory. Do not use any type of wedge program while using VIC Crunch. Next, load and run Crunch just as you would any BASIC program, without the ",1" extension. The actual machine language program will be loaded to the top of memory, and certain pointers changed in order to protect it from BASIC. The loader program will then erase itself after printing the address to SYS in order to use Crunch. Write this address down. You now have 880 fewer bytes of memory, and on the unexpanded VIC this means that the program you want to crunch must be 2704 bytes or less in order for it to reside in memory at the same time.

A maximum line length of 255 bytes is automatically selected by the loader program in line 22 by POKEing location 250 with 255. If you wish to change it, POKE 250 with any number from 0–255 after running the program but before typing SYS, or permanently change line number 22 in the loader program.

Next, load the program you wish to crunch and SYS to the address previously given by the loader program. After a few moments you'll see the READY prompt, which means your program was successfully crunched. If your program contained references to nonexistent lines, you'll see an error message such as:

```
100 <500>
```

This means the error was in line number 100 and the nonexistent line was number 500.

Once you've saved your crunched program, turn your computer off and on to restore your full amount of memory before testing your new program.

Crunching The Cruncher

How was a 1.5K machine language program (the 64 version) reduced to 880 bytes while retaining all of the crunching power? The summary was deleted and the error message was shortened. Gone, too, is the convenient menu for selecting maximum line length. And neither the 64 version nor the VIC version uses a buffer to rewrite each line. Instead, the new program is written directly over the old (which is a little tricky). However, the greatest reduction was made by using numerous machine language routines already existing within the BASIC ROM interpreter. This was not done on the 64 for two reasons. First, it wasn't necessary, since the 64 version fits with room to spare inside a block of RAM memory unused by BASIC. Second, the 64's ROM has been subjected to various revisions in the past and could be revised again in the future. Therefore, any direct subroutine calls to the ROM operating system might not work on all or future machines.

If you'd rather not type in the program, you can order COMPUTE!'s GAZETTE DISK, offered elsewhere in this issue, or send a blank tape or formatted disk (VIC version, tape only) with a self-addressed, stamped mailer and $3 to:

James A. Ledger
7821 Country Dr.
Mobile, AL 36609

With Crunch in your programming toolbox, you can write programs that are easy to read and debug without sacrificing memory and speed.

See program listings on page 72.

ZOUNDS!
Part 2

Lawrence Cotton

In this second of a three-part series, the author presents six more short and impressive sound demos for the Commodore 64.

Last month, we introduced this series with six short sound demos. This month, we'll look at (and listen to) six more. If you have last month's issue, take a minute to refresh your memory by looking back over the article, which discusses what "Zounds!" is and how you can use these demos as routines in your own programs.

The Zounds demos this month are short—only 3 to 12 lines—and can be made even shorter by deleting the REM statements in the program listings. As we mentioned last month, you can modify the sounds by changing various values in the programs. But, some of the programs are so delicately balanced that even a small change can produce some very unpleasant results. So be sure to save a copy of each program to disk or tape before running. And if you modify any of the sounds and find them to your liking, be sure to save them before experimenting further.

Sounding Off

All the programs in this series accomplish two things in the first two lines: clear the sound chip and set the volume to maximum in line 10; and set up the envelope (how fast a sound starts and ends) in line 20. Also, certain variables are consistent in all of the programs: The "Z" loop always represents the number of times a sound is cycled, and F1 and F2 are the two values POKEd into frequency registers for voices one and three, respectively.

"The Last Xither" contains only two nested loops—for frequency incrementing (Y) and for counting the number of cycles (Z). Try changing the initial value of F2 and its multiplier.

"Starwalker" is a two-part program based on waveform 23 (see Part 1 for more details on this). Notice the explanations in the REM statements.

"Not a Bell" uses three nested loops but is based on waveform 21 (sync omitted). Normally 21 is used for bell sounds which depend on an abrupt attack and a gradual release. But an attack/decay value of 8 and a sustain/release value of 255, combined with frequency sweeping (multiplying) yield sounds like anything but a bell.

For a super-crunched sound, try "Hyperwarp." We'll leave this one without comment and see if can you predict how it will sound before running it.

"Decelerator" is unique. It uses a combination of the square (64) plus triangle (16) waveforms, along with ring modulation (4) and gating (1) to yield a waveform value of 85. As mentioned in the REM in line 30, this is also the only program to use the least significant byte of the two frequency registers for voice one (54272).

My favorite sound is "Three Reasons to Own a Computer," which looks (as a listing) very much like the others but sounds entirely different. To see how delicately balanced this sound is, try changing any value just a little.

Experiment with these sounds and see what surprises your 64 has in store. Next month, we'll conclude our series with six more programs.

See program listings on page 76.

Creating Hi-Res Graphics On The 64

Todd Heimarck, Assistant Editor

With one POKE, you can make your 64 display a high-resolution graphics screen containing 64,000 points of light. It takes only a few more POKEs to set up the screen for your own hi-res pictures. Here's a step-by-step explanation of the mysteries of bit-mapped graphics on the 64.

If you've ever tackled high-resolution (hi-res) graphics on the 64, you probably remember first reading about a lot of PEEKs, POKEs, ANDs, ORs, bitmaps, bit masking, and 16K video banks. There are a few rules to learn—the "grammar" of hi-res—but we'll put them off for now. First let's experiment a bit, and create a hi-res screen with a single POKE:

```
POKE53265,PEEK(53265)OR32
```

Clear the screen (hold down SHIFT and press CLR/HOME). You'll notice that the colors are now red and black, but the screen didn't clear as you might have expected. You'll also see some points at the top of the screen blinking on and off. (If you're curious, that's the first 8K of memory you're seeing, including zero page.) Each one of the dots on the screen is a *picture element*, or *pixel* for short. The top part of the screen is a garbled mess, but the bottom seems to contain both character sets.

Now press some keys on the keyboard. The pixels under the cursor change color, as does the background color of each eight by eight block of pixels.

Apart from changing some colors, we don't seem to have any control over what appears on the screen. Set the screen back to normal by holding down RUN/STOP and tapping RESTORE.

Foreground Colors

A 64 can display 16 different colors, numbered 0 to 15:

0 Black	CHR$(144)	8 Orange	CHR$(129)
1 White	CHR$(5)	9 Brown	CHR$(149)
2 Red	CHR$(28)	10 Light Red	CHR$(150)
3 Cyan	CHR$(159)	11 Gray 1 (Dark)	CHR$(151)
4 Purple	CHR$(156)	12 Gray 2 (Medium)	CHR$(152)
5 Green	CHR$(30)	13 Light Green	CHR$(153)
6 Blue	CHR$(31)	14 Light Blue	CHR$(154)
7 Yellow	CHR$(158)	15 Gray 3 (Light)	CHR$(155)

There are several ways to change the foreground color. You can hold down CTRL (for colors 0–7) or the Commodore key (for colors 8–15) and press a number key from 1 to 8. Or you can PRINT a color change using the CHR$ values above—PRINT CHR$(129), for example, changes the cursor color to orange. You can also POKE to 646, the location in memory which keeps track of the current character color.

It's also possible to change colors by POKEing directly to color memory. This doesn't affect the current cursor color; it changes a character that's already on the screen. To see all 256 characters in white, run this program (don't type NEW after running it, we'll be using part of this program later):

```
15 PRINTCHR$(147);
20 FORJ=0TO255:POKE1024+J,J:POKE55296+J,1
   :NEXT
25 GOTO25
```

Line 15 clears the screen. Next, the screen codes 0–255 are POKEd into screen memory, and the number 1 (the color code for white) goes into 256 consecutive bytes of color memory. Screen memory runs from 1024 to 2023, with corresponding color memory at 55296 to 56295.

Five Screen Colors

Changing background colors requires a POKE or two. Five registers hold the current screen colors:

53280	Border Color
53281	Background Color 0
53282	Background Color 1
53283	Background Color 2
53284	Background Color 3

You may be familiar with statements like POKE53281,5, which changes the background color to green (try other numbers between 0 and 15, to see different background colors). The other three background colors can be used in two ways, multicolor mode and extended background color mode.

Extended Background Color Mode

Add the following line to the previous program and then type RUN.

```
12 POKE53281,15:POKE53282,6:POKE53283,1:P
   OKE53284,7:POKE53265,PEEK(53265)OR64
```

The four background registers are POKEd with 15, 6, 1, and 7—light gray, blue, white, and yellow. And 53265, the same register that controlled hi-res mode above, is ORed with 64 (more on OR below).

Examine the characters on the screen. Instead of 256 unique characters, there are now only 64. But they have different background colors. This is extended background color mode, where each character can have one of sixteen foreground colors and one of four background colors. You should see some characters that are solid white, because background color 2 and the character color are both the same. Change the color POKE at the end of line 20 to get new foreground colors. Or you could change the POKE to 53283 in line 12.

To get back to normal, enter **POKE53265, PEEK(53265)AND(255−64)**. Or, more easily, press RUN/STOP–RESTORE.

Multicolored Characters

Extended background color mode offers 16 foreground choices and four background choices, but each character still has only two colors. Multicolor mode allows you to paint characters with up to four colors. Press RUN/STOP–RESTORE, change the cursor color to black (CTRL-1) and list the program in memory. Now enter this in direct mode (without a line number):

POKE53270,PEEK(53270)OR16

Nothing happened, right? Now change the cursor color to one of the eight colors between orange and light gray (colors 8–15); for example, hold down the Commodore key and press 8. List the program again. Try POKEing different numbers into the registers from 53281 to 53283 to get different effects (53284 is not used in multicolor mode).

To see the full character set, add this replacement line to the program in memory (the [<8>] means type 8 with the Commodore key held down):

```
12 POKE53281,12:POKE53282,6:POKE53283,1:P
   RINT"[8]":POKE53270,PEEK(53270)OR16
```

If it doesn't work the first time, make sure line 20 is POKEing color memory (55296 and following) with a number higher than seven.

Screen Memory Becomes Color Memory

We'll do one more experiment before delving into the PEEKs, POKEs, ANDs, and ORs for hi-res. Delete line 12 from the program and add this line:

```
10 POKE53272,24:POKE53265,59
```

This is a stable area of memory. There are no blinking pixels at the top and no character sets at the bottom. You're looking at the 8000 memory locations 8192–16191, which have been translated from bits in memory to pixels.

The memory in this area is called a *bitmap* because each of the 64,000 bits here corresponds ("maps") to one of the pixels on the screen.

The POKEs to 1024 and on, which is usually screen memory, are doing something strange. Instead of putting 256 characters on the screen, the POKEs are displaying every combination of color.

Press STOP, cursor down to a blank (red and black) line and enter this:

FORJ=8192TO9191:POKEJ,7:NEXT

You'll have to type this blind—you won't see the characters, you'll see different color changes. If you make a mistake, the SYNTAX ERROR message will be printed underneath (in colors rather than characters). You could add this to your program as a line 24 if you prefer (press RUN/STOP–RESTORE and you'll be able to enter a new line). This series of 1000 POKEs changes the pattern of the pixels on the top three lines of eight pixels, plus part of the fourth line.

At this point, we have some control over the hi-res screen. The bitmap runs from 8192 to 16191, and the color map is located at 1024–2023. Now we'll learn more about turning individual pixels on and off.

Masking Bits

Each memory location in RAM contains eight bits that are like tiny switches you can turn on and off. The bits are numbered 0–7, *starting from the right*. Each bit has a specific value:

Bit #	7	6	5	4	3	2	1	0
Value	128	64	32	16	8	4	2	1

PEEKing a memory location yields a number from 0 to 255, depending on which bits are on and off (add up the values of the on bits to get the PEEK number).

You can turn individual bits on with the OR function. For example, 53265 usually holds a 27 (00011011). And we turned on hi-res mode by PEEKing 53265, ORing it with 32, and POKEing the result back into 53265:

	00011011	(27)
OR	00100000	(32)
	00111011	(59)

Note that if both bits are off (zeros), the result is a 0. But if either one *or* both are on, the result is 1.

The AND function allows you to turn bits off:

	00111011	(59)
AND	11011111	(223)
	00011011	(27)

The only time a 1 appears in the result is when both the first *and* the second bit are turned on. With specific ANDs and ORs, you can switch between hi-res, extended background, and multicolor modes.

Masking bits with AND and OR is also necessary for turning the hi-res screen pixels on and off.

Character Shapes

To put a red letter A in the top left corner of the screen, you would **POKE1024,1:POKE55296,2**.

A 64 has to translate the numbers in screen and color memory into the shape of a red A. It reads through character memory and finds eight numbers that represent the A shape, listed below in decimal and binary:

Decimal	Binary	Pixels
24	00011000	**
60	00111100	****
102	01100110	** **
126	01111110	******
102	01100110	** **
102	01100110	** **
102	01100110	** **
0	00000000	

For a regular character, the 1s are the foreground color, which is taken from color memory (55296–56295). The 0s are the color from background register 0 (memory location 53281). The top row of eight pixels for a red letter A on a white screen would be white, white, white, red, red, white, white, white.

A Screen With 1000 Custom Characters

Exactly 1000 regular characters can be displayed on the screen of the 64. As we saw above, each character shape is defined by eight bytes, each containing eight bits. So there must be 64,000 pixels on the entire screen (not counting the border). The hi-res screen contains 320 pixels across, 200 pixels down (320 × 200 = 64000).

Because each byte is composed of 8 bits, we need 8000 bytes of memory to bitmap the screen (8000 × 8 = 64,000). You might expect them to be numbered consecutively, but that's not how it works. In fact, the hi-res screen operates as if it were made of 1000 custom characters, each one eight bytes high and eight bits wide (remember, these are *bytes*, each of which contains eight bits):

0	8	16	24	...	312
1	9	17	25	...	313
2	10	18	26	...	314
3	11	19	27	...	315
4	12	20	28	...	316
5	13	21	29	...	317
6	14	22	30	...	318
7	15	23	31	...	319
320	328	336	344	...	632
321	329	337	345	...	633

If you were to take the eight numbers that define an "A" (24, 60, 102, 126, 102, 102, 102, and 0) and POKE them into the first eight bytes of the hi-res screen, the letter A would appear.

Finding The Pixel

You'd need a lot of graph paper and a calculator to figure out the coordinates for a large picture. Fortunately, there's a shortcut to figuring out which bits in memory correspond to certain pixels.

Imagine a grid numbered 0 to 319 across the top and 0 to 199 (from top to bottom) down the side. The top left corner would be location 0,0 and the bottom right would be 319,199. The first number is the X-value, the second the Y-value. To find the corresponding byte in memory, use these formulas:

```
HR = 8192: BY = HR + 40 * (YAND248) + (YAND7)
+ (XAND504)
```

(HR is the beginning of the hi-res screen; BY is the byte.)

Turn on the bit:
POKE BY, PEEK(BY) OR (2↑(NOTXAND7))
Turn off the bit:
POKE BY, PEEK(BY) AND (255−2↑(NOTXAND7))

The first line figures out which byte in memory to POKE, assuming the hi-res screen (HR) starts at 8192. The second figures out which bit inside the byte needs to be turned on or off.

Adding Color

To give each of the 64,000 pixels its own separate color would require 32,000 bytes of color memory. Due to the limits of the VIC-II video chip, this is impossible. So colors are assigned to groups of eight bytes (64 bits) as if each were a character. This reduces color memory to 1000 bytes.

In the example above, hi-res color memory was located at 1024–2023 (for technical reasons, we can't use the regular color memory). Byte 1024 contained color information for 8192–8199, 1025 held the colors for 8200–8207, and so on. In each byte of hi-res color memory, bits 0–3 control background color, and the top four bits correspond to the foreground color.

If you want to change the color of a group of 64 pixels, use the formula above to find the variable BY. Then subtract the variable HR (8192, in this case) and divide by eight. Add that number to 1024 (the beginning of hi-res color memory) to find the memory location to POKE. Multiply the foreground color (0–15) by 16 and add the background color (0–15):

```
HR=8192:CB=(BY-HR)/8+1024
CL=FG*16+BG
POKECB,CL
```

HR is the beginning of the hi-res bitmap, CB is the color byte, CL is the color, from FG (foreground) and BG (background).

The Limits Of The Video Chip

When you're working in hi-res, all of the video information—the 8000 byte bitmap and 1000 bytes of color memory—has to come from one of the four 16K banks of memory. You control which bank is used by POKE56578,3 and then a POKE to 56576:

Bank	POKE	Memory Used
* 0	POKE56576,7	0–16383
1	POKE56576,6	16384–32767
* 2	POKE56576,5	32768–49151
3	POKE56576,4	49152–65535

The VIC-II chip, which manages all the video information, can only "see" 16K of memory at a time. So sprite shapes and character shapes must also be within the 16K bank currently switched in.

The banks marked with asterisks contain shadows of character ROM: 4096–8191 in bank 0, 36864–40959 in bank 2. *You should not put hi-res screens, hi-res color, or sprite shapes in these two areas; the video chip sees only character shapes at these memory locations.*

A hi-res screen always starts at an even 8K boundary—a number divisible by 8192. Within each of the four 16K video banks you have two choices, first half or second, for a total of eight. Two are unavailable (because of the character shadows), leaving 8192, 16384, 24576, 40960, 49152, and 57354. Although BASIC and Kernal ROM start at 40960, the VIC-II chip gets its information from the RAM underneath the ROM, so it's possible to set up a hi-res screen that takes no memory away from BASIC.

To set the hi-res bitmap to the first 8K of a 16K bank, **POKE53272,PEEK(53272)AND247**. To put the bitmap at the second half of a bank, **POKE53272,PEEK(53272)OR8.**

You should also tell the 64 where the hi-res color memory will be located. There are 16 1K sections of memory (1024 bytes) within each video bank. They're numbered 0–15 and, to avoid interference with the hi-res screen, should be in the section you're not using for the bitmap—that is, the other half of the 16K bank. To set color memory, **POKE 53272, (PEEK(53272) AND 15) OR (16*CM)** where CM is a number between 0 and 15.

Five POKEs To Set Up Hi-Res

Let's say you want to put a hi-res screen at 16384, the first half of video bank one. Hi-res color memory can't go into the first eight 1K areas (numbered 0–7) because they're used by the bitmap. So we'll use section number 8 (starting at 16384 + 8 × 1024, or 24576). You would follow these steps in your program:

1. **POKE56578,3:POKE56576,6** to set video memory to 16K bank number one.
2. **POKE53272,PEEK(53272)AND247** to put the hi-res screen at the first 8000 bytes in bank one.
3. **CM=8: POKE53272, (PEEK(53272) AND15) OR (16*CM)** to set hi-res color memory to section 8 (24576). To put color memory elsewhere, change CM to another number 0–15.
4. **POKE53265,PEEK(53265)OR32** to turn hi-res on.

To clear the screen, you'll have to POKE a 0 into each of the 8000 locations from 16384 to 24383. Then, use the formulas for locating a pixel, changing HR (the beginning of the bitmap) from 8192 to 16384, and changing the beginning of hi-res color memory (CM) from 1024 to 24576.

A Memory Conflict

In our first example of hi-res graphics, we put the screen at 8192, with color memory beginning at 1024. Since BASIC programs are stored at 2049, about 6K below the bitmap area, this poses a problem: If the BASIC program and its variables grow beyond 6K, either the hi-res screen or the program will be scrambled.

There are two solutions: to move the beginning of BASIC up, past the end of the hi-res screen with **POKE44,64: POKE64*256,0: NEW**; or to move the hi-res screen out of the way of BASIC into 16K bank number 3 with **POKE 56578,3:POKE56576,4**. Either way, you'll avoid the memory conflict.

Hi-Res Toolbox

John E. Banks

The speed of machine language is important when you're working with hi-res graphics. This program for the 64 adds several ML routines you can call from BASIC.

One of the 64's excellent features is its ability to display a high-resolution screen with 64,000 individual specks of light you can turn on and off. But there are a couple of drawbacks to the way hi-res graphics are handled. First, it takes a lot of memory—8,000 bytes—to bitmap the screen. This is seldom a problem, though, because the 64 has plenty of memory for most applications.

The more serious problem is the slow speed of BASIC. Clearing the screen takes nearly half a minute (by POKEing zeros into all 8,000 locations). Machine language (ML) is the solution.

Two Example Programs

"Hi-Res Toolbox" adds a few ML routines that speed up or simplify certain hi-res functions. It's written as a BASIC loader, so you can just type it in and save to tape or disk.

When you first run it, the screen clears and a message appears. Enter RUN 100 to see a sample sine wave. RUN 200 gives you a doodling program. You can draw in hi-res with a joystick (port 2). Hold down the fire button and the pixel cursor will blink on and off; you'll be able to move around the screen without leaving a trail. (For more about hi-res graphics, see "Creating Hi-Res Graphics on the 64" elsewhere in this issue.)

These two internal BASIC routines (sine wave and the joystick doodler) are example programs embedded in Program 1 and are intended to show how to use the Toolbox commands, so feel free to modify them. Try RUN 100 once, press a key to go back to the regular screen, then remove the SYS CLEAR from line 205. Modify line 130, where the sine wave is calculated. Change SIN to COS. Change the 60 to a 30, or the (X/10) to (X/8). You could also revise the main loop to clear the hi-res screen if f1 is pressed, or add new routines for plotting circles and squares.

The machine language portion, discussed later, is relocatable, so if you have a program or utility that begins at 49152, change the value of SA in lines 600 and 1010 to another safe section of memory.

The Sine Wave

Here's how the sine wave program (lines 100–160) works:

Line 100 calls subroutine 1000, which turns on the hi-res screen and sets up necessary variables. The variable FLAG must be POKEd to zero if you want pixels to be turned on.

In line 110, the bitmap is cleared and the color combination set to black on white. The main loop is found in lines 120 through 150. The values of X and Y are calculated and then plotted. Line 160 waits for a key to be pressed and then goes to subroutine 2000, which sets the screen back to normal.

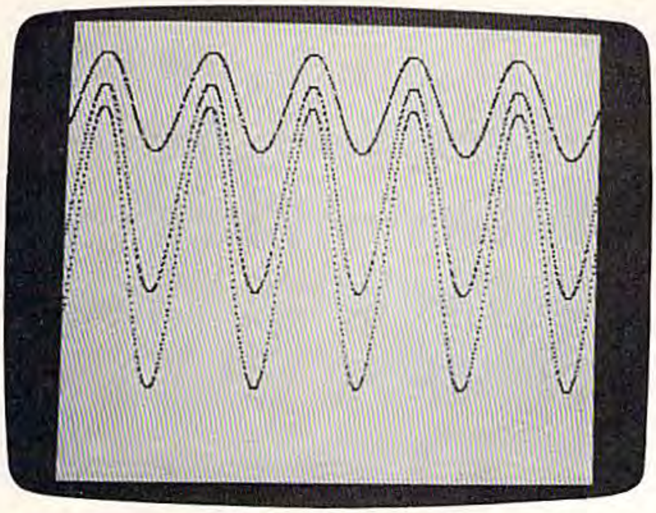
The Joystick Routine

Here's how the second routine, the joystick doodler, works. First, line 200 calls subroutine 1000, which turns on the hi-res screen, then line 205 clears it and sets the color to black pixels on a white background. Two arrays which assign joystick moves to the equivalent X/Y coordinates are created in lines 210–215.

Line 220 is the start of the main loop. First, the joystick is PEEKed to see if a new value should be plotted. New values of X and Y are assigned in lines 230–240. If the fire button is pressed, line 245 causes the cursor pixel to flash (without leaving a trail). The point is plotted in 250 and the program loops back to 220, to check the joystick again.

Four New Commands

The machine language routines (lines 600–2020) provide four new commands—CLEAR, COLOR, PLOT, and FLAG—which you can insert in your own programs. Lines 10–250 are used by the two BASIC routines discussed above. You needn't include them if you plan to use the ML hi-res routines in your own programs. At the beginning of your program, include a GOSUB600 (you only have to do this once in your program).



A mathematical pattern—three sine waves—created with Toolbox commands.

A joystick routine converts Hi-Res Toolbox to an artist's drawing pad.

Here's how to use the new commands:

SYS CLEAR rapidly clears the bitmap area that controls the hi-res screen.

SYS COLR,C (where **C** is a number 0–255) fills color memory with your choice of foreground and background colors. Calculate C with the formula C=FG*16+BG using color codes 0–15 for FG (foreground) and BG (background). And be sure to put a comma between COLR and C.

SYS PLOT,X,Y turns the pixel at X/Y on or off, depending on the value in FLAG. Always keep X within the range 0–319 and Y within 0–199. You can insert numbers, variables, or even formulas for X and Y. The top left corner is location 0,0; the bottom right is 319,199. The X-axis runs across the top of the screen left to right. The Y-axis is vertical from top to bottom.

POKE FLAG,0 causes SYS PLOT to turn pixels on. **POKE FLAG,1** turns pixels off when a SYS PLOT occurs.

In addition to the ML routines, there are two BASIC subroutines which control the hi-res screen. GOSUB 1000 each time you want to turn on the hi-res screen. Lines 1010–1020 put the bitmap at 8192, and the color memory at 1024. The other subroutine starts at 2000. It turns hi-res off, and clears the normal screen.

Avoiding Memory Problems

In certain cases, Hi-Res Toolbox could interfere with BASIC programs. The bitmap starts at 8192, with hi-res color memory at 1024. If your program (plus variables) becomes larger than about 6K, either variables will overwrite the hi-res screen, or the screen will destroy the end of your BASIC program.

If you anticipate such a conflict, move the beginning of BASIC up to 16384, with a POKE and a SYS:

```
POKE642,64:SYS58260
```

Be sure to enter this line before you load the program you're working on.

A Few Ideas

High-resolution graphics are not just for mathematicians studying sine waves or artists who like doodling with a joystick. A hi-res screen is like a piece of graph paper containing 64,000 squares. It's especially good for business applications like graphs and charts. If you invest in stocks, you could get a whole year's worth of information on one screen (52 weeks of 5 days each is 260, well within the horizontal resolution of 320 pixels). It's possible to save a section of memory as if it were a program, so you could use "MetaBASIC" (in the April 1985 issue) to BSAVE"CHART",8192,16192. You can then retrieve the screen from disk with LOAD"CHART",8,1.

Also, hi-res is often used in games to give the illusion of three dimensions. Sprite graphics are not affected by hi-res mode (but be sure not to put the sprite shapes in the memory used by the bitmap).

You could even create your own Turtle language (similar to Logo) for drawing pictures on the screen. You can then print them out using a hi-res screen dump program.

It's possible to put text on a hi-res screen (see "Mixing Text and Hi-Res Graphics," which is compatible with Hi-Res Toolbox, elsewhere in this issue). This provides even more flexibility when working in hi-res.

See program listing on page 76.

ReDisk

Michael Mueller

Making backups of machine language programs and sequential files is a breeze with this fast and efficient utility for the 64, VIC, Plus/4, and 16. It's also a handy tool for GAZETTE DISK subscribers.

Copying programs written in BASIC is easy. It's as simple as loading the program from one disk and saving it to another. This method is fine for BASIC programs but is useless for machine language programs and sequential files.

"ReDisk" allows you to copy any unmachine language program or sequential file. And, if you're copying to a new disk, the program provides a format option.

ReDisk is a very short program, using less than 2K of memory, and some machine language is used (in DATA statements) to increase speed. You don't need to know anything about machine language, however, to use the program.

Be extremely careful when typing in the program, taking special precaution with the DATA statements, which are the machine language portion of the program. Also, be sure to save a copy before typing RUN.

ReDisk is written for the 64, but with the following single line substitutions, it will run on other Commodore computers.

For the unexpanded VIC:

```
1 F1=7679:F2=3:F$="{20 SPACES}{UP}"
                                   :rem 154
```

For the VIC with 8K expansion:

```
1 F1=16383:F2=3:F$="{20 SPACES}{UP}"
                                   :rem 194
```

For the VIC with 16K expansion:

```
1 F1=24575:F2=3:F$="{20 SPACES}{UP}"
                                   :rem 196
```

For the Plus/4:

```
1 F1=32767:F2=3:F$="{39 SPACES}{UP}"
```

For the Commodore 16:

```
1 F1=16127:F2=3:F$="{39 SPACES}{UP}"
```

Getting Started

After you've determined which file (machine language program or sequential file) you wish to copy, write it down on a piece of paper and note whether it is a program (PRG) or sequential (SEQ) file. Load ReDisk and respond to the prompts, pressing RETURN after each entry. The first prompt asks if you wish to format the "Destination" disk (note that "Destination" disk is the disk to receive the file to be copied, and "Source" disk is the disk containing the program to be copied). An "N" (for "No") appears with the flashing prompt, so just press RETURN if you do not wish to format the disk. Press "Y" if you do.

When entering disk names, disk IDs (for the format option only), filenames, and file types, be sure to use a comma with no spaces before or after. The screen example serves as a reminder.

It's handy to have the Commodore DOS Wedge program (supplied with your disk drive) loaded into memory before loading ReDisk, since this allows you to look at a disk directory without disturbing the current program. This also makes memorizing or writing down filenames unnecessary.

See program listing on page 69.

How To Type In *COMPUTE!'s GAZETTE* Programs

Each month, COMPUTE!'s GAZETTE publishes programs for the VIC-20, Commodore 64, Plus 4, and 16. Each program is clearly marked by title and version. Be sure to type in the correct version for your machine. Also, carefully read the instructions in the corresponding article. This can save time and eliminate any questions which might arise after you begin typing.

We publish two programs, which appear periodically, designed to make your typing effort easier: The Automatic Proofreader, and MLX, designed for entering machine language programs.

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

Special Characters

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

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

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

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

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

The Quote Mode

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

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

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

When You Read:	Press:	See:
{PUR}	CTRL 5	
{GRN}	CTRL 6	
{BLU}	CTRL 7	
{YEL}	CTRL 8	
{F1}	f1	
{F2}	SHIFT f1	
{F3}	f3	
{F4}	SHIFT f3	
{F5}	f5	
{F6}	SHIFT f5	
{F7}	f7	
{F8}	SHIFT f7	

When You Read:	Press:	See:
←	←	
↑ (underlined)	SHIFT ↑	

For Commodore 64 Only

When You Read:	Press:	See:
⌈1⌉	C= 1	
⌈2⌉	C= 2	
⌈3⌉	C= 3	
⌈4⌉	C= 4	
⌈5⌉	C= 5	
⌈6⌉	C= 6	
⌈7⌉	C= 7	
⌈8⌉	C= 8	

The Automatic Proofreader

"The Automatic Proofreader" will help you type in program listings from COMPUTE!'s Gazette without typing mistakes. It is a short error-checking program that hides itself in memory. When activated, it lets you know immediately after typing a line from a program listing if you have made a mistake. Please read these instructions carefully before typing any programs in COMPUTE!'s Gazette.

Preparing The Proofreader

1. Using the listing below, type in the Proofreader. The same program works on both the VIC-20 and Commodore 64. Be very careful when entering the DATA statements — don't type an l instead of a 1, an O instead of a 0, extra commas, etc.

2. SAVE the Proofreader on tape or disk at least twice *before running it for the first time.* This is very important because the Proofreader erases this part of itself when you first type RUN.

3. After the Proofreader is SAVEd, type RUN. It will check itself for typing errors in the DATA statements and warn you if there's a mistake. Correct any errors and SAVE the corrected version. Keep a copy in a safe place — you'll need it again and again, every time you enter a program from COMPUTE!'s Gazette.

4. When a correct version of the Proofreader is RUN, it activates itself. You are now ready to enter a program listing. If you press RUN/STOP-RESTORE, the Proofreader is disabled. To reactivate it, just type the command SYS 886 and press RETURN.

Using The Proofreader

All VIC and 64 listings in COMPUTE!'s Gazette now have a *checksum number* appended to the end of each line, for example ":rem 123". *Don't enter this statement when typing in a program.* It is just for your information. The rem makes the number harmless if someone does type it in. It will, however, use up memory if you enter it, and it will confuse the Proofreader, even if you entered the rest of the line correctly.

When you type in a line from a program listing and press RETURN, the Proofreader displays a number at the top of your screen. *This checksum number must match the checksum number in the printed listing.* If it doesn't, it means you typed the line differently than the way it is listed. Immediately recheck your typing. Remember, don't type the rem statement with the checksum number; it is published only so you can check it against the number which appears on your screen.

The Proofreader is not picky with spaces. It will not notice extra spaces or missing ones. This is for your convenience, since spacing is generally not important. But occasionally proper spacing *is* important, so be extra careful with spaces, since the Proofreader will catch practically everything else that can go wrong.

There's another thing to watch out for: if you enter the line by using abbreviations for commands, the checksum will not match up. But there is a way to make the Proofreader check it. After entering the line, LIST it. This eliminates the abbreviations. Then move the cursor up to the line and press RETURN. It should now match the checksum. You can check whole groups of lines this way.

Special Tape SAVE Instructions

When you're done typing a listing, you must disable the Proofreader before SAVEing the program on tape. Disable the Proofreader by pressing RUN/STOP-RESTORE (hold down the RUN/STOP key and sharply hit the RESTORE key). This procedure is not necessary for disk SAVEs, *but you must disable the Proofreader this way before a tape SAVE.*

SAVE to tape erases the Proofreader from memory, so you'll have to LOAD and RUN it again if you want to type another listing. SAVE to disk does not erase the Proofreader.

Since the Proofreader is a machine language program stored in the cassette buffer, it will be erased during a tape SAVE or LOAD. If you intend to type in a program in more than one sitting or wish to make a safety SAVE, follow this procedure:

1. LOAD and RUN the Proofreader.
2. Disable it by pressing RUN/STOP–RESTORE.
3. Type the following three lines in direct mode (without line numbers):

```
A$="PROOFREADER.T":B$="{10 SPACES}":FO
RX=1TO4:A$=A$+B$:NEXTX
FORX=886 TO 1018:A$=A$+CHR$(PEEK(X)):N
EXTX
OPEN1,1,1,A$:CLOSE1
```

After you type the last line, you will be asked to press RECORD and PLAY. We recommend you start at the beginning of a new tape.

You now have a new version of the Proofreader (PROOFREADER.T, as renamed in the above code). Turn your computer off and on, then LOAD the program you were working on. Put the cassette containing PROOFREADER.T into the tape unit and type:

OPEN1:CLOSE1

You can now get into the Proofreader by typing SYS 886. To test this, PRINT PEEK (886) should return the number 173. If it does not, repeat the steps above, making sure that A$ (PROOFREADER.T) contains 13 characters and that B$ contains 10 spaces.

The new version of Automatic Proofreader will load itself into the cassette buffer whenever you type OPEN1:CLOSE1 and PROOFREADER.T is the next program on your tape. It will not disturb the contents of BASIC memory.

Automatic Proofreader For VIC And 64

```
100 PRINT"{CLR}PLEASE WAIT...":FORI=886TO
    1018:READA:CK=CK+A:POKEI,A:NEXT
110 IF CK<>17539 THEN PRINT"{DOWN}YOU MAD
    E AN ERROR":PRINT"IN DATA STATEMENTS.
    ":END
120 SYS886:PRINT"{CLR}{2 DOWN}PROOFREADER
     ACTIVATED.":NEW
886 DATA 173,036,003,201,150,208
892 DATA 001,096,141,151,003,173
898 DATA 037,003,141,152,003,169
904 DATA 150,141,036,003,169,003
910 DATA 141,037,003,169,000,133
916 DATA 254,096,032,087,241,133
922 DATA 251,134,252,132,253,008
928 DATA 201,013,240,017,201,032
934 DATA 240,005,024,101,254,133
940 DATA 254,165,251,166,252,164
946 DATA 253,040,096,169,013,032
952 DATA 210,255,165,214,141,251
958 DATA 003,206,251,003,169,000
964 DATA 133,216,169,019,032,210
970 DATA 255,169,018,032,210,255
976 DATA 169,058,032,210,255,166
982 DATA 254,169,000,133,254,172
988 DATA 151,003,192,087,208,006
994 DATA 032,205,189,076,235,003
1000 DATA 032,205,221,169,032,032
1006 DATA 210,255,032,210,255,173
1012 DATA 251,003,133,214,076,173
1018 DATA 003
```

ReDisk

(Article on page 66.)

BEFORE TYPING . . .

Before typing in programs, please refer to "How To Type In COMPUTE!'s GAZETTE Programs," which appears before the Program Listings.

```
0 POKE55,0:POKE56,PEEK(44)+8:CLR:PRINT"
  {CLR}{RVS}REDISK{OFF}{2 DOWN}":P=880
                                   :rem 14
1 F1=53247:F2=1:F$="{39 SPACES}{UP}"
                                  :rem 192
2 READA:IFA>-1THENPOKEP,A:P=P+1:GOTO2
                                  :rem 104
3 POKE909,(F1+1)/256:POKE917,F2:POKE950,F
  2:POKE881,PEEK(56):POKE919,PEEK(56)
                                  :rem 169
4 PRINT"{DOWN}DO YOU WANT TO FORMAT THE D
  EST. DISK{2 SPACES}N{3 LEFT}";:INPUTA$
                                   :rem 69
5 OPEN15,8,15:IFRIGHT$(A$,1)="Y"THEN19
                                  :rem 180
6 PRINT"{DOWN}NAME,TYPE (PRG OR SEQ) OF F
  ILE TO COPY.":INPUTP$,T$:PRINT :rem 213
7 T$=LEFT$(T$,1):IF(T$<>"P"ANDT$<>"S")ORL
  EN(P$)>16THENPRINT"{3 UP}":GOTO6
                                  :rem 163
8 M$="INSERT SOURCE DISK":GOSUB23:PT$="0:
  "+P$+","+T$+",R"                :rem 209
9 POKE1000,LEN(PT$):FORX=1TOLEN(PT$):POKE
  827+X,ASC(MID$(PT$,X,1)):NEXT   :rem 33
10 SYS958:SYS982:SYS880:P=PEEK(247)+256*P
   EEK(248):CLOSE5:GOSUB27        :rem 163
11 IFP>F1THENPRINT"{DOWN}{RVS}FILE HAS OV
   ERFLOWED{3 SPACES}THE BUFFER.":GOTO17
                                  :rem 182
12 PRINT"{DOWN}{RVS}FILE IS NOW LOADED
   {4 SPACES}INTO BUFFER."        :rem 210
13 PRINT"{DOWN}ENTER NEW FILE NAME.":PRIN
   T"{2 RIGHT}"+P$:INPUT"{UP}";P$:PRINT
                                   :rem 22
14 M$="INSERT DEST. DISK":GOSUB23:PT$="@0
   :"+P$+","+T$+",W"              :rem 208
15 POKE1000,LEN(PT$):FORX=1TOLEN(PT$):POK
   E827+X,ASC(MID$(PT$,X,1)):NEXT :rem 78
16 SYS958:SYS989:SYS914:OPEN15,8,15:GOSUB
   27:PRINT"{DOWN}{RVS}FILE IS NOW COPIED
   ."                             :rem 113
17 CLOSE15:OPEN15,8,15:CLOSE15:INPUT"
   {DOWN}ANOTHER FILE";A$          :rem 18
18 ON-(LEFT$(A$,1)="Y")GOTO4:PRINT"{CLR}"
   :END                           :rem 220
19 PRINT"{DOWN}NAME,ID OF DISK TO BE FORM
   ATTED":INPUTP$,T$:PRINT         :rem 95
20 M$="INSERT DEST. DISK":GOSUB23:rem 209
21 PRINT"{DOWN}{RVS}FORMATTING DISK":PRIN
   T#15,"N0:"+P$+","+T$           :rem 210
22 GOSUB27:PRINT"{DOWN}{RVS}DISK FORMATTE
   D":GOTO6                       :rem 245
23 PRINTM$"{UP}":FORT=0TO50:GETA$:ON-(A$<
   >"")GOTO25:NEXT                 :rem 50
24 PRINTF$:FORT=0TO50:GETA$:ON-(A$<>"")GO
   TO25:NEXT:GOTO23                :rem 47
25 IFA$=CHR$(13)THENPRINT:RETURN  :rem 36
26 GOTO23                           :rem 6
27 INPUT#15,A$,B$,C$,D$:IFB$="OK"THENRETU
   RN                              :rem 37
28 PRINT:PRINTA$",{RVS}"B$"{OFF},"C$","D$
   :PRINT"{2 DOWN}TRY AGAIN.":GOTO17
                                  :rem 225
29 DATA 160,16,132,248,160,0,132,247,32,2
   07,255,145,247,200,240,8,32,183,255
                                  :rem 151
30 DATA 240,243,132,247,96,230,248,165,24
   8,201,208,208,240,96,234,169,54,133
                                  :rem 172
31 DATA 1,160,16,132,254,160,0,132,253,17
   7,253,32,210,255,200,240,18,196,247
                                  :rem 136
32 DATA 208,244,166,254,228,248,208,238,3
   2,231,255,169,55,133,1,96,230,254,76
                                  :rem 233
33 DATA 166,3,234,169,5,162,8,160,5,32,18
   6,255,173,232,3,162,60,160,3,32,189
                                  :rem 160
34 DATA 255,32,192,255,96,234,162,5,32,19
   8,255,96,234,162,5,32,201,255,96,-1
                                  :rem 174
```

Space Dock

(Article on page 54.)

Program 1: Space Dock—VIC Version

```
10 POKE56,28:POKE55,0:CLR:GOSUB90:RESTORE
   :PRINT"{CLR}":ME=3:Z=36878:V=36877:POK
   E36879,110                      :rem 43
11 PRINT"{HOME}{RVS}+":PRINT"{HOME}{WHT}
   {2 DOWN}{RIGHT}{5 DOWN}{3 RIGHT}{RVS}
   {RIGHT}PLEASE WAIT":READX$:PRINT"
   {HOME}{RVS}V":IFX$<>"@"THEN11   :rem 11
12 PRINT"{HOME}{9 DOWN}{5 RIGHT}{RVS}DOCK
   INGS";PO:FORI=1TO9:READM(I):NEXT:RESTO
   RE:PRINT"{HOME}{RVS}V"         :rem 125
13 PRINT"{3 UP}{6 RIGHT}{RVS}SHIPS";ME
                                  :rem 252
14 E=8138+INT(RND(1)*20):PRINT"{HOME}
   {RVS}+":POKE653,128            :rem 237
15 Q=7780:POKE650,128             :rem 149
16 FORX=1TOINT(RND(1)*300)+1:Q=Q+1:NEXT:
                                  :rem 154
17 N=7780:PRINT"{HOME}{RVS}V      :rem 173
18 FORX=1TOINT(RND(1)*300)+1:N=N+1:NEXT
                                   :rem 92
19 D=7780:PRINT"{HOME}{RVS}+      :rem 170
20 FORX=1TOINT(RND(1)*300)+1:D=D+1:NEXT
                                   :rem 65
21 PRINT"{HOME}V                  :rem 251
22 FORX=7424TO7431:POKEX,0:NEXT   :rem 185
23 FORX=7168TO7168+79             :rem 203
24 READL:POKEX,L:PRINT"{HOME}{RVS}V":NEXT
   :PRINT"{CLR}"                   :rem 36
25 DATA0,8,8,28,28,28,28,28,28,28,28,62,9
   9,99,65,0                      :rem 236
26 DATA28,28,28,62,99,107,93,8,0,189,231,
   189,189,0,0,0                  :rem 166
27 DATA48,48,32,32,47,63,63,127   :rem 48
28 DATA16,16,56,124,255,255,57,57:rem 152
29 DATA12,12,4,4,244,252,252,254  :rem 78
30 DATA127,127,127,63,127,127,63,31
                                  :rem 233
31 DATA255,255,255,255,255,195,129,0
                                   :rem 41
```

```
32 DATA254,254,252,254,254,254,252,248
                                    :rem 138
33 S=7424:FORX=1TO8:POKES,0:S=S+1:NEXT:PO
   KE7428,32                        :rem 98
34 T=2:A$="{BLK}DEF{3 LEFT}{DOWN}GHI{WHT}
   "                                :rem 110
35 POKE36869,255                    :rem 111
36 IFP=1THENPOKEZ,0                 :rem 202
37 POKE37139,0:IFNOTPEEK(37137)AND16THENL
   =-1                              :rem 129
38 POKE37154,127:IFNOTPEEK(37152)AND128TH
   ENL=1                            :rem 237
39 POKE37154,255:IFNOTPEEK(37137)AND4THEN
   P=2                              :rem 145
40 E=E+L:IFL<>0THEN:POKEE-1,32:POKEE+1,32
   :POKEE+21,32:POKEE+23,32:L=0     :rem 87
41 FORX=1TOP:POKEE,32:POKEE+22,32:E=E-22:
   IFPEEK(E)=8ORPEEK(E+22)=8THENGOTO66
                                    :rem 209
42 IFPEEK(E)=42+128THENPOKEE,42+128:POKEE
   +42+128,32:GOTO80                :rem 133
43 IFPEEK(E)=3THEN80                :rem 184
44 IFPEEK(E+22)=3THEN80             :rem 72
45 POKEE,0:POKEE+22,2:POKEV,255:POKEZ,15:
   NEXT                             :rem 41
46 IFE<7746THENGOTO80               :rem 34
47 POKEV,0                          :rem 76
48 PRINTTAB(T);"{HOME}{52 SPACES}{HOME}";
   TAB(T);A$:T=T+1                  :rem 236
49 FORX=1TO3                        :rem 240
50 POKEQ,32:Q=Q+1:IFPEEK(Q)=0ORPEEK(Q)=1O
   RPEEK(Q)=2THEN80                 :rem 44
51 POKEQ,3                          :rem 69
52 NEXT:POKEV,255                   :rem 45
53 FORX=1TO2:POKEN,32:N=N+1:IFPEEK(N)=0OR
   PEEK(N)=1ORPEEK(N)=2THEN80       :rem 217
54 POKEN,3:NEXT                     :rem 190
55 POKED,32:D=D-1:IFPEEK(D)=0ORPEEK(D)=1O
   RPEEK(D)=2THEN80                 :rem 229
56 POKED,3                          :rem 61
57 POKEV,0                          :rem 77
58 S=INT(RND(1)*7):IFS=0THENPOKE7428,128
                                    :rem 131
59 IFS=1THENPOKE7428,8              :rem 85
60 IFS=2THENPOKE7428,32             :rem 123
61 IFS=3THENPOKE7427,32             :rem 124
62 IFS=4THENPOKE7427,0              :rem 73
63 IFS=5THENPOKE7429,128            :rem 184
64 IFS=6THENPOKE7429,0              :rem 79
65 POKEV,255:POKEE+22,1:P=1:GOTO36:rem 38
66 PRINT"{HOME}{9 DOWN}{RVS}{3 RIGHT}MISS
   ION COMPLETE":POKEV,0:ME=ME+1:PRINT"
   {2 DOWN}{RVS}{6 RIGHT}BONUS MAN"
                                    :rem 47
67 E=E+22:POKEE,0:POKEE+22,1:POKEE+1,75+1
   28:POKEE-1,74+128                :rem 56
68 POKEZ,15:POKEV,0:FORX=255TO128STEP-3.2
   :POKEV,X:POKEZ,0:POKEZ,15        :rem 231
69 D=7424:FORC=1TO8:POKED,RND(1)*255:D=D+
   1:NEXT                           :rem 71
70 NEXTX                            :rem 254
71 POKEZ,15:FORX=1TO33:POKE36876,INT(RND(
   1)*120)+128:NEXT                 :rem 180
72 PRINT"{HOME}{6 DOWN}";:FORX=1TO130:PRI
   NT"{2 SPACES}";:NEXT             :rem 203
73 D=7424:FORC=1TO8:POKED,0:D=D+1:NEXT
                                    :rem 70
74 PO=PO+1:POKEV,0:POKE36876,0:POKEZ,0:GO
   TO11                             :rem 36
75 ME=ME-1:IFME<>0THEN97            :rem 207
76 POKEZ,0:POKE36876,0:PRINT"{HOME}
   {7 DOWN}{RVS} PLAY AGAIN (Y/N) ?
   {4 RIGHT}{DOWN}DOCKINGS"PO:POKE198,0
                                    :rem 165
77 GETX$:IFX$=""THEN77              :rem 45
78 IFX$="Y"THENPOKEZ,0:POKEZ,0:POKE36869,
   240:RUN                          :rem 241
79 POKE828,0:SYS828                 :rem 120
80 FORX=128TO255STEP2:POKEZ,INT(RND(1)*10
   )+5:POKEV,X:POKE36876,X-50       :rem 120
81 FORX=200TO255:POKE36874,X:NEXT :rem 40
82 FORX=255TO200STEP-1:POKE36874,X:NEXT:P
   OKE36874,0                       :rem 148
83 POKEE,214:POKEE+22,214           :rem 162
84 POKEE,170:POKEE+22,170:          :rem 223
85 FORI=0TO9:FORK=1TO9:G=E+M(K)*I:IFPEEK(
   G)=32THENPOKEG,171               :rem 184
86 NEXT:POKE36875,0                 :rem 127
87 FORK=1TO9:IFPEEK(E+M(K)*I)=171THENPOKE
   E+M(K)*I,32                      :rem 135
88 NEXT:NEXT                        :rem 40
89 FORX=1TO999:NEXT:GOTO75          :rem 196
90 PRINT"{CLR}{6 DOWN}{6 SPACES}{RVS}SPAC
   E DOCK                           :rem 176
91 PRINT"{3 DOWN}USE JOYSTICK TO MOVE
   {2 SPACES}LEFT AND RIGHT"        :rem 33
92 PRINT"{DOWN}PRESS UP TO ACCELERATE
                                    :rem 201
93 PRINT"{DOWN}{3 RIGHT}PRESS FIREBUTTON"
                                    :rem 52
94 POKE37139,0:WAIT37137,32,32      :rem 149
95 POKE36869,255:RETURN             :rem 143
96 DATA"@",23,21,22,1,-1,-22,-23,-21,23
                                    :rem 108
97 PRINT"{CLR}{5 DOWN}{6 SPACES}{RVS}DOCK
   INGS"PO:POKEZ,0                  :rem 75
98 PRINT"{3 DOWN}{7 SPACES}{RVS}SHIPS"ME
                                    :rem 160
99 FORG=1TO20                       :rem 19
100 FORX=0TO7:POKE7424+X,255:POKE7424+X-1
    ,0:POKE7431,0:NEXT              :rem 32
101 NEXTG:RESTORE:GOTO14            :rem 78
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Program 2: Space Dock—64 Version

Translation by Kevin Mykytyn, Editorial Programmer

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49152 :234,169,048,133,249,169,234
49158 :053,133,250,032,249,195,150
49164 :169,000,141,021,208,032,071
49170 :090,196,032,026,193,032,075
49176 :064,194,032,162,193,173,074
49182 :030,208,076,118,194,173,061
49188 :141,002,240,007,169,000,083
49194 :141,167,002,240,244,169,237
49200 :001,141,167,002,208,231,030
49206 :230,247,169,001,141,025,099
49212 :208,173,167,002,208,003,053
49218 :076,228,192,032,219,193,238
49224 :206,060,003,240,003,076,148
49230 :228,192,173,061,003,141,108
49236 :060,003,162,007,160,014,234
49242 :169,000,133,002,189,086,157
49248 :003,208,044,189,062,003,093
49254 :024,125,094,003,157,062,055
49260 :003,189,070,003,125,126,112
49266 :003,157,070,003,189,078,102
49272 :003,105,000,157,078,003,210
49278 :201,001,208,047,189,070,074
49284 :003,201,090,208,040,032,194
49290 :241,192,076,177,192,189,181
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49296 :062,003,056,253,094,003,103
49302 :157,062,003,189,070,003,122
49308 :253,126,003,157,070,003,000
49314 :189,078,003,233,000,157,054
49320 :078,003,201,255,208,003,148
49326 :032,241,192,189,102,003,165
49332 :056,253,118,003,157,102,101
49338 :003,189,110,003,233,000,212
49344 :157,110,003,189,070,003,212
49350 :153,000,208,189,110,003,093
49356 :153,001,208,189,078,003,068
49362 :074,038,002,136,136,202,030
49368 :016,132,165,002,141,016,176
49374 :208,169,250,141,018,208,192
49380 :173,013,220,041,001,240,148
49386 :003,076,188,254,076,049,112
49392 :234,173,027,212,041,001,160
49398 :157,078,003,157,086,003,218
49404 :072,224,000,240,006,024,050
49410 :105,193,157,248,007,104,048
49416 :240,002,169,090,157,070,224
49422 :003,173,027,212,201,090,208
49428 :144,249,157,094,003,096,251
49434 :160,023,169,000,153,000,019
49440 :212,136,016,250,169,047,094
49446 :141,024,212,169,055,141,012
49452 :005,212,169,010,141,001,070
49458 :212,162,007,160,014,189,026
49464 :195,193,157,110,003,153,099
49470 :001,208,189,203,193,157,245
49476 :039,208,189,211,193,157,041
49482 :248,007,169,000,157,118,005
49488 :003,153,000,208,141,016,089
49494 :208,169,001,157,126,003,238
49500 :136,136,202,016,214,169,197
49506 :128,141,018,212,169,255,253
49512 :141,015,212,162,006,032,160
49518 :241,192,202,208,250,162,085
49524 :006,189,086,003,221,085,194
49530 :003,240,238,202,208,245,234
49536 :169,150,141,077,003,169,069
49542 :000,141,085,003,141,133,125
49548 :003,169,090,141,125,003,159
49554 :169,128,133,003,160,000,227
49560 :185,165,196,153,000,048,131
49566 :136,208,247,096,120,169,110
49572 :054,141,020,003,169,192,231
49578 :141,021,003,169,027,141,160
49584 :017,208,169,127,141,013,083
49590 :220,169,129,141,026,208,051
49596 :088,169,255,141,021,208,046
49602 :096,050,075,100,125,150,022
49608 :175,200,230,001,002,003,043
49614 :004,005,001,007,008,195,170
49620 :193,193,193,193,193,193,090
49626 :192,173,000,220,074,176,029
49632 :013,032,053,194,174,125,047
49638 :003,224,255,240,003,238,169
49644 :125,003,074,176,013,032,147
49650 :053,194,174,125,003,224,247
49656 :080,240,003,206,125,003,137
49662 :074,176,011,032,053,194,026
49668 :166,003,224,255,240,002,126
49674 :230,003,074,176,011,032,024
49680 :053,194,166,003,224,001,145
49686 :240,002,198,003,169,000,122
49692 :141,093,003,169,128,056,106
49698 :229,003,016,010,073,255,108
49704 :024,105,001,162,001,142,219
49710 :093,003,010,141,101,003,141
49716 :096,160,128,140,004,212,024
49722 :160,129,140,004,212,096,031
49728 :169,147,032,210,255,169,022
49734 :232,133,251,169,003,133,223
49740 :252,169,232,133,253,169,004
49746 :215,133,254,162,004,160,242
49752 :024,173,027,212,201,030,243
49758 :176,011,169,046,145,251,124
49764 :173,027,212,041,015,145,201
49770 :253,200,208,235,230,252,204
49776 :230,254,202,208,228,096,050
49782 :173,117,003,201,022,240,106
49788 :043,173,077,003,208,007,123
49794 :173,085,003,240,033,208,104
49800 :012,173,077,003,201,090,180
49806 :208,005,173,085,003,208,056
49812 :019,173,030,208,010,176,252
49818 :003,076,061,195,162,007,146
49824 :202,010,144,252,224,000,224
49830 :240,069,169,000,141,167,184
49836 :002,169,240,141,006,212,174
49842 :169,128,141,004,212,169,233
49848 :129,141,004,212,169,241,056
49854 :141,023,212,169,039,141,147
49860 :005,212,169,050,133,247,244
49866 :202,208,013,162,200,173,136
49872 :027,212,074,074,168,169,164
49878 :000,153,000,048,165,247,059
49884 :141,022,212,201,200,208,180
49890 :231,169,128,141,004,212,087
49896 :198,250,076,012,192,173,109
49902 :117,003,201,057,144,180,172
49908 :169,000,141,167,002,162,117
49914 :012,160,010,024,032,240,216
49920 :255,169,064,160,195,032,107
49926 :030,171,230,249,165,249,076
49932 :201,003,208,002,230,250,138
49938 :169,150,141,008,212,169,099
49944 :230,141,001,212,169,028,037
49950 :141,012,212,162,005,169,219
49956 :020,141,011,212,169,021,098
49962 :141,011,212,169,000,133,196
49968 :247,165,247,201,030,208,122
49974 :250,202,208,233,076,012,011
49980 :192,076,035,192,158,083,028
49986 :085,067,067,069,083,083,008
49992 :070,085,076,032,068,079,226
49998 :067,075,073,078,071,033,219
50004 :000,158,018,083,080,065,232
50010 :067,069,032,068,079,067,216
50016 :075,000,146,150,076,069,100
50022 :086,069,076,032,049,017,175
50028 :017,157,157,157,157,157,142
50034 :157,157,157,157,157,157,032
50040 :157,080,082,069,083,083,162
50046 :032,070,073,082,069,066,006
50052 :085,084,084,079,078,000,030
50058 :146,150,078,085,077,066,228
50064 :069,082,032,079,070,032,252
50070 :068,079,067,075,073,078,078
50076 :071,083,032,032,017,017,152
50082 :157,157,157,157,157,157,080
50088 :157,157,157,157,157,157,086
50094 :157,157,157,157,157,157,092
50100 :157,157,154,082,079,067,108
50106 :075,069,084,083,032,082,099
50112 :069,077,065,073,078,073,115
50118 :078,071,032,032,032,158,089
50124 :000,032,018,080,082,069,229
50130 :083,083,032,085,080,032,093
50136 :084,079,032,076,065,085,125
50142 :078,067,072,000,018,080,025
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50148 :082,069,083,083,032,085,150
50154 :080,032,070,079,082,032,097
50160 :078,069,087,032,071,065,130
50166 :077,069,000,169,000,141,190
50172 :033,208,169,147,032,210,027
50178 :255,162,008,160,015,024,114
50184 :032,240,255,169,085,160,181
50190 :195,032,030,171,162,011,103
50196 :160,017,024,032,240,255,236
50202 :169,098,160,195,032,030,198
50208 :171,162,180,160,000,136,073
50214 :208,253,202,208,250,173,052
50220 :000,220,074,176,010,174,186
50226 :207,005,224,049,240,003,010
50232 :206,207,005,074,176,010,222
50238 :174,207,005,224,051,240,195
50244 :003,238,207,005,074,074,157
50250 :074,176,212,169,053,056,046
50256 :237,207,005,141,061,003,222
50262 :141,060,003,096,169,147,190
50268 :032,210,255,162,010,160,153
50274 :010,024,032,240,255,169,060
50280 :138,160,195,032,030,171,062
50286 :165,249,141,173,005,165,240
50292 :250,141,253,005,162,018,177
50298 :160,010,024,032,240,255,075
50304 :165,250,201,048,208,017,249
50310 :104,104,169,226,160,195,068
50316 :032,030,171,169,192,072,038
50322 :169,000,072,240,007,169,035
50328 :205,160,195,032,030,171,177
50334 :173,000,220,074,176,250,027
50340 :096,000,060,000,000,126,190
50346 :000,000,126,000,000,189,229
50352 :000,000,189,000,000,189,042
50358 :000,000,255,000,000,255,180
50364 :000,000,255,000,000,255,186
50370 :000,067,255,194,223,255,164
50376 :251,255,255,255,255,255,190
50382 :255,223,255,251,067,231,208
50388 :194,000,066,000,000,000,216
50394 :000,000,000,000,000,000,218
50400 :000,000,000,000,146,000,114
50406 :000,000,000,000,000,007,237
50412 :128,000,006,000,000,006,120
50418 :000,000,007,000,000,007,000
50424 :000,000,247,128,000,079,190
50430 :255,240,000,000,024,007,012
50436 :255,252,079,255,254,247,066
50442 :128,000,007,000,000,007,152
50448 :000,000,006,000,000,006,028
50454 :000,000,007,128,000,000,157
50460 :000,000,000,000,000,000,028
50466 :000,000,255,000,000,000,033
50472 :000,000,000,000,001,224,009
50478 :000,000,096,000,000,096,238
50484 :000,000,224,000,000,224,244
50490 :000,001,239,015,255,242,042
50496 :024,000,000,063,255,224,118
50502 :127,255,242,000,001,239,166
50508 :000,000,224,000,000,224,012
50514 :000,000,096,000,000,096,018
50520 :000,001,224,000,000,000,057
50526 :000,000,000,000,000,000,094
50532 :255,251,099,063,251,094,089
50538 :223,123,110,222,123,118,001
50544 :030,059,122,220,028,198,001
50550 :216,015,255,224,007,255,066
50556 :224,001,255,128,000,000,220
50562 :000,000,000,000,000,000,130
50568 :000,000,000,000,000,000,136
50574 :000,000,000,000,000,000,142
50580 :000,000,000,000,000,000,148
50586 :000,000,000,000,000,000,154
50592 :000,000,000,000,080,013,253
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Crunch

(Article on page 56.)

BEFORE TYPING . . .

Before typing in programs, please refer to "How To Type In COMPUTE!'s GAZETTE Programs," which appears before the Program Listings.

Program 1: Crunch—64 Version

(See instructions in article before typing in.)

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49152 :160,002,185,124,000,153,112
49158 :052,003,136,016,247,169,117
49164 :201,133,124,169,058,133,062
49170 :125,169,176,133,126,169,148
49176 :001,141,032,208,141,033,068
49182 :208,169,169,160,197,032,197
49188 :235,196,032,228,255,240,198
49194 :251,201,133,208,004,169,240
49200 :255,208,014,201,134,208,044
49206 :004,169,080,208,006,201,210
49212 :135,208,231,169,000,133,168
49218 :250,169,055,160,198,032,162
49224 :235,196,169,000,133,163,200
49230 :133,169,032,160,192,165,161
49236 :163,240,043,165,043,133,103
49242 :095,165,044,133,096,162,017
49248 :000,032,063,193,160,001,033
49254 :177,095,170,200,177,095,248
49260 :133,096,134,095,136,177,111
49266 :095,208,234,169,070,160,026
49272 :198,032,235,196,032,002,047
49278 :197,108,002,160,165,045,035
49284 :133,180,165,046,133,181,202
49290 :032,077,193,165,250,133,220
49296 :169,032,160,192,032,077,038
49302 :193,032,113,195,032,002,205
49308 :197,108,002,160,032,221,108
49314 :196,032,238,195,032,238,069
49320 :195,160,000,177,122,208,006
49326 :001,096,032,238,195,177,145
49332 :122,133,251,032,238,195,127
49338 :177,122,133,252,032,115,249
49344 :000,201,000,240,222,201,032
49350 :002,240,218,201,034,208,077
49356 :015,032,115,000,201,000,055
49362 :240,207,201,002,240,203,023
49368 :201,034,208,241,201,137,214
49374 :240,016,201,141,240,012,048
49380 :201,138,240,008,201,155,147
49386 :240,004,201,167,208,206,236
49392 :032,115,000,144,006,032,057
49398 :000,196,076,190,192,032,164
49404 :035,196,165,020,164,021,085
49410 :133,253,132,254,032,174,212
49416 :196,144,014,162,002,032,046
49422 :063,193,032,121,000,201,112
49428 :044,240,217,208,220,230,155
49434 :163,169,013,032,210,255,100
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49440 :165,252,166,251,032,090,220
49446 :196,169,049,160,197,032,073
49452 :235,196,165,254,166,253,033
49458 :032,090,196,169,057,160,242
49464 :197,032,235,196,076,016,040
49470 :193,165,095,208,002,198,155
49476 :096,198,095,138,160,000,243
49482 :145,095,096,032,191,195,060
49488 :169,000,133,164,133,170,081
49494 :133,171,168,177,122,133,222
49500 :182,032,245,195,032,203,213
49506 :195,032,004,195,032,115,159
49512 :000,201,002,240,004,201,240
49518 :000,208,008,032,251,193,034
49524 :144,240,076,072,195,201,020
49530 :058,208,008,032,009,196,121
49536 :133,182,076,102,193,201,247
49542 :136,240,221,201,143,208,003
49548 :006,032,067,194,076,116,119
49554 :193,201,130,208,031,032,173
49560 :009,196,032,115,000,240,232
49566 :017,201,002,240,013,201,064
49572 :044,208,243,169,058,032,150
49578 :009,196,169,130,208,231,089
49584 :032,000,196,076,102,193,007
49590 :201,034,208,006,032,215,110
49596 :194,076,116,193,201,131,075
49602 :208,006,032,125,194,076,067
49608 :116,193,032,023,196,144,136
49614 :032,032,009,196,032,115,110
49620 :000,144,005,032,023,196,100
49626 :144,013,032,009,196,032,132
49632 :115,000,144,251,032,023,021
49638 :196,176,246,032,000,196,052
49644 :076,102,193,201,139,208,131
49650 :002,133,164,032,009,196,010
49656 :076,102,193,133,182,201,111
49662 :002,208,028,160,000,177,061
49668 :167,201,034,208,003,032,137
49674 :245,195,169,000,133,170,154
49680 :032,009,196,032,203,195,171
49686 :176,004,032,004,195,024,201
49692 :096,165,164,208,224,160,021
49698 :004,200,177,122,201,000,226
49704 :240,004,201,002,208,245,172
49710 :136,136,136,136,196,249,011
49716 :176,203,032,203,195,176,013
49722 :198,169,058,133,182,032,062
49728 :009,196,096,032,115,000,000
49734 :201,000,240,004,201,002,206
49740 :208,245,170,165,182,201,223
49746 :058,208,007,032,245,195,059
49752 :138,076,251,193,201,002,181
49758 :240,013,160,004,032,245,020
49764 :195,136,208,250,134,182,181
49770 :076,019,194,224,002,208,061
49776 :008,169,143,032,009,196,157
49782 :076,088,194,032,203,195,138
49788 :096,197,170,208,005,032,064
49794 :245,195,169,044,032,009,056
49800 :196,032,115,000,160,000,127
49806 :177,122,201,034,208,005,121
49812 :032,224,194,144,240,201,159
49818 :000,240,029,201,002,240,098
49824 :041,201,058,240,013,201,146
49830 :044,240,221,032,009,196,140
49836 :032,238,195,076,140,194,023
49842 :032,208,194,032,000,196,072
49848 :024,096,160,005,177,122,000
49854 :201,131,208,008,133,170,017
49860 :169,000,133,171,240,003,144
49866 :032,208,194,076,251,193,132
49872 :160,000,132,170,132,171,205
49878 :096,032,224,194,176,001,169
49884 :096,076,251,193,032,009,109
49890 :196,032,238,195,160,000,023
49896 :177,122,201,000,240,013,217
49902 :201,002,240,009,201,034,157
49908 :208,234,032,009,196,024,179
49914 :096,170,169,034,032,009,248
49920 :196,138,056,096,169,000,143
49926 :133,164,165,169,133,249,251
49932 :169,255,032,009,196,032,193
49938 :009,196,165,251,032,009,168
49944 :196,165,252,032,009,196,106
49950 :096,032,191,195,032,203,011
49956 :195,176,032,032,115,000,074
49962 :201,000,208,249,032,238,202
49968 :195,165,122,170,160,000,092
49974 :145,167,200,165,123,145,231
49980 :167,133,168,134,167,032,093
49986 :000,196,076,034,195,096,151
49992 :032,231,195,032,221,196,211
49998 :169,000,168,145,122,145,059
50004 :167,032,231,195,145,167,253
50010 :032,231,195,165,167,133,245
50016 :045,133,047,133,049,165,156
50022 :168,133,046,133,048,133,251
50028 :050,032,031,195,096,169,169
50034 :073,160,197,032,235,196,239
50040 :056,165,180,229,043,170,195
50046 :165,181,229,044,032,090,099
50052 :196,032,183,195,169,107,246
50058 :160,197,032,235,196,056,246
50064 :165,045,229,043,170,165,193
50070 :046,229,044,032,090,196,019
50076 :032,183,195,169,134,160,005
50082 :197,032,235,196,056,165,019
50088 :180,229,045,170,165,181,114
50094 :229,046,032,090,196,032,031
50100 :183,195,096,169,161,160,120
50106 :197,032,235,196,096,165,083
50112 :043,133,167,165,044,133,109
50118 :168,032,221,196,096,160,047
50124 :002,177,122,240,020,200,197
50130 :177,122,133,251,200,177,246
50136 :122,133,252,162,004,032,153
50142 :238,195,202,208,250,024,059
50148 :096,056,096,230,167,208,057
50154 :002,230,168,096,230,122,058
50160 :208,002,230,123,096,165,040
50166 :167,208,002,198,168,198,163
50172 :167,230,249,096,165,122,001
50178 :208,002,198,123,198,122,085
50184 :096,032,231,195,160,000,210
50190 :145,167,196,249,240,002,245
50196 :198,249,096,201,065,144,205
50202 :005,233,091,056,233,165,041
50208 :096,024,096,162,000,134,032
50214 :020,134,021,176,046,233,156
50220 :047,133,097,165,021,133,128
50226 :098,165,020,010,038,098,223
50232 :010,038,098,101,020,133,200
50238 :020,165,098,101,021,133,088
50244 :021,006,020,038,021,165,083
50250 :020,101,097,133,020,144,077
50256 :002,230,021,032,115,000,224
50262 :076,041,196,096,134,097,214
50268 :133,098,162,003,169,000,145
50274 :149,099,202,016,251,160,207
50280 :015,006,097,038,098,120,222
50286 :248,165,099,101,099,133,187
50292 :099,165,100,101,100,133,046
50298 :100,165,101,101,101,133,055
```

```
50304 :101,216,088,136,016,227,144
50310 :162,002,181,099,072,074,212
50316 :074,074,074,032,163,196,241
50322 :104,041,015,032,163,196,185
50328 :202,016,237,165,102,208,058
50334 :003,032,167,196,096,197,081
50340 :102,240,251,009,048,133,179
50346 :102,076,210,255,165,043,253
50352 :166,044,160,001,133,095,007
50358 :134,096,177,095,240,031,187
50364 :200,200,165,021,209,095,054
50370 :144,024,240,003,136,208,181
50376 :009,165,020,136,209,095,066
50382 :144,012,240,010,136,177,157
50388 :095,170,136,177,095,176,037
50394 :215,024,096,024,165,043,017
50400 :105,255,133,122,165,044,024
50406 :105,255,133,123,096,133,051
50412 :097,132,098,160,000,177,132
50418 :097,240,012,032,210,255,064
50424 :230,097,208,243,230,098,074
50430 :076,239,196,096,160,002,255
50436 :185,052,003,153,124,000,009
50442 :136,016,247,096,032,071,096
50448 :079,084,079,032,000,032,066
50454 :071,079,083,085,066,032,182
50460 :000,032,084,072,069,078,107
50466 :032,000,032,082,085,078,087
50472 :032,000,032,076,073,083,080
50478 :084,032,000,032,076,073,087
50484 :078,069,032,035,000,032,042
50490 :068,079,069,083,078,039,218
50496 :084,032,069,088,073,083,237
50502 :084,013,000,147,017,017,092
50508 :017,017,017,017,017,032,193
50514 :032,032,032,079,076,068,145
50520 :032,080,082,079,071,082,002
50526 :065,077,032,076,069,078,235
50532 :071,084,072,058,032,032,193
50538 :000,013,032,032,032,032,247
50544 :078,069,087,032,080,082,028
50550 :079,071,082,065,077,032,012
50556 :076,069,078,071,084,072,062
50562 :058,032,032,000,013,032,041
50568 :032,032,032,080,082,079,217
50574 :071,082,065,077,032,082,039
50580 :069,068,085,067,069,068,062
50586 :032,066,089,058,032,032,207
50592 :000,032,066,089,084,069,244
50598 :083,013,000,147,152,017,066
50604 :017,017,017,032,032,032,063
50610 :032,083,069,076,069,067,062
50616 :084,032,068,069,083,073,081
50622 :082,069,068,032,077,065,071
50628 :088,073,077,085,077,032,116
50634 :078,085,077,066,069,082,147
50640 :032,079,070,013,032,032,210
50646 :032,032,066,089,084,069,074
50652 :083,032,080,069,082,032,086
50658 :076,073,078,069,058,013,081
50664 :017,017,017,032,032,032,123
50670 :032,032,032,032,032,018,160
50676 :070,049,146,032,061,032,122
50682 :050,053,053,013,017,032,212
50688 :032,032,032,032,032,032,192
50694 :032,018,070,051,146,032,099
50700 :061,032,056,048,013,017,239
50706 :032,032,032,032,032,032,210
50712 :032,032,018,070,053,146,119
50718 :032,061,032,079,082,073,133
50724 :071,073,078,065,076,032,175
50730 :076,073,078,069,032,076,190
50736 :069,078,071,084,072,013,179
50742 :000,013,017,067,082,085,062
50748 :078,067,072,073,078,071,243
50754 :046,046,046,000,013,017,234
50760 :032,032,032,032,032,032,008
50766 :045,045,045,032,080,082,151
50772 :079,071,082,065,077,032,234
50778 :078,079,084,032,067,082,000
50784 :085,078,067,072,069,068,023
50790 :032,045,045,045,000,013,026
```

Program 2: Crunch—VIC Version

(See instructions in article before typing in.)

```
10 L=PEEK(644)*256+PEEK(643)-880:POKE644,
   INT(L/256):POKE643,L-PEEK(644)*256
                                  :rem 221
11 FORI=56TO52STEP-2:POKEI,PEEK(644):POKE
   I-1,PEEK(643):NEXT             :rem 153
12 PRINT"{CLR}{6 DOWN} LOADING MACHINE LA
   NG.":PRINT"{DOWN}{2 SPACES}(ABOUT 1 1/
   2 MIN.)"                        :rem 45
13 P=L:FORI=1TO26:READS$:X=LEN(S$):FORJ=0
   TOX-2STEP2:C$=LEFT$(RIGHT$(S$,X-J),2)
                                   :rem 68
14 E=ASC(LEFT$(C$,1)):F=ASC(RIGHT$(C$,1))
                                   :rem 15
15 V=-(E>64)*(E-55)*16-(E<65)*(E-48)*16-(
   F>64)*(F-55)-(F<65)*(F-48)      :rem 41
16 POKEP,V:P=P+1:NEXT:NEXT        :rem 205
17 P=P-1:IFP<LTHEN22              :rem 215
18 IFPEEK(P)<124ORPEEK(P)>127THEN17
                                  :rem 103
19 IFP=L+3502THEN17                :rem 94
20 V=PEEK(P)*256+PEEK(P-1)+L-31888:POKEP,
   INT(V/256)                     :rem 196
21 POKEP-1,V-PEEK(P)*256:P=P-1:GOTO17
                                  :rem 204
22 POKE250,255                    :rem 242
23 PRINT"{CLR}{7 DOWN} TYPE {RVS}SYS";L;"
   {OFF}TO USE":NEW               :rem 223
24 DATA20A4E3A90085A385A920D17CA5A3F021A5
   2B855FA52C8560A20020767DA001B15FAAC8
                                  :rem 239
25 DATAB15F8560865F88B15FD0EA6C02C020847D
   A5FA85A920D17C20847D6C02C0208EC620D7
                                   :rem 27
26 DATA7F20D77FA000B17AD0016020D77FB17A85
   FB20D77FB17A85FC207300C900F0DEC902F0
                                   :rem 32
27 DATADAC922D00F207300C900F0CFC902F0CBC9
   22D0F1C989F010C98DF00CC98AF008C99BF0
                                   :rem 98
28 DATA04C9A7D0CE207300900620E97F4CEF7C20
   6BC9A514A41585FD84FE2013C6900EA20220
                                  :rem 250
29 DATA767D207900C92CF0D9D0DCE6A3A90D20D2
   FFA5FCA6FB20CDDDA92020D2FFA93C20D2FF
                                  :rem 194
30 DATAA5FEA6FD20CDDDA93E20D2FFA90D20D2FF
   4C417DA55FD002C660C65F8AA000915F6020
                                  :rem 128
31 DATAA87FA90085A485AA85ABA8B17A85B620DE
   7F20B47F203B7F207300C902F004C900D008
                                    :rem 5
32 DATA20327E90F04C7F7FC93AD00820F27F85B6
   4C9D7DC988F0DDC98FD006207A7E4CAB7DC9
                                  :rem 142
33 DATA82D01F20F27F207300F011C902F00DC92C
   D0F3A93A20F27FA982D0E720E97F4C9D7DC9
                                   :rem 55
34 DATA22D006200F7F4CAB7DC983D00620B41E4C
```

```
   AB7D2013D1902020F27F2073009005 2013D1
                                :rem 164
35 DATA900D20F27F2073009 0FB2013D1B0F620E9
   7F4C9D7DC98BD00285A420F27F4C9D7D85B6
                                 :rem 33
36 DATAC902D01CA000B1A7C922D00320DE7FA900
   85AA20F27F20B47FB004203B7F1860A5A4D0
                                :rem 241
37 DATAE0A004C8B17AC900F004C902D0F5888888
   88C4F9B0CB20B47FB0C6A93A85B620F27F60
                                 :rem 52
38 DATA207300C900F004C902D0F5AAA5B6C93AD0
   0720DE7F8A4C327EC902F00DA00420DE7F88
                                 :rem 29
39 DATAD0FA86B64C4A7EE002D008A98F20F27F4C
   8F7E20B47F60C5AAD00520DE7FA92C20F27F
                                :rem 126
40 DATA207300A000B17AC922D00520177F90F0C9
   00F01DC902F029C93AF00DC92CF0DD20F27F
                                :rem 235
41 DATA20D77F4CC37E20077F20E97F1860A005B1
   7AC983D00885AAA90085ABF00320077F4C32
                                :rem 236
42 DATA7EA00084AA84AB6020177FB001604C327E
   20F27F20D77FA000B17AC900F00DC902F009
                                :rem 216
43 DATAC922D0EA20F27F1860AAA92220F27F8A38
   60A90085A4A5A985F9A9FF20F27F20F27FA5
                                 :rem 68
44 DATAFB20F27FA5FC20F27F6020A87F20B47FB0
   20207300C900D0F920D77FA57AAAA00091A7
                                 :rem 22
45 DATAC8A57B91A785A886A720E97F4C597F6020
   D07F208EC6A900A8917A91A720D07F91A720
                                 :rem 25
46 DATAD07FA5A7852D852F8531A5A8852E853085
   3220567F60A52B85A7A52C85A8208EC660A0
                                :rem 240
47 DATA02B17AF014C8B17A85FBC8B17A85FCA204
   20D77FCAD0FA1860386 0E6A7D002E6A860E6
                                 :rem 82
48 DATA7AD002E67B60A5A7D002C6A8C6A7E6F960
   A57AD002C67BC67A6020D07FA00091A7C4F9
                                 :rem 62
49 DATAF002C6F960                :rem 189
```

Mixing Text And Hi-Res Graphics

(Article on page 52.)

Text Print

```
2500 GOSUB2680                        :rem 23
2510 FORI=869TO922:READD:POKEI,D:NEXT:REM
      DATA FOR ML BIT MAP CLEAR     :rem 45
2520 FORI=923TO956:READD:POKEI,D:NEXT:REM
      DATA FOR ML COLOR FILL       :rem 174
2530 BM=8192:POKE53272,PEEK(53272)OR8:REM
      PUT BIT MAP AT 8192          :rem 145
2540 SYS869:REM CLEAR BIT MAP       :rem 179
2550 PIXCOL=2:SCRCOL=1:POKE251,PIXCOL*16+
     SCRCOL                         :rem 246
2560 SYS923:REM SET COLOR MATRIX :rem 200
2570 POKE53265,PEEK(53265)OR32:REM ENTER
     {SPACE}BIT MAP MODE             :rem 45
2580 REM HI-RES PLOT                :rem 154
2590 FORY=60TO132:X=40               :rem 31
2600 GOSUB2920                       :rem 21
2610 NEXTY                           :rem 97
2620 FORX=110TO210:Y=28              :rem 72
2630 GOSUB2920                       :rem 24
2640 NEXTX                           :rem 99
2650 FORX=96TO182:Y=X                :rem 30
2660 GOSUB2920                       :rem 27
2670 NEXTX:GOTO2740                 :rem 166
2680 FORI=828TO868:READD:POKEI,D:NEXT:REM
      DATA FOR ML CHARACTER ROM COPY
                                    :rem 203
2690 POKE56334,PEEK(56334)AND254:REM TURN
      OFF INTERRUPTS               :rem 124
2700 POKE1,PEEK(1)AND251:REM SWITCH IN CH
     ARACTER ROM                    :rem 105
2710 SYS828:REM COPY 128 CHARACTERS TO RA
     M STARTING AT 50176            :rem 198
2720 POKE1,PEEK(1)OR4:REM SWITCH OUT CHAR
     ACTER ROM                       :rem 54
2730 POKE56334,PEEK(56334)OR1:RETURN:REM
     {SPACE}ENABLE INTERRUPTS       :rem 120
2740 REM PRINT TEXT                 :rem 131
2750 TX=24:TY=68:TCOL=5:D=320:TEXT$="VERT
     ICAL"                           :rem 91
2760 GOSUB2960                       :rem 32
2770 TX=120:TY=16:TCOL=0:D=8:TEXT$="HORIZ
     ONTAL"                         :rem 209
2780 GOSUB2960                       :rem 34
2790 TX=120:TY=104:TCOL=4:D=328:TEXT$="DI
     AGONAL"                        :rem 159
2800 GOSUB2960                       :rem 27
2810 TX=160:TY=64:TCOL=2:D=8:TEXT$="CHARA
     CTERS, TOO:"                     :rem 3
2820 GOSUB2960                       :rem 29
2830 TX=160:TY=80:TCOL=6:D=8:TEXT$="{*}
     {L} {U} {Y} {D} {A} {Q} {E}":rem 139
2840 GOSUB2960                       :rem 31
2850 TY=104:TCOL=2:TEXT$="Q Z X A S V U W
     "                              :rem 230
2860 GOSUB2960                       :rem 33
2870 GETA$:IFA$=""THEN2870:REM PRESS ANY
     {SPACE}KEY TO RETURN TO BASIC
                                    :rem 201
2880 POKE53265,PEEK(53265)AND223:REM EXIT
      FROM BIT MAP MODE            :rem 133
2890 POKE53272,21:REM RESTORE NORMAL VIDE
     O                               :rem 22
2900 PRINTCHR$(147)                  :rem 70
2910 END                            :rem 163
2920 REM HI-RES PLOT SUBROUTINE     :rem 168
2930 ROW=INT(Y/8):CHAR=INT(X/8):LINE=YAND
     7:BIT=7-(XAND7)                :rem 254
2940 BYTE=BM+ROW*320+CHAR*8+LINE:POKEBYTE
     ,PEEK(BYTE)OR2↑BIT              :rem 50
2950 RETURN                         :rem 176
2960 REM TEXT PRINT SUBROUTINE      :rem 151
2970 BM=8192:SCRCOL = 1             :rem 224
2980 ROW=INT(TY/8):CHAR=INT(TX/8)  :rem 60
2990 BYTE=BM+ROW*320+CHAR*8          :rem 97
3000 FORI=1TOLEN(TEXT$)             :rem 157
3010 POKE1024+(BYTE-BM)/8,TCOL*16+SCRCOL
                                    :rem 109
3020 SV=ASC(MID$(TEXT$,I,1)):REM GET ASCI
     I                              :rem 196
3030 IFSV<64THEN3060                :rem 156
3040 IFSV<192THENSV=SV-64:GOTO3060
                                    :rem 104
3050 SV=SV-128                       :rem 31
3060 CA=50176+SV*8                  :rem 195
3070 FORJ=0TO7                       :rem 66
3080 POKEBYTE+J,PEEK(CA+J)           :rem 62
```

```
3090 NEXTJ                                    :rem 85
3100 BYTE=BYTE+D                              :rem 216
3110 NEXTI                                    :rem 77
3120 RETURN                                   :rem 166
3130 DATA234,72,138,72,152,72,160,0,185,0
     ,208,153,0,196,185,0,209,153,0,197,1
     85                                       :rem 98
3140 DATA0,210,153,0,198,185,0,211,153,0,
     199,200,208,229,104,168,104,170,104,
     96                                       :rem 80
3150 DATA234,72,138,72,152,72,162,32,169,
     0,133,251,138,133,252,160,0,169,0
                                              :rem 99
3160 DATA145,251,200,208,251,232,224,63,2
     08,239,169,0,133,251,169,63,133,252
                                              :rem 206
3170 DATA160,0,169,0,145,251,200,192,64,2
     08,249,104,168,104,170,104,96
                                              :rem 164
3180 DATA234,72,138,72,152,72,160,0,173,2
     51,0,153,0,4,153,250,4,153,244,5,153
                                              :rem 234
3190 DATA238,6,200,192,250,208,239,104,16
     8,104,170,104,96                         :rem 44
```

Hi-Res Toolbox

(Article on page 64.)

```
10 GOSUB 600                                  :rem 119
20 PRINT"{CLR}{DOWN}RUN 100 FOR SINE CURV
   E"                                         :rem 248
30 PRINT "{DOWN}RUN 200 FOR JOYSTICK PLOT
   TING"                                      :rem 148
40 END                                        :rem 59
100 GOSUB 1000:POKE FLAG,0                    :rem 177
110 SYS CLEAR:SYS COLR,1                      :rem 190
120 FOR X=0 TO 319 STEP.5                     :rem 30
130 Y= INT(100+60*SIN(X/10))                  :rem 213
140 SYS PLOT,X,Y                              :rem 220
150 NEXT                                      :rem 213
160 POKE 198,0:WAIT 198,15:GOSUB 2000:END
                                              :rem 244
200 GOSUB 1000                                :rem 211
205 SYS CLEAR:SYS COLR,1                      :rem 195
210 YJ(1)=-1:YJ(2)=1:XJ(4)=-1:XJ(5)=-1:YJ
    (5)=-1:XJ(6)=-1:YJ(6)=1:XJ(8)=1
                                              :rem 187
215 XJ(9)=1:YJ(9)=-1:XJ(10)=1:YJ(10)=1
                                              :rem 45
220 JV=15-(PEEK(56320)AND15)                  :rem 4
230 X=X+XJ(JV)                                :rem 64
240 Y=Y+YJ(JV):POKE FLAG,0                    :rem 35
245 IF(PEEK(56320)AND16)=0THEN POKE FLAG,
    1                                         :rem 109
250 SYS PLOT,X,Y:GOTO 220                     :rem 229
600 SA=49152:FOR A=SA TO SA+186:READ B:CK
    =CK+B:POKE A,B:NEXT                       :rem 201
605 IF CK=19865 THEN RETURN                   :rem 17
610 PRINT "{CLR}{DOWN} ERROR IN DATA ":EN
    D                                         :rem 88
620 DATA 169,0,133,2,169,32                   :rem 44
630 DATA 133,3,162,32,160,0                   :rem 30
640 DATA 152,145,2,136,208,251                :rem 192
650 DATA 230,3,202,208,246,96                 :rem 146
660 DATA 169,0,133,2,169,4                    :rem 255
670 DATA 133,3,32,177,192,152                 :rem 149
680 DATA 162,4,160,0,145,2                    :rem 244
690 DATA 136,208,251,230,3,202                :rem 189
700 DATA 208,246,96,32,177,192                :rem 210
710 DATA 133,5,152,41,248,133                 :rem 140
720 DATA 4,152,41,7,133,6                     :rem 196
730 DATA 32,177,192,152,74,74                 :rem 158
740 DATA 74,133,3,152,41,248                  :rem 97
750 DATA 133,2,169,0,133,251                  :rem 90
760 DATA 162,3,6,2,38,251                     :rem 202
770 DATA 202,208,249,165,3,24                 :rem 150
780 DATA 101,251,133,3,152,41                 :rem 134
790 DATA 7,24,101,2,133,2                     :rem 192
800 DATA 144,2,230,3,24,101                   :rem 25
810 DATA 4,133,2,165,3,105                    :rem 241
820 DATA 32,133,3,165,3,101                   :rem 32
830 DATA 5,133,3,166,6,232                    :rem 250
840 DATA 169,0,56,106,202,208                 :rem 146
850 DATA 252,166,252,240,27,160               :rem 248
860 DATA 0,72,81,2,145,2                      :rem 148
870 DATA 169,0,133,162,165,162                :rem 202
880 DATA 201,2,208,250,104,73                 :rem 139
890 DATA 255,49,2,145,2,24                    :rem 4
900 DATA 144,6,160,0,17,2                     :rem 191
910 DATA 145,2,96,32,253,174                  :rem 102
920 DATA 32,158,173,32,170,177                :rem 203
930 DATA 96                                   :rem 37
1000 REM TURN ON HIRES GRAPHICS               :rem 87
1010 SA = 49152:POKE53272,PEEK(53272)OR8:
     REM PUT BIT MAP AT 8192                  :rem 191
1020 POKE 53265,PEEK(53265)OR32:REM TURN
     {SPACE}BIT MAP ON                        :rem 101
1025 CLEAR = SA:COLR = SA+24:PLOT = SA+51
     :FLAG = 252                              :rem 209
1030 RETURN                                   :rem 164
2000 REM TURN OFF HIRES GRAPHICS              :rem 150
2010 POKE 53272,21:POKE 53265,27:REM REST
     ORE DEFAULT VALUES                       :rem 158
2020 PRINT "{CLR}":RETURN                     :rem 66
```

Zounds!

(Article on page 59.)

Program 1: The Last Xither

```
10 FORL=54272TO54295:POKEL,0:NEXT:POKE542
   96,15                                      :rem 16
20 POKE54277,8:POKE54278,255:POKE54276,23
   :F1=10                                     :rem 138
30 FORZ=1TO24:F2=30:REM F2 = PITCH, Z = N
   O. OF CYCLES                               :rem 158
40 POKE54273,F1                               :rem 59
50 FORY=1TO10:POKE54287,F2:REM Y CONTROLS
    SPEED                                     :rem 138
60 F2=F2*1.01:NEXTY:REM CONTROLS HARMONIC
    CONTENT                                   :rem 77
70 F1=F1+8:NEXTZ:REM CONTROLS HARMONIC CO
   NTENT                                      :rem 198
80 POKE54278,15:REM CHANGE SUSTAIN-RELEAS
   E TO STOP SOUND                            :rem 190
```

Program 2: Starwalker

```
10 FORL=54272TO54295:POKEL,0:NEXT:POKE542
   96,15                                      :rem 16
20 POKE54277,8:POKE54278,255:POKE54276,23
                                              :rem 59
30 FORZ=1TO2:REM NO. OF CYCLES                :rem 40
35 F1=10:FORY=1TO6:REM Y CONTROLS LENGTH
   {SPACE}OF FIRST PART OF SOUND              :rem 93
40 F2=10:POKE54273,F1                         :rem 139
50 FORX=1TO4:POKE54287,F2                     :rem 0
60 F2=F2*1.02:NEXTX:F1=F1*1.2:NEXTY:REM E
   ND OF FIRST PART OF SOUND                  :rem 168
```

```
70 FORW=1TO8:REM CONTROLS LENGTH OF SECON
   D PART                            :rem 202
80 F2=20:POKE54273,F1                :rem 144
90 FORV=1TO3:REM V CONTROLS PITCH RANGE O
   F SECOND PART. TRY DIFFERENT V'S!
                                     :rem 244
100 POKE54287,F2:F2=F2*1.2:NEXTV:F1=F1/1.
    2:NEXTW:NEXTZ                    :rem 39
110 REM F1, F2, AND ALL MULTIPLIERS CHANG
    E HARMONIC CONTENT OF BOTH SOUND PART
    S                                :rem 170
120 POKE54278,15:REM THIS SHUTS IT UP
                                     :rem 141
```

Program 3: Not A Bell

```
10 FORL=54272TO54295:POKEL,0:NEXT:POKE542
   96,15                             :rem 16
20 POKE54277,8:POKE54278,255:POKE54276,21
                                     :rem 57
30 FORZ=1TO4:REM NO. OF CYCLES       :rem 42
40 F1=10:FORY=1TO5:REM Y IS NO. OF INCREM
   ENTS                              :rem 164
50 F2=40:POKE54273,F1                :rem 143
60 FORX=1TO5:POKE54287,F2:REM X CONTROLS
   {SPACE}SPEED                      :rem 93
70 F2=F2*1.01                        :rem 126
80 NEXTX:F1=F1*1.5:NEXTY:NEXTZ       :rem 199
90 REM F1, F2 AND MULTIPLIERS GREATLY AFF
   ECT HARMONIC CONTENT OF FINAL SOUNDS
                                     :rem 157
100 POKE54278,15                     :rem 92
```

Program 4: Hyperwarp

```
10 FORL=54272TO54295:POKEL,0:NEXT:POKE542
   96,15:POKE54277,8:POKE54278,255:rem 33
20 POKE54276,21:F1=2:FORZ=1TO24:F2=80:POK
   E54273,F1:FORY=1TO5:POKE54287,F2
                                     :rem 121
30 F2=F2/1.1:NEXTY:F1=F1+9:NEXTZ:POKE5427
   8,15:REM SUPER CRUNCHED SOUND   :rem 68
```

Program 5: Decelerator

```
10 FORL=54272TO54295:POKEL,0:NEXT:POKE542
   96,15:POKE54277,8:POKE54278,255:rem 33
20 POKE54276,85:REM SQUARE + TRIANGLE + R
   ING MOD                           :rem 221
25 F1=100:F2=230:REM FREQUENCIES TO BE PO
   KED INTO VOICES 1 AND 3           :rem 95
30 FORZ=1TO77:POKE54272,F1:REM THIS IS ON
   LY SOUND TO USE 54272 INSTEAD OF 54273
                                     :rem 38
40 POKE54287,F2:REM VOICE 3          :rem 8
50 F2=F2-2:F1=F1*.99:NEXT            :rem 153
60 POKE54278,15                      :rem 49
```

Program 6: Three Reasons To Own A Computer

```
10 FORL=54272TO54295:POKEL,0:NEXT:POKE542
   96,15                             :rem 16
20 POKE54277,8:POKE54278,255:POKE54276,23
   :REM ENVELOPE AND WAVEFORM VOICE 1
                                     :rem 152
30 F2=4:REM F2 CONTROLS LOWER PITCH LIMIT
                                     :rem 214
40 FORZ=1TO3:POKE54287,F2:REM Z = NO. OF
   {SPACE}CYCLES                     :rem 216
50 FORF1=1TO200:REM F1 IS UPPER PITCH LIM
   IT                                :rem 26
60 POKE54273,F1:F2=F2+.01:NEXTF1:NEXTZ:PO
   KE54278,15                        :rem 38
```

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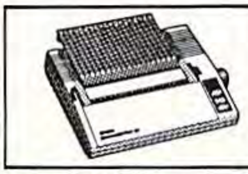

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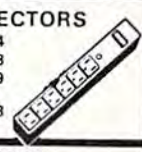

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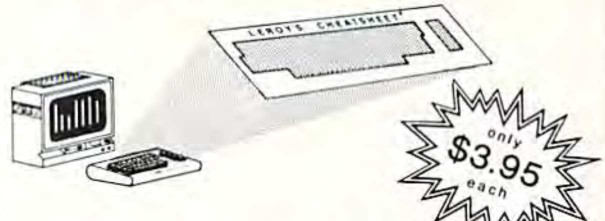

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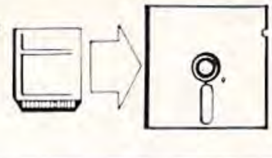

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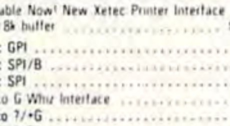

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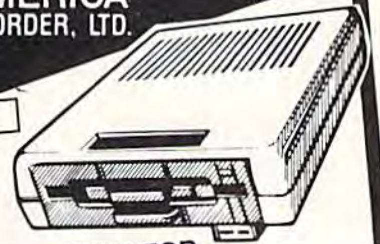

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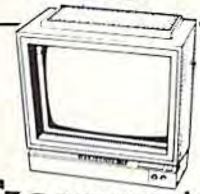

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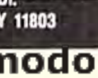

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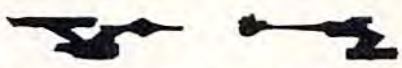

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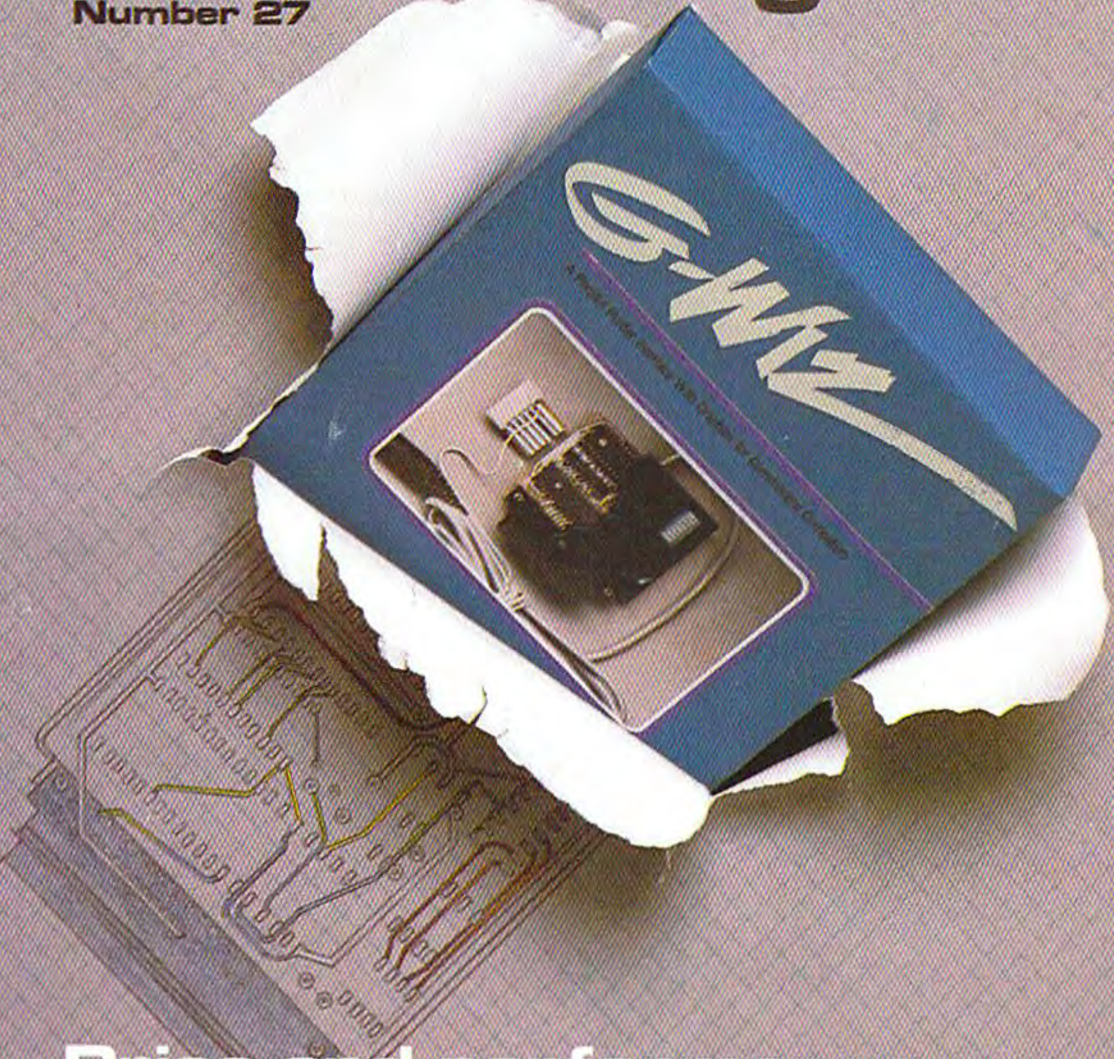

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