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COMPUTE!

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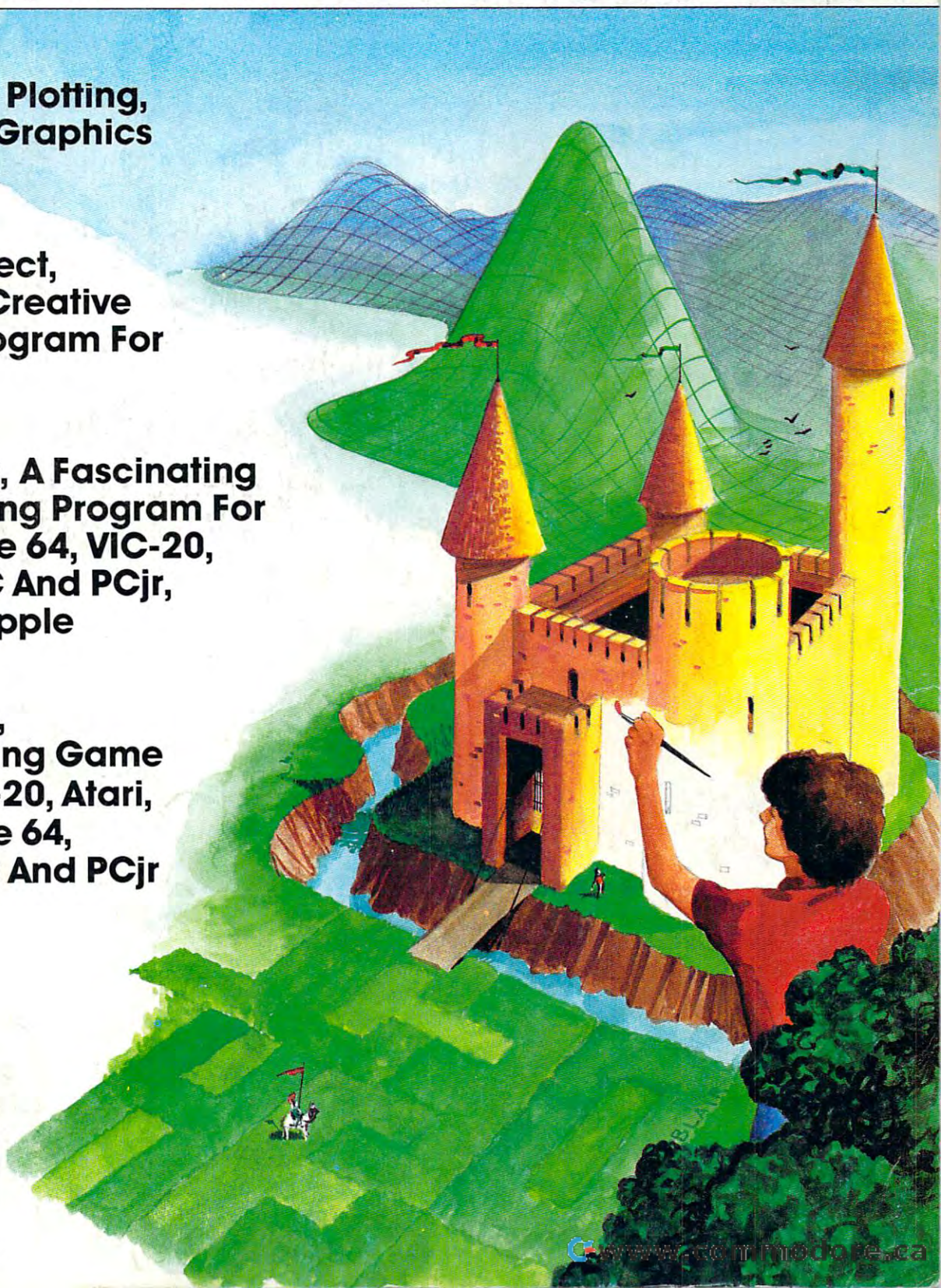

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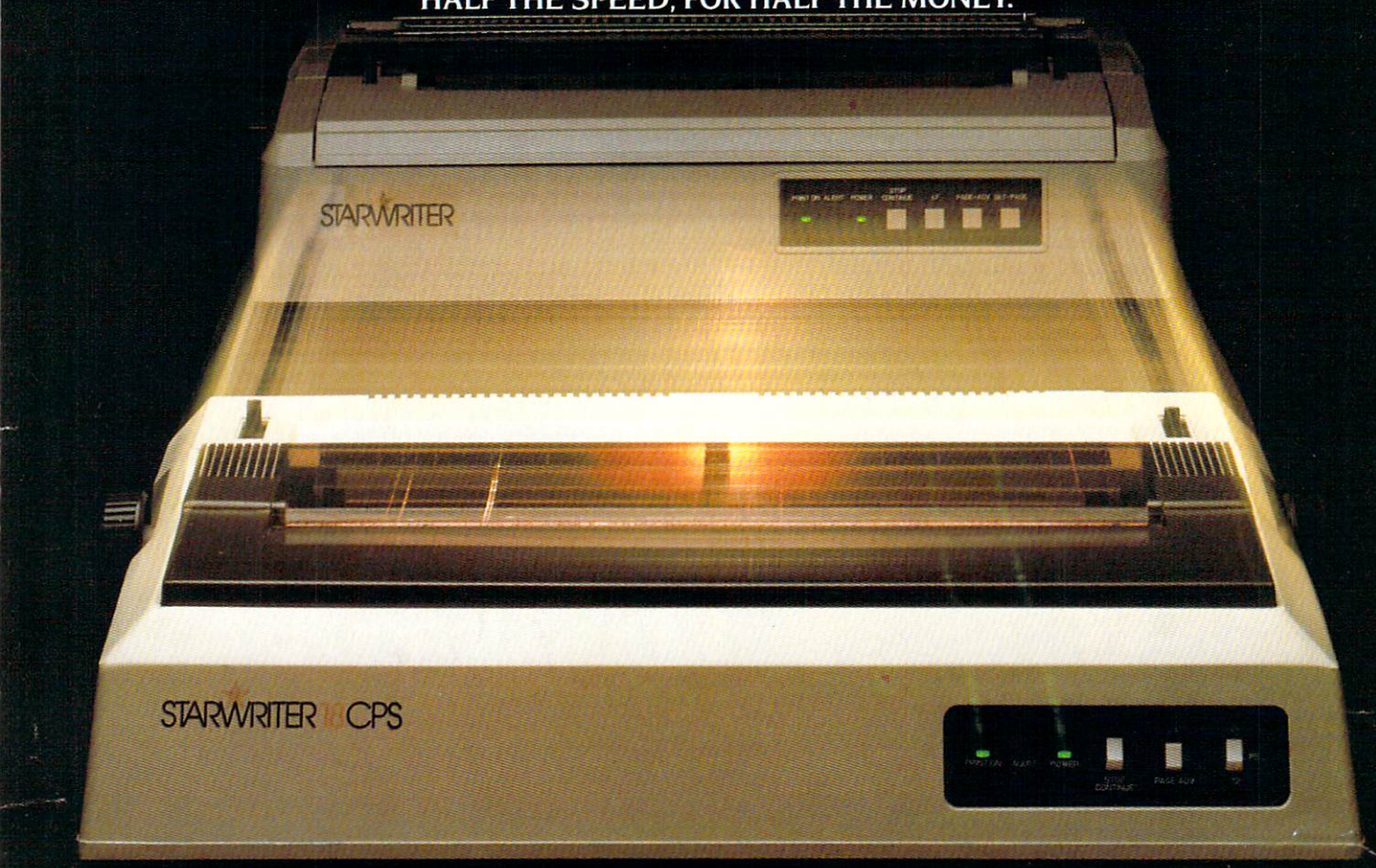

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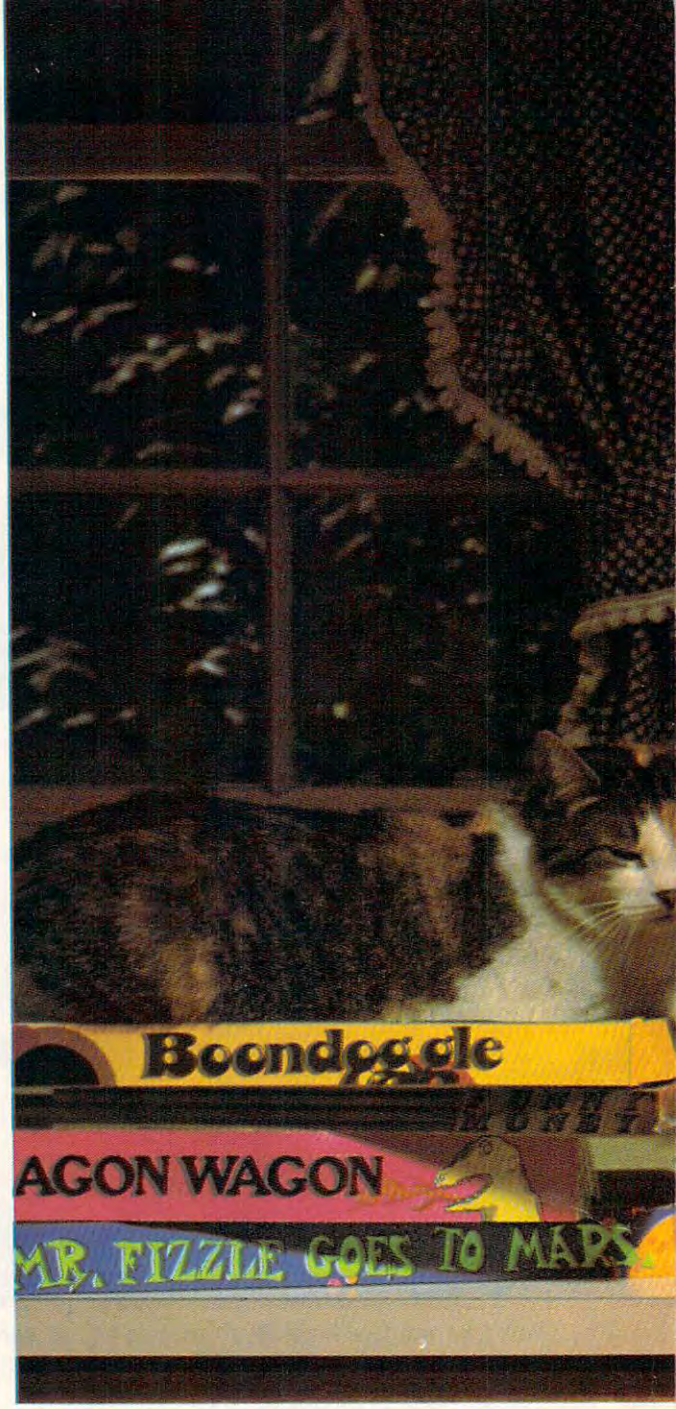

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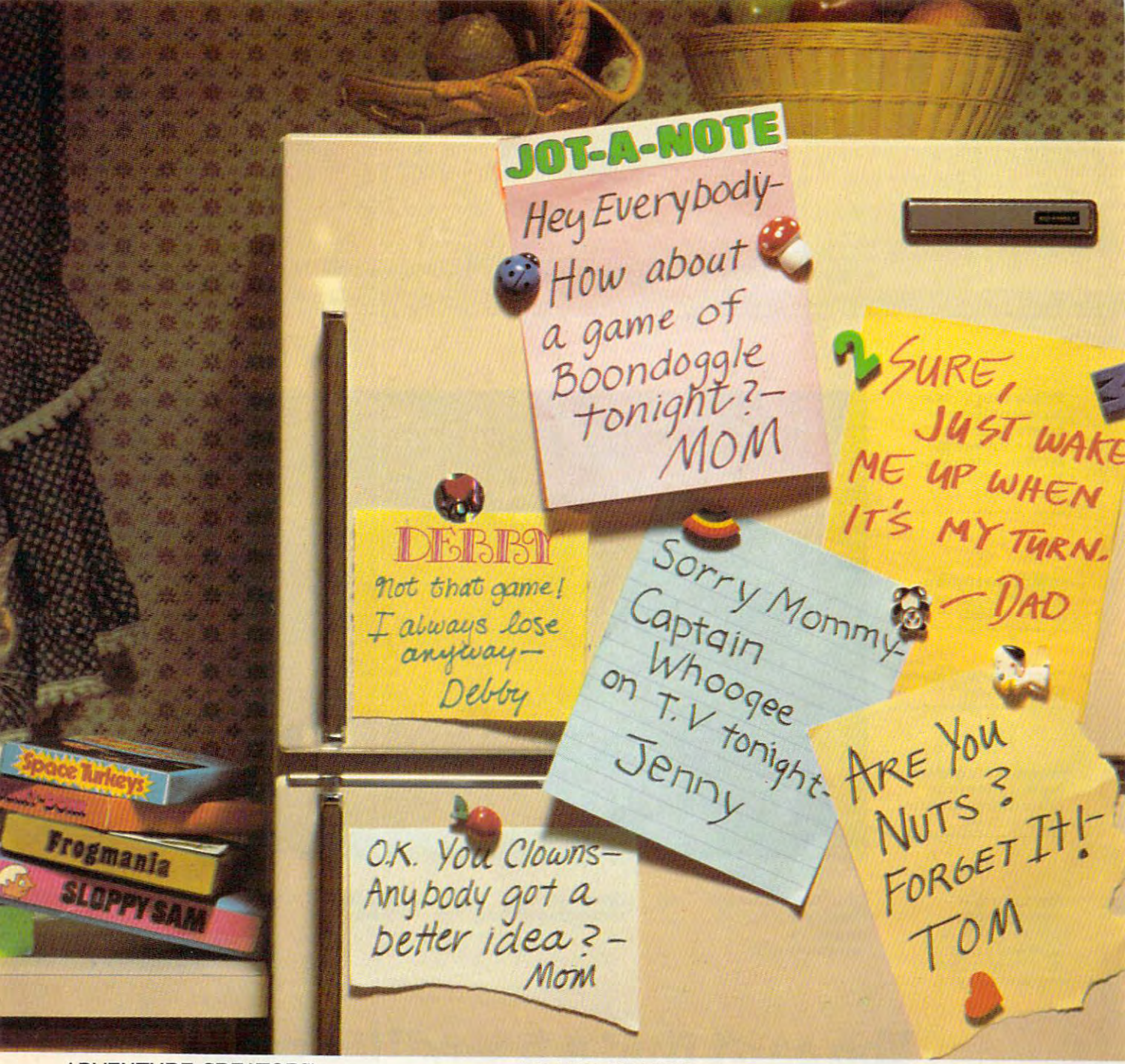

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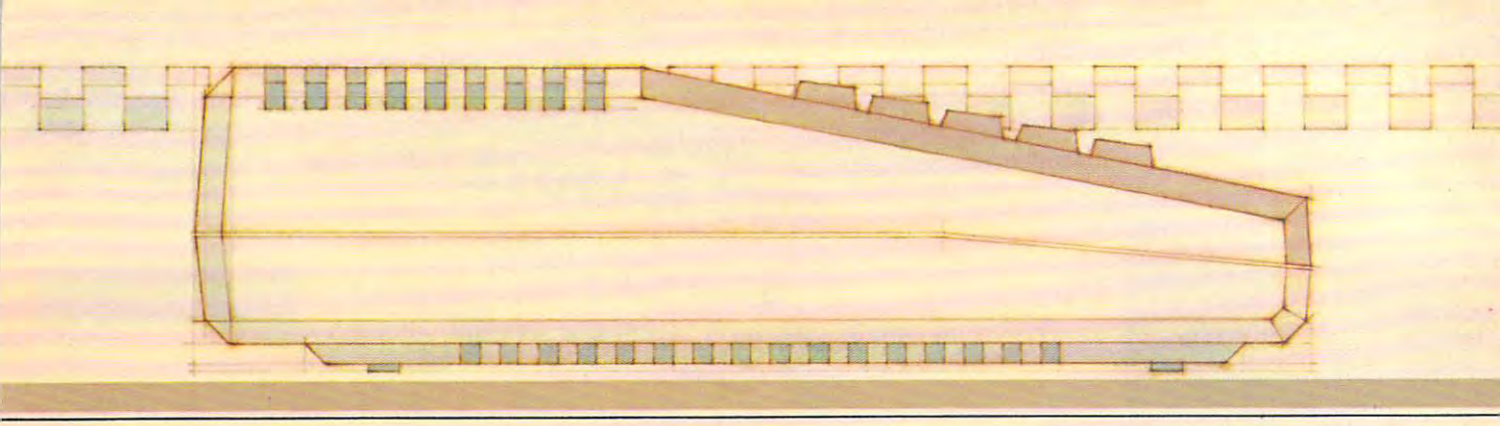

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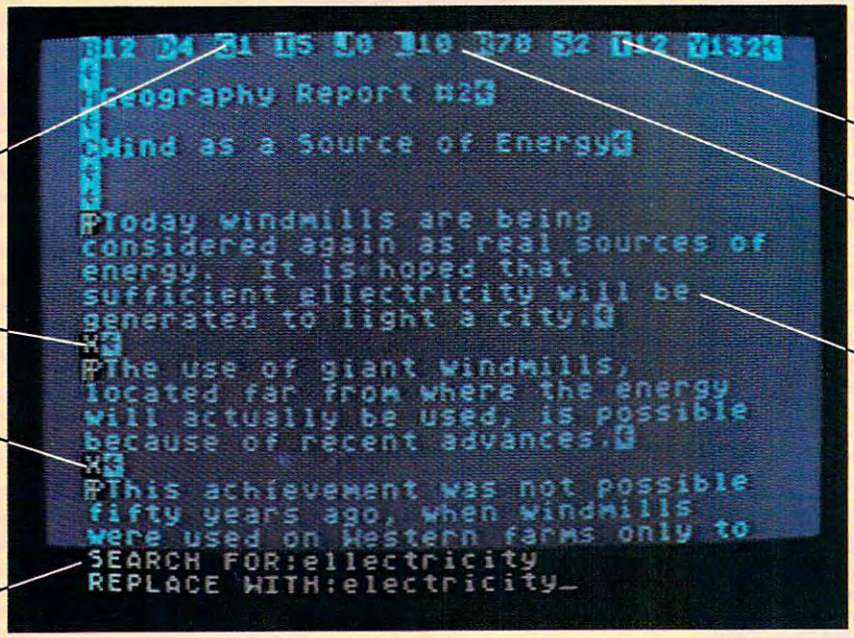

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EDITOR'S NOTES

This month, Richard Mansfield, senior editor of COMPUTE!, *expresses some concerns in this guest editorial about the way programming is taught in schools.*

Robert Lock
Editor In Chief

Which computer language is best? Ask that question at a computer club and you're sure to start a debate. But computer users rarely have much choice in the matter. If you buy a personal computer, you'll get BASIC. It's usually built into the computer. If you learn programming at school, you'll get Pascal. It's built into the curriculum.

Of course, other languages can be purchased for personal computers and are sometimes taught in schools, but BASIC and Pascal are by far the most common ways that most people are learning to communicate with computers.

Why is it that Pascal isn't built into consumer computers and BASIC is frowned upon by academics? What's the difference between these languages? Is Pascal the easier language to learn? Or is it just the easier language to *teach*.

The goal of a teacher is to pass knowledge, even wisdom sometimes, to the student. Good teaching accomplishes this transfer with a minimum of damage to the student's creativity and freedom of thought. But like all human activities, teaching can go awry.

On the first day of driver education, the teacher told me and the two young women in my group that we couldn't get into the car until we'd promised to follow the Three Rules of Good Driving. Evidently there had been some hair-raising moments in the past and these rules were for everyone's safety. 1. Keep your eyes on the road at all times. 2. Keep both hands on the wheel at all times. 3. Always use the turn signal, but also roll down the window and signal with your hand too. This last rule struck us as perhaps excessive. For one thing, we'd never seen anyone driving like that. And doesn't rule 3 violate rule 2?

Never mind, that's the way to drive. As the weeks progressed, other strange rules were added: Don't adjust the mirrors or the seatbelt while in motion, never converse with other passengers, and so on. We followed the rules, but of course discovered later that these were not realistic guidelines. Some of what we had been taught were the Rules of Good Driver Education, as distinct from rules of good driving.

I suggest that Pascal is not easier to learn than BASIC. Nor is Pascal more flexible or faster to program in than BASIC. In fact, Pascal has no significant advantage over BASIC save one—it is easier to grade.

That's because Pascal and languages like it stress *structured programming*. Pascal has more rules than BASIC. For example, in BASIC you can create variables anytime you want to. Just say INCOME = 15000 and that's that. In Pascal, you must define your variables at the start of the program. You must declare whether they're integer, string, floating point, etc.

Another rule associated with Pascal is program formatting: Loops should be indented, each programming event should be on its own line, and subroutines should be set off by additional spacing.

A third rule is possibly the most confining: You are not allowed to GOTO. In BASIC, this command allows you to branch to any other instruction in the program. And you can keep on branching at will. Pascal permits branching, but you must always return to the place from which you branched.

Forbidding GOTO branches is the keystone of structured programming, and it has an important effect on the way a student approaches programming. Before actual programming can begin, the programmer must plan the structure of the program. This is analogous to the requirement imposed by some English teachers that no one should begin writing an essay until they've first constructed a detailed outline. In Pascal classes, flowcharts abound.

Pascal, of course, is not a terrible way to program computers. And BASIC isn't perfect. They differ mainly in the psychological effects they have on programmers. But if the primary virtue of Pascal is that it is the easier language to teach, maybe some questions should be raised. The most important question might be—is Pascal the best language to learn?

What's worrisome about Pascal's emphasis on preplanning and its blizzard of rules is that such academic programming might be the only experience many people will ever have with computer programming. They might assume that all computer languages are restrictive. They might never go on to discover that communicating with computers can be an exceptionally rewarding, even entertaining, pastime.

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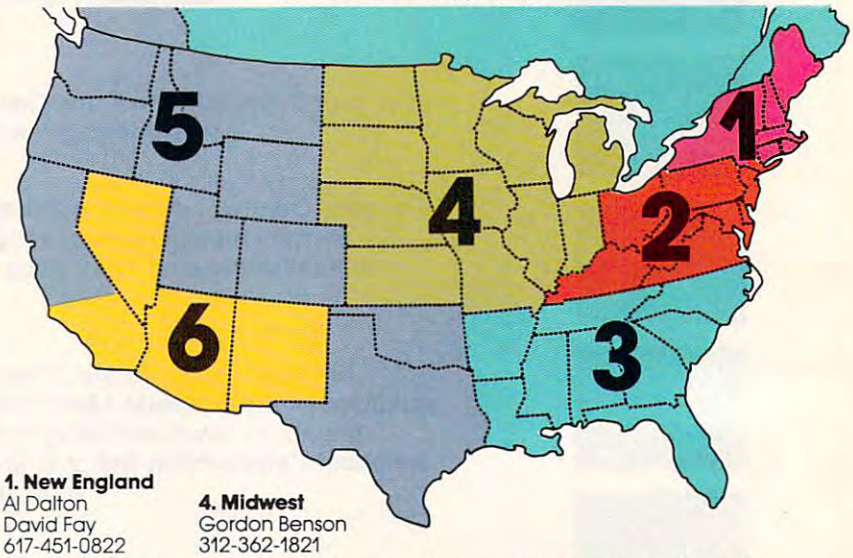

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READERS' FEEDBACK

The Editors and Readers of COMPUTE!

Can Disks Be Mailed?

Should disks be mailed, and if so, what is the proper way to mail them?

Brian Mangan

Disks can be mailed, as long as they are enclosed in a snugly fitting, rigid package. Many office supply stores sell padded jackets (called mailers) especially made for 5¼-inch disks. Also, for what it's worth, many users write a message on the outside of the mailer, to warn mail handlers that the package contains a magnetic recording which can be damaged by electromagnetic fields.

Commodore Sequential Append

I recently made a discovery that I think will help programmers using Commodore disk drives to create and use sequential files. In addition to writing a sequential file (OPEN 2,8,2,"SEQFILE,S,W") and reading a sequential file (OPEN 2,8,2, "SEQFILE,S,R"), it is possible to append a sequential file. This is a great help; rather than having to rewrite the entire file when additions are made (OPEN 2,8,2,"@0:SEQFILE,S,W"), all you have to do is use an A in place of the W when you open the sequential file for writing: OPEN 2,8,2, "SEQFILE,S,A". The DOS finds the end of the file and simply adds on the new data. You use the regular PRINT#2 statement to accomplish this.

Steve Gibson

Disabling The Atari Break Key

I want to inform your readers about a technique I discovered that disables the Atari's BREAK key, but does not need to be reexecuted after each GRAPHICS command. It is so simple that I wonder why no one has ever mentioned it, or if it conflicts with something that I have not yet found out:

```
POKE 566,143:POKE 567,231
```

to disable

and

```
POKE 566,84:POKE 567,231
```

to enable

The preceding statements change the BREAK key interrupt vector to point to address 59279 ($E73F) which contains a machine code PLA and RTI instruction used by the OS. This method will work only with the OS B ROMs, which contain the interrupt vector for the BREAK key.

Neil Weisenfeld

A TI Quit Fix

Have you ever hit FUNCTION + instead of SHIFT + while you are typing in a program? It's extremely frustrating to see all your work go down the drain. Here's a way to disable the QUIT key on the TI.

To do this you will need either the Mini Memory or Editor/Assembler cartridge or Extended BASIC and the 32K Memory Expansion. This is because the console BASIC does not contain the CALL LOAD subprogram (better known as POKE). Whenever you turn your computer on, type the following line in the command mode: CALL LOAD(–31806,16). This will disable the QUIT key. If you are using Extended BASIC, use CALL INIT::CALL LOAD(–31806,16). If you wish to return to the Master Title Screen, you can still do so by typing BYE.

Credit for this information goes to the documentation that comes with the TI Forth package.

By the way, does anybody know of a comprehensive memory map for the TI?

Davin A. Trulsen, Jr.

What's An EPROM?

I would like to know what EPROMs are and what they are used for.

Bob Cullen

EPROM stands for Erasable Programmable Read Only Memory. EPROMs are memory chips which can "remember" programs even when the computer's power is switched off. Important machine language programs like the BASIC language or the computer's operating system are often permanently stored in ROM, but standard ROM can be programmed only once (when the chip is made). EPROMs, on the other hand, can be programmed by any computer user with a relatively simple peripheral device, the EPROM programmer. EPROMs can also be erased by exposing them to ultraviolet light. You could use an EPROM to store any machine language program you use frequently—even to make your own game cartridges.

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64 Sprite Collisions

I have a Commodore 64, and am having trouble with collision detection with sprite graphics. I use the following line to check for collisions:

```
IF (PEEK(53278)ANDX) = X THEN action
```

This is easy to convert to machine language. In all of my programs, this statement is unreliable. Sometimes it detects a collision between two sprites when they aren't colliding, other times it doesn't detect a collision when they are touching, and other times it works just fine.

I've read in past articles that this problem may be caused by "sparkle" on the 64, and that the solution to the problem is to relocate screen memory. I tried that, and it didn't help.

I've also found that by putting a PRINT PEEK(53279) in my programs, the collision registers work every time. But I don't know how to PRINT a PEEK in machine language.

Eric Rotenberg

First, sparkle can *cause spurious collisions with sprites, but you have to relocate the character set, not the screen, to disable the sparkle. Second, be aware of the nature of the collision register. It is set when two sprites collide, and stays set, even after the sprites have moved away from each other.*

Also, the register is cleared when you try to read it, so you can't keep doing an LDA or a PEEK to check for different collisions. The first PEEK resets the register. If the sprites are still touching, they will then set the collision register again. When you are checking for a collision, save the results of the first PEEK for later use.

BASIC B For The Atari 400 And 800?

1. Is Atari going to make a Revision B of BASIC, as found in the new XL series on cartridge or other form for the 400 and 800 computers?

2. I've been having trouble with my BASIC cartridge. *Pac-Man* works just fine, but when I plug in BASIC, either the screen goes blank, or I get two clicks and the screen goes blank, or it goes right into memo pad mode. This happens after I put in any other cartridge. Can anyone help me?

Kevin Bailey

As far as we know, Atari has no plans for offering an upgraded BASIC.

Even though ROMs are sturdy, solid-state devices, they can be damaged by static electricity or by being dropped. It's a good idea to ground yourself (by touching something made of metal) before you operate any computer equipment. But your BASIC's not necessarily bad. You may just need to clean the contacts.

Normally, the contacts are not exposed, but you can stick a pencil or paper clip into the slot to lower the protective hood. Then, using a swab and rubbing alcohol, thoroughly clean the contacts, then let the cartridge dry. Incidentally, this is also a recommended procedure for your Operating System board and other RAM boards. You may also want to try some TV tuner cleaner in place of the rubbing alcohol.

We don't know of any problems with one cartridge leaving the machine in a state that prevents it from running another cartridge, especially since the power is cut off between cartridge changes. If any other readers are having similar problems, or have a cure, please write in.

Slow TI BASIC

In his review of *Robot Runner* for the TI-99/4A in COMPUTE!, January 1984, Tony Roberts stated that games written in BASIC on the TI are notoriously slow because the microprocessor can't interpret BASIC fast enough. I want to clear up any implication that the TMS9900 CPU in the 99/4A is at fault.

TI BASIC is indeed slow, due to the unusual architecture of the machine and the design of the BASIC interpreter. First of all, the RAM in which BASIC programs are stored is not CPU RAM. The 16K of RAM in the 99/4A is maintained by the TMS9918A video display processor (VDP). There are only 256 bytes of CPU RAM in the 99/4A console.

Every time the microprocessor accesses or RUNs a BASIC program, it must request the program from the VDP one byte at a time, one statement at a time. This causes a great increase in execution time, because the microprocessor must wait for the VDP. While the TMS9900 microprocessor is a word-oriented (16 bits) chip, the VDP works in bytes.

The second reason why TI BASIC is so slow is that the interpreter itself is not written in machine language. It is written in another high-level language known as Graphics Programming Language, or GPL. The GPL interpreter is also built into the 99/4A console. Thus, whenever a BASIC program is RUN, a *double interpretation* takes place. This is similar to writing a BASIC interpreter in BASIC for an IBM PC. It is really amazing that the TMS9900 can run BASIC as fast as it does, considering.

Chris Clark

Use Of COMPUTE! Programs

Concerning the "Readers' Feedback" of September 1983, you stated that the programs in COMPUTE! are not in the public domain, and that only people who own a specific issue of COMPUTE! can have access to the programs in that issue. My question is, what if a computer club takes out a

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subscription to COMPUTE!? Would that club be allowed to place those programs in those issues in its library for all members? And what if a school or public library takes out a subscription? Could everyone who is allowed access to the library be allowed access to those programs in those issues?

Gary Lee Crowell

Sorry, the answer in each case is no. You can only use the programs in an issue of COMPUTE! *if you own a copy of that issue.*

VIC Video Typewriter

I have written a short program that transforms your VIC into a typewriter (without any annoying syntax errors). I use it to practice my typing after school. To disable the program, use the f1 key.

Vicky Cwiertnie

```
10 PRINTCHR$(8):PRINTCHR$(14)
20 POKE36879,26:PRINT"{CLR}"
30 PRINT"** VIDEO TYPEWRITER **"
40 GETA$:IFA$=""THEN40
50 IFA$="{F1}"THENEND
60 IFA$=CHR$(13)THENPOKE36878,15:POKE3687
   6,220:FORX=1TO50:NEXT:POKE36876,0
70 PRINTA$;:GOTO40
```

Atari Tape Verify

Here is a one-line program which verifies that an Atari tape file is recorded properly. The utility works whether you CSAVE, LIST, or PRINT (data) to the tape. It performs essentially the same as Michael J. Barkan's "Atari Verify" (COMPUTE!, August 1983), but is much shorter. This utility can be LISTed to tape and ENTERed from tape, but since it is so short, it is easy to enter it from the keyboard in direct mode (without the line number). Just use this line:

```
0 CLOSE #1:OPEN #1,4,0,"C:":FOR A=1 TO
  400:GET #1,A:NEXT A
```

After recording a file on tape and while the program or data is still in memory, enter and run this utility. Rewind the tape to the beginning of the file and push PLAY. The utility will read the entire file, one character at a time, to insure that the file is recorded properly. Operation will end with an error code. If you get this code, the file was read successfully, showing that it is good:

```
136  END OF FILE
```

If you get one of the following error codes, save the file again, since it could not be read by the computer:

```
138  DEVICE TIMEOUT
140  SERIAL BUS ERROR
143  DATA FRAME CHECKSUM ERROR
```

The same variable is used for loop control and to hold each character as it is read from tape. This way, the loop never ends and will check any length of file. This variable can be changed to one of those in your program, if desired, to avoid adding to the Variable Name Table of your program.

Douglas J. Wilder

TI Randomness Test

Richard Mansfield's article "Zones Of Unpredictability, Part 2" ("The Beginner's Page," COMPUTE!, December 1983) included a program called "Randomness Test." Since it wouldn't work on my TI-99/4A, I wrote a similar program. It takes several thousand cycles to get close to even distribution for each number, but it's fun to let it run.

Gaston Porterie

```
100 CALL CLEAR
110 PRINT "TEST OF THE RANDOM NUMBE
    R","FUNCTION ON THE TI-99":::::
    :::
120 PRINT "PLEASE WAIT..."
130 T=T+1
140 RANDOMIZE
150 X=INT(10*RND)+1
160 A(X)=A(X)+1
170 FOR I=1 TO 10
180 P(I)=INT(A(I)/T*100)
190 NEXT I
200 IF T/100<>INT(T/100)THEN 130
210 CALL CLEAR
220 PRINT "AFTER";T;"CYCLES";"OF RA
    NDOMIZATION"
230 PRINT
240 PRINT "RANDOM","%","NUMBERS","O
    CCURRENCE"
250 S=0
260 FOR I=1 TO 10
270 PRINT I,P(I)
280 S=S+P(I)
290 NEXT I
300 PRINT "","---"
310 PRINT "TOTAL",S;"%"
320 GOTO 130
```

Easy DATA Statements

Here is a one-liner that I have found very useful while programming many statements that are almost identical. Used in the direct mode it can yield a set of DATA statements that fill the screen. The program can just as easily use POKE, or REM statements, or any combination of these.

```
FOR X=100 TO 300 STEP 10:PRINT X "DATA":
  NEXT X
```

Chuck Cole

Constant 1541 Errors

Ever since I bought my 1541 disk drive, I have been getting the errors 23 READ ERROR and 27 READ ERROR. This not only happens on my

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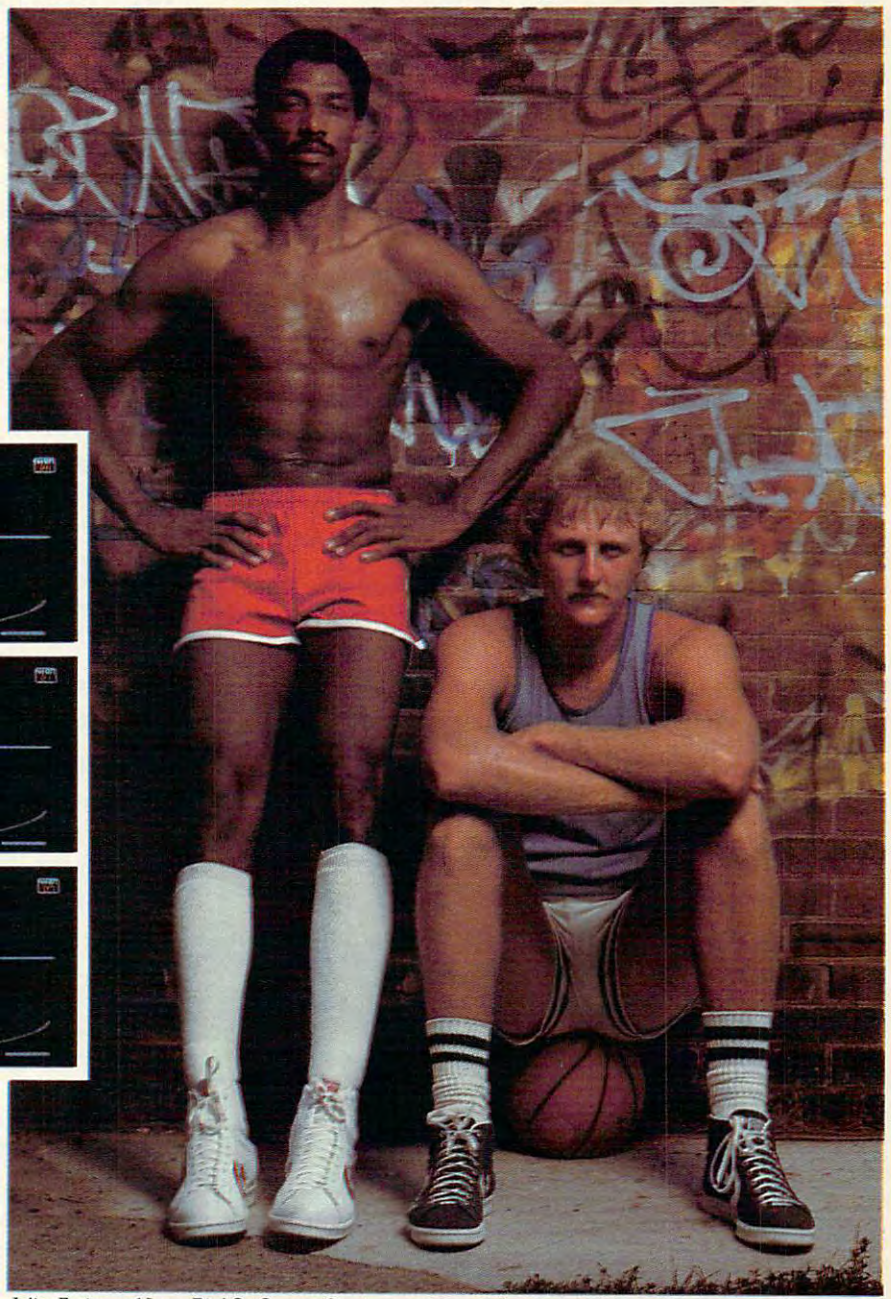

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disks, but also on prepackaged disks. I have read what these errors mean in Appendix B of my disk users guide, but these descriptions don't tell me much.

Could you please give me more information on these errors, and tell me what I can do about them?

Jay Elmore

The fact that this occurs both on your own disks and on commercial disk programs strongly indicates a hardware problem. Ask the dealer from whom you purchased the drive for the address of the nearest service center and have the drive checked out.

Sprite Data Problems

I am a Commodore 64 owner and I have a question about sprites. I understand how to create a sprite and move it around the screen. I also know how to move more than one sprite, if the data for them is the same. My problem occurs when I have more than one set of data. I can't seem to get both sprites on the screen at the same time. The *Programmer's Reference Guide* doesn't have an example with two sets of data. I would appreciate it if you would help me out.

Seth Hausman

Jim Butterfield replies:

I can think of two possible problems with your sprites:

1. *You may have forgotten to link each sprite to its drawing in memory. With normal memory mapping, sprite 0 needs to have its drawing number (usually 11, 13, 14, or 15) placed into memory address 2040, sprite 1 into 2041, and so on up to sprite 7 into address 2047. If you use drawing number 11, the drawing of the sprite should be in addresses 704–766 decimal; for number 13, addresses 832–894; for number 14, addresses 896–958; and for 15, 960–1022.*

2. *Many sprite register addresses control all eight sprites at the same time. To turn sprite 0 on, you would POKE 53269,1; to turn sprite 1 on, you would POKE 53269,2;* to turn them both on, *you would add 1 and 2 and POKE 53269,3. The following table shows the bit values for each sprite:*

Sprite	*0 – 1*
	1 – 2
	2 – 4
	3 – 8
	4 – 16
	5 – 32
	6 – 64
	7 – 128

Thus, to turn on sprites 0, 2, and 4, we add 1+4+16 and POKE 53269,21.

Be sure that you keep the difference between a sprite number and a drawing number clear in your mind. Several sprites can use one drawing (or "definition"); or a single sprite can be switched from one drawing to another as it moves its arms, legs, tentacles, or whatever.

Using Atari Cartridge Memory

I have an Atari 800, and am currently writing a text-adventure game using the Assembler Editor cartridge. I hope to run the program without the cartridge when I'm finished. How can I use the 8K block of RAM used by cartridge (not to mention all those zero-page pointers that the cartridge uses)? Does it have to go to waste? I hope not, because I'll need all the memory I can get for this thing.

John Bushakra

No, the memory need not be wasted, but you cannot test the program with the Assembler Editor. Just define the memory you need, then assemble your program to disk. The object code will not go into memory, but will become an executable object file on the disk. The syntax is:

```
ASM,,#D:filename
```

You can then take all the cartridges out of your machine, boot DOS, then Load Binary File. If you make these the last two lines of your machine code

```
*=$2E0
.WOR START
```

where START is a label for the start address, your program will run automatically after it is RUN. Otherwise, you'll have to use Run At Address to start your program from DOS.

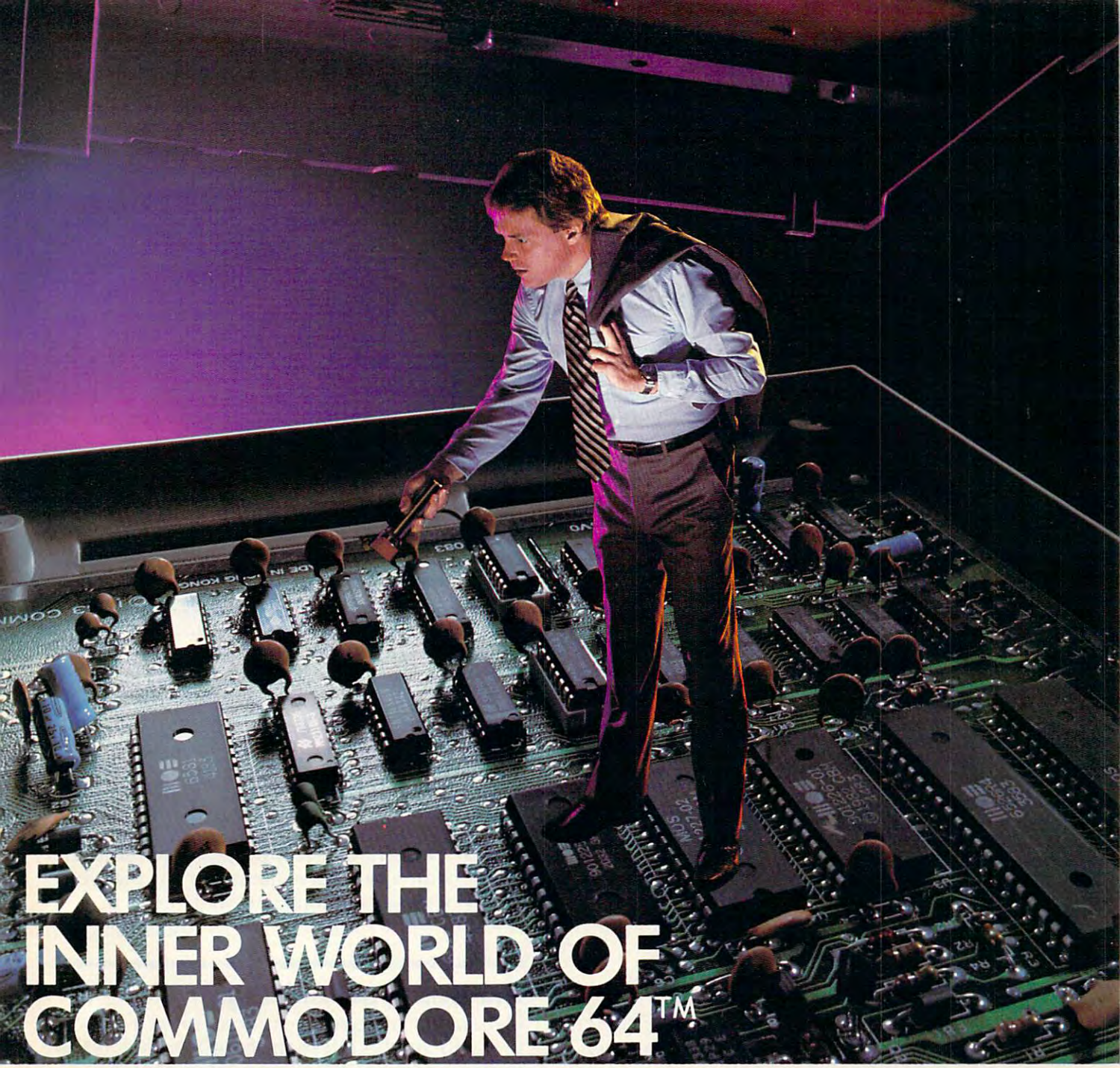
More Solutions For TI Cartridge Loading Problems

In the January 1984 "Readers' Feedback," I read a question about TI-99/4A cartridge loading problems. The problem was with lockup of the keyboard and broken screen display patterns after insertion of a program cartridge. The remedy given by COMPUTE! was to clean the contact strips of the program cartridge. I've found this to help, yet also discovered that this is not necessarily the complete solution. The cartridge connector extension that protrudes from the main circuit board may also be at fault. To remedy the problem means disassembling the computer, cleaning the contacts on both sides and both ends of the cartridge connector extension. This solved all of the problems I had encountered.

Richard Winslow

About four months after buying my TI, I had the same problem with loading the cartridges. I solved the problem by taking apart the computer and straightening the bracket which the cartridge plugs into. (It was bent.) Works perfectly now.

David L. Jones



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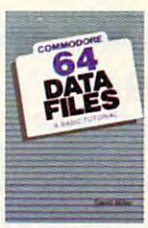

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I discovered that slightly lifting the back of an in-place cartridge seems to improve contact. So I cemented a small rectangle of soft black plastic about .1 inch thick onto the cartridge insertion area to lift each cartridge a little.

I also use a "Widgit" (Navarone Industries) that holds three command modules and prevents some wear and tear on contacts.

John K. Newell

VIC Video Revisited

I made some modifications to Jim Butterfield's program in "Visiting The VIC-20 Video, Part 4" (COMPUTE!, August 1983) that I think your readers will be interested in. Although the program is a little slow, the patterns that result are remarkable.

The program is short, but because of the loops, it runs for a while. To get some really interesting three-dimensional patterns, try inputs with a value of 1.02, 1.03, 1.04, etc. The input sets a step value for line 600. An input of 2 will give a gray field.

William B. Broome

```
100 POKE56,22:CLR
105 INPUT"{CLR}PATTERN #";C
110 POKE36869,222
120 POKE36866,144
130 POKE36867,32
200 FORJ=6144TO8191
210 POKEJ,0:NEXTJ
300 FORJ=0TO255
310 POKEJ+5632,J
320 NEXTJ
330 FORJ=37888TO38911
340 POKEJ,0:NEXTJ
600 FORJ=6100TO8800 STEPC
610 X=128
620 FORK=JTOJ+7
630 POKEK,PEEK(K)ORX
640 X=X/2
650 NEXTK,J
700 GOTO700
```

Try adding STEP C to line 620 as well, to get another interesting effect.

Another Kerosene Warning

A letter in your January 1984 issue questioned the use of kerosene heaters near a home computer. You compared the emissions of a kerosene heater to those of a gas stove, and suggested the use of an electrostatic air cleaner as a precaution.

The sulfur content of most kerosene fuels is high enough to create sulfur oxide levels that are technically in violation of EPA clean air regulations. These sulfur oxides can corrode exposed metals and cause problems with electrical contacts. Besides the corrosion of metals, the sulfur oxides can cause health problems.

Since the combustion products of kerosene are gases and not particulates, an electrostatic air cleaner will not help clean the air of sulfur oxides. An activated charcoal filter may help, but this is not a common appliance in most homes. Corrosion problems may not occur with other electronic appliances, such as televisions or radios, because the components are soldered or otherwise permanently fixed inside the appliance.

Those appliances which use exposed electrical contacts, such as game cartridges and computer keyboards, are most prone to corrosion by sulfur oxides. Readers should avoid the use of kerosene heaters in a home with a computer, electric typewriter, or silver tea set.

W. J. Tolonen

VIC Graphics And Super Expander

I'd like to share something with other readers who have VIC Super Expanders. We find that it interferes with some programs written for the unexpanded VIC, especially ones with custom characters. When I find such a program, or am told to "remove all expansion devices" for a certain program, I add the following as the first line in the program (or enter it in the direct mode before RUNning the program), and the program runs fine with the Super Expander left in. (In the case of two-part programs, insert the line in the second part.)

```
POKE51,30: POKE55,0: POKE52,30: POKE56,30:
  POKE646,6
```

This has worked on every program I've encountered so far, and what's nice about it is that you are left with the additional memory as well.

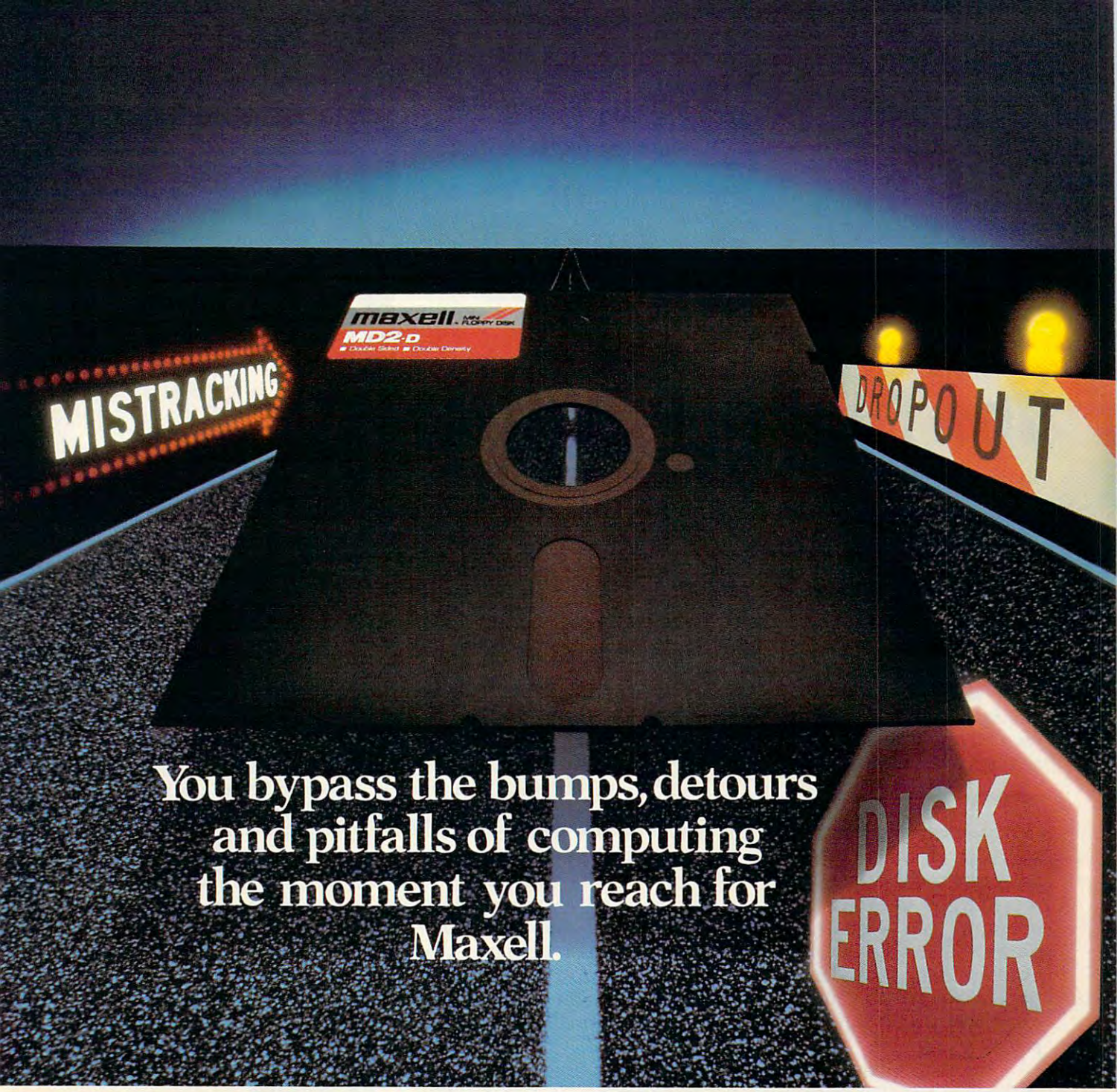
Robert M. Bleich

The *Whiz Kids* Were Right

I would like to point out an error in your response to David Smith's question about *Whiz Kids* (COMPUTE!, February 1984). You mention that the sprinkler system that they turned on should have shorted out the terminal they were using. You may have missed this, but it did short out. For a while they were successful in keeping the terminal dry by standing over it, using their jackets as umbrellas. But when the water did get to the terminal, it shorted out.

Karen Wilson

COMPUTE! welcomes questions, comments, or solutions to issues raised in this column. Write to: Readers' Feedback, COMPUTE! Magazine, P.O. Box 5406, Greensboro, NC 27403. COMPUTE! reserves the right to edit or abridge published letters. ©



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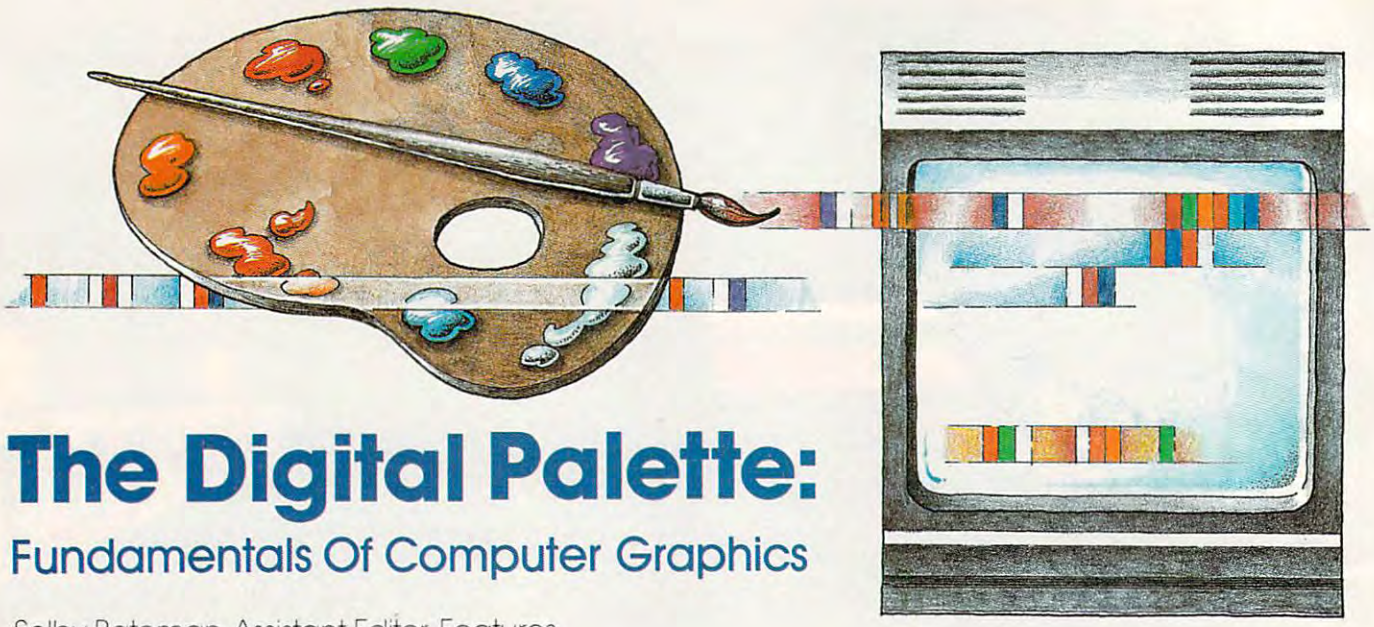

The Digital Palette:

Fundamentals Of Computer Graphics

Selby Bateman, Assistant Editor, Features

Your computer screen is a colorful gateway to the world of digitized graphics. But to appreciate all the video magic that's available, you first have to understand the basics. Here's a look at the pixel power behind your computer's video display.

"I remember standing back with everyone else, saying 'There's no way; I'm never going to touch this thing. It's not creative enough,'" says Kari Beims with a laugh. "I took a computer graphics class; it was full of people like me who are in the graphic arts field. And they were *petrified*."

The "thing" that petrified Beims and her classmates was, of course, a computer; a machine which, when used as a graphics tool, can appear so novel, so daunting, and ultimately so seductive that artists at first exposure may be simultaneously attracted and repelled.

Beims and many others have changed their views about the computer as a graphics machine. An artist at Maximus, Inc., of McLean, Virginia, Beims now uses and helps promote her company's new *Visualizer*, one of a new breed of graphics software packages for home computers that is as easy to use as it is useful.

"It's a lot of fun," Beims says. "*I* can do it, and I have no programming experience. I mean, I walked into here knowing nothing about computers."

An Undeniable Attraction

Graphic artists like Beims may be among the most perceptive analysts of how well a computer functions as a graphics tool. And although the polls haven't yet closed, Beims and a growing number of other artists are predicting a landslide in favor of the computer.

"It's getting—I hate to use this term because everybody says it—but it's getting *user friendly*; it truly is," Beims says. "People are starting to ask graphic artists what they need, and the results are beginning to show up in the computer software and the peripherals. And we need that."

The glow of a computer screen is the first thing that attracts many people to computing. You don't have to know anything about pixels, raster scans, character sets, and RGB monitors to appreciate that something special, something new and powerful is possible when *you* can decide what appears on a TV screen.

If you want to create colorful, high-resolution graphics for games, business, or art, today's microcomputers have the capabilities to produce almost any image you wish. Peripherals such as light pens, graphics tablets, and touch screens will free you from the restrictions of the keyboard. And graphics software packages are becoming surprisingly easy and powerful tools for designing anything from pie charts to paintings.

You Don't Have To Be A Genius

A 20-year fascination with computer graphics led Joseph Deken to write the text last year for *Computer Images: State of the Art*, a full-color collection of computer artworks. Deken, an assistant professor of computer sciences and general business at the University of Texas at Austin, uses an Atari 800 and one of the IBM-compatibles at home. He believes you don't have to be a genius to understand and appreciate computer graphics.

"I use graphics to teach

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SURVIVAL ON PLANET X WITH THE ATARI™ HOME COMPUTER, by Orkin and Bogas, uses the exciting adventures of Vivian on Planet X to teach kids basic programming concepts and techniques. The fun is interspersed with short programs, illustrated by noted animator Bud Lucky.

ATARI™ LOGO ACTIVITIES, by Steve DeWitt, provides over 150 activities which encourage young and old alike to be inventive and creative when using Atari Logo™ educational language. The book includes five big projects and an in-depth discussion of Logo.™

ADVENTURES WITH THE ATARI™, by Jack Hardy, teaches you how to write adventure games in Atari PILOT™, Microsoft BASIC, and BASIC. It includes six actual adventure games to study, type in, and play, plus tips and techniques to help you create your own.

A+ PROGRAMMING IN ATARI™ BASIC, by John Reisinger, is a self-study workbook which gives you step-by-step instructions for BASIC programming on the Atari 400, 800, 600XL and 800XL™ computers. Stressing top-down programming in a fun and friendly manner, this book is perfect for school, workshop and computer camp.

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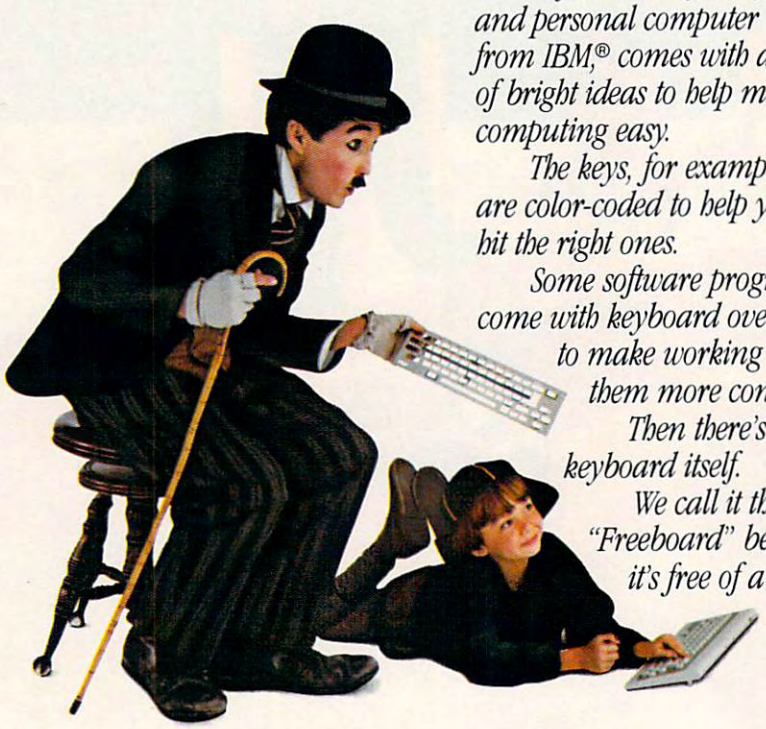

PCjr, the new family and personal computer from IBM,® comes with a lot of bright ideas to help make computing easy.

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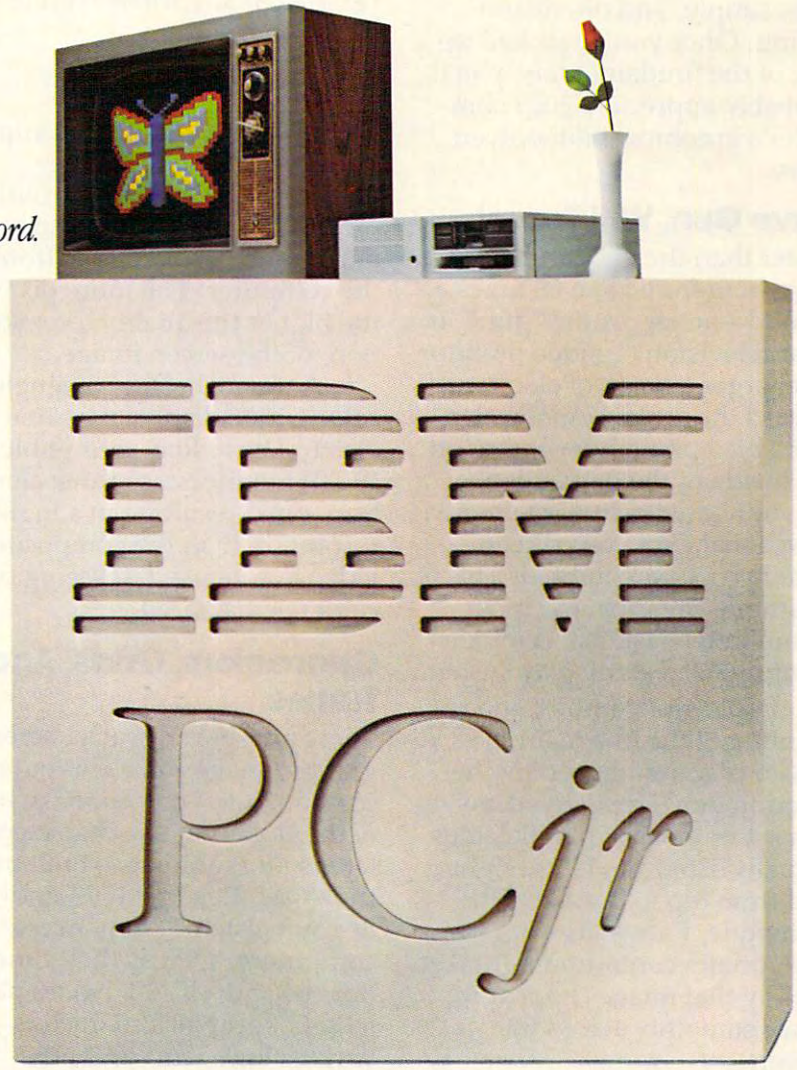

Little Tramp character licensed by Bubbles Inc., s.a.

about computers in introductory courses at the university," he says. "I'm always concerned with the stereotype that computers just have to do with mathematics. And I'm concerned with how to get students who aren't mathematically inclined interested in computers. Graphics winds up being a good vehicle for that."

An important first step in anyone's computer graphics education is the knowledge that capabilities costing thousands of dollars on mainframes just a few years ago are now available on inexpensive microcomputers. Learning the basics of computer graphics can now be inexpensive, simple, and often fascinating. Once you've picked up a few of the fundamentals, you'll probably appreciate your computer's graphics abilities even more.

The selection screen from Penguin Software's The Complete Graphics System.

Have Gun, Will Travel

Faster than the eye can follow—anywhere from 25 to 60 times a second—an electronic "gun" in your television or video monitor discharges a beam of electrons toward the screen. As the electrons hit a phosphor coating on the inside of the video display, the individual picture elements which make up your screen—called *pixels*—are lighted. This is a cathode-ray tube, the most common television and microcomputer screen display system.

Rapid-fire painting and repainting of the image on the TV screen is accomplished by the electron gun's repeated drawing of a set number of parallel lines (usually 525) from left to right and from top to bottom. This technique, known as a *raster scan*, occurs continuously and so rapidly that images appear to move smoothly across the screen.

The creation of characters and shapes on your computer screen is similar to the effects produced when thousands of college football fans use flip cards to spell messages of team support from the stands. The densely packed pixels flip either on or off, and from color to color, in response to directions from the computer. The more pixels, the higher the quality, or resolution, of the screen image.

A monochrome, or single-color, video display uses one electron gun. Red-green-blue (RGB) monitors use three electron guns, resulting in a higher resolution than the composite video you're used to seeing on a color television set.

Characters, Grids, And Turtles

There are several ways to create graphic images on a computer screen. First, you can make use of the alphanumeric characters—letters and numbers—built into the ROM (Read Only Memory) of your system. Many microcomputers, such as the Commodore 64 and VIC-20, have a parallel set of graphics characters—various lines, curves, and boxes—built into permanent memory. Using them as building blocks, you can combine characters into a variety of figures.

A more time-consuming, but flexible method for creating graphics is to manipulate the individual pixels. You tell the computer which pixels you want lighted and in what colors by communicating with it in a language, such as BASIC. In a personal computer which has a high resolution of, say, 320 x 200 pixels, there are 64,000 graphic points which you can potentially control. Locations in your computer's memory literally form a video map of what you can address on the screen.

(For more information on actually creating color graphics on your computer, see *COMPUTE!'s First Book of Atari Graphics*, *COMPUTE!'s First Book of Commodore 64 Sound and Graphics*, and other COMPUTE! books.)

Turtle graphics is a third way of producing images on your screen. Based on the Logo programming language, turtle graphics helps to teach programming and geometric principles. A small triangle on the screen—the imaginary turtle—can be directed to move about the screen, leaving an image in its wake. Intricate patterns can be achieved through this simple,

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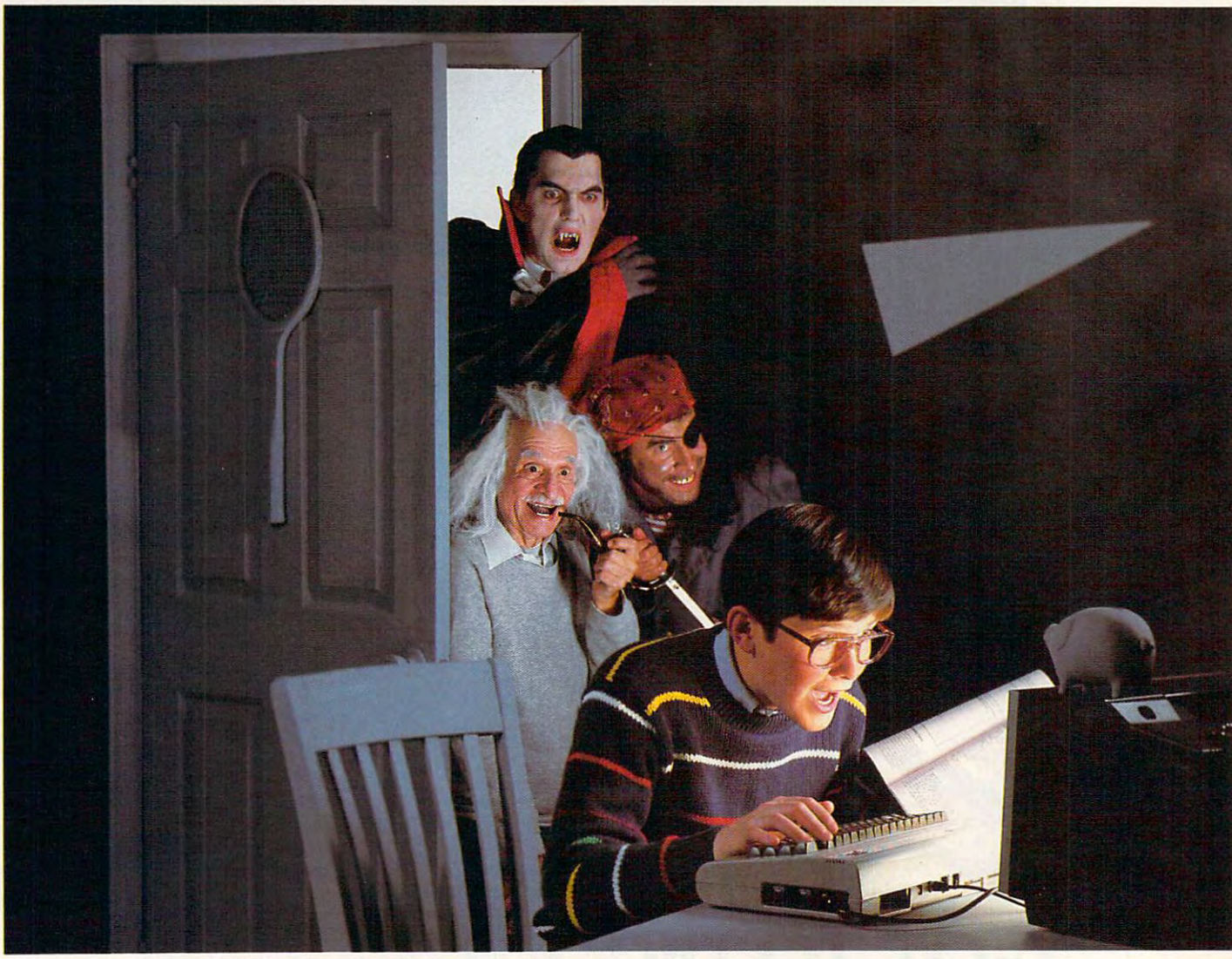

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ADVANCED BASIC PROGRAMMING FOR THE COMMODORE 64 AND OTHER COMMODORE COMPUTERS
Michael Richter

This is the next step for the Commodore user who has mastered the basics and wants to move on to more advanced software. In this book, the reader will learn how good programs are written, how to read and use them, how to know a good one when they see it, and how to gain knowledge through the experience of writing advanced software.

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COMMODORE 64: GETTING THE MOST FROM IT
Tim Onosko

Written for users with little or no previous programming experience, this handy guide is the only source with information on all three versions of the Commodore 64. It includes material on both the classroom model and the portable version. It offers a thorough and understandable introduction to the computer—including a solid approach to BASIC programming. It covers word processing, color graphics, and sound.

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but subtly powerful graphics language system.

To Mimic More Closely

As microcomputers become more sophisticated graphics machines, a similar process is occurring with the devices used to draw and paint images on the computer screen. The graphics software now available relies more and more on such peripheral devices as joysticks, light pens, graphics tablets, touch screens, and mice (defined below).

These peripherals fall into three basic price ranges, according to research conducted by Koala Technologies, producer of the KoalaPad Touch Tablet and the Gibson Light Pen. You can find game paddles and most joysticks from $15 to $30; trackballs, mice, graphics tablets, and better light pens from $30 to $400; and precision tablets, called digitizers, from $400 on up. (See "Light Pens And Graphics Tablets" and "A Graphics Glossary," both in this issue.)

All of these devices attempt to mimic more closely the actual procedure of drawing or painting on a flat surface, as opposed to the more indirect, less satisfactory process of typing in graphics commands on a keyboard. Often, a joystick, light pen, or graphics tablet may be used in conjunction with keyboard commands to produce lines, boxes, circles, rays, points, and various fill patterns.

Other commands allow you to transpose and merge images, lock onto and move parts of a picture, magnify sections of an image for more detailed work, save pictures for later use, and select or change colors.

For Atari And Commodore

Kari Beims says that a mouse—a hand-controlled device which rolls on a flat surface to move the screen cursor—is the most successful device for creating graphics. "It's closer to the kind of tools you're used to working with. With a joystick or a light pen, it's a little different. The mouse lets you work flat-on; you've got more control. And it's closer to the actual production work you've done before," she says.

Software companies are

A Graphics Glossary

ASCII: (Pronounced *askey*) American Standard Code for Information Interchange. A standard code used in microcomputers to represent alphanumeric information (letters, numbers, and symbols). The capital letter A, for example, is represented in ASCII code by the number 65.

bitmap graphics: A high-resolution graphics plotting technique by which pixels (picture elements) on a computer screen are turned on and off.

CAD: Computer-aided design. The use of computer graphics to help in design development and modification, often eliminating the need to create costly or dangerous prototypes. CAD is usually associated with CAM, or computer-aided manufacturing.

character graphics: The text characters that appear on your computer screen when it is turned on, including letters, numbers, symbols, and punctuation marks.

CRT: Cathode-ray tube. A video display terminal, such as a television or video monitor, which uses a beam of electron particles to draw images on a screen's phosphor coating. The electron beam can write on the screen with a single beam or, more commonly, in a series of parallel lines to form an image. (See **raster scan** and **vector scan**.)

electron gun: The mechanism within a CRT which shoots a narrow beam of electrons at the screen, creating images. The beam is constantly redrawing the screen at speeds usually ranging from 25 to 60 times a second. Monochrome (single-color) displays use one electron gun. Red-green-blue (RGB) displays use three separate guns (one for each color), and have a higher resolution than the composite color displays found on television sets.

fractals: Geometric patterns which, when repeated, can create new patterns seemingly unrelated to the original forms. Especially useful in computer generation of detailed maps and duplication of the intricacies of many natural objects.

graphics set: The complete set of graphics characters that a computer can display.

graphics tablet: A pad, usually square or rectangular, on which the X and Y coordinates of the computer screen can be plotted by the use of a stylus, or, on some models, your finger, allowing you to create graphic images.

icons: Graphic symbols, most often used as visual representations of computer software options and procedures. For example, a paintbrush icon would represent the painting option in a graphics software package. Similarly, a trash can icon might indicate a delete option.

image processing: Computer enhancement and alteration of photographs and other graphic images by digitizing a picture into pixels, each of which is then measured for light and color intensity. The pixels can subsequently be manipulated to change the image.

light pen: A stylus which emits low-level electrical pulses and, when pulled across a computer screen, creates an image. Most often used in creating graphics and in interacting with software menu options.

Logo: An easy-to-use, graphics-oriented programming language originally developed to help children learn programming and the concepts of geometry.

mouse: A small hand-controlled device which rolls on a flat surface, allowing you to control the screen cursor, draw graphic images, and select from menu options.

phosphor coating: The coating inside a CRT that glows when struck by a beam of electrons. A computer activates an electron gun to draw and redraw graphic images at high speed on the coating, thus producing graphics that appear to move smoothly across the screen.

pixel: Picture element. The smallest graphic point addressable by a computer. Pixels are turned on or off to form the characters and graphic images on a computer screen.

raster scan: A video picture drawn by an electron gun which sweeps horizontally across the screen in a series of parallel lines at a high rate of speed. The most common method by which a microcomputer system displays a screen image.

resolution: The clarity of a video image based on the number of pixels available on the display screen. The more pixels there are, the higher the resolution and the more detailed the screen image.

RGB monitor: Red-green-blue monitor. A high-resolution color monitor which uses three electron guns to produce very clear and crisp images. By comparison, a color television would normally have a composite color video system in which the three primary colors would be blended, producing a lower quality video display.

simulation: Computer graphics created to model reality in appearance and usually in performance. Numerous airline companies, for example, use computer-generated flight simulations to help train their personnel.

sprite graphics: Sometimes called movable object blocks (MOBs), sprites are programmable graphics characters that can move around the screen independent of the primary screen image, the background.

touch screen: A video screen or plastic screen overlay which allows you to draw, write, and make menu selections from the screen at the touch of a finger or stylus.

turtle graphics: Closely associated with the Logo programming language, the turtle graphics system is most often used in an educational context, especially in teaching children about computer programming and geometric shapes. A triangular screen cursor (the turtle) moves across the face of a display monitor in response to directions entered into a computer, allowing the user to program a wide variety of geometric graphic images.

vector scan: A video picture drawn by the focused beam of an electron gun, much like a pencil's movement across a piece of paper. This produces a slower, but higher quality, video image than the parallel-line technique of a raster scan.

video chip: A tiny microprocessor on a silicon chip which handles the video data within a computer, assisting the central processing unit (CPU) by managing the screen image.

exploring all types of input devices in order to give users the right mix of creative flexibility and control. The newer packages offer more options, and a greater number of practical applications as well.

One such product is the *Visualizer* graphics animation package introduced by Maximus, Inc., at Softcon, the international conference and trade fair of the software industry, held recently in New Orleans. Available now for the Atari computer with at least 48K and disk drive, the $49.95 package should be ready for the Commodore 64 in May.

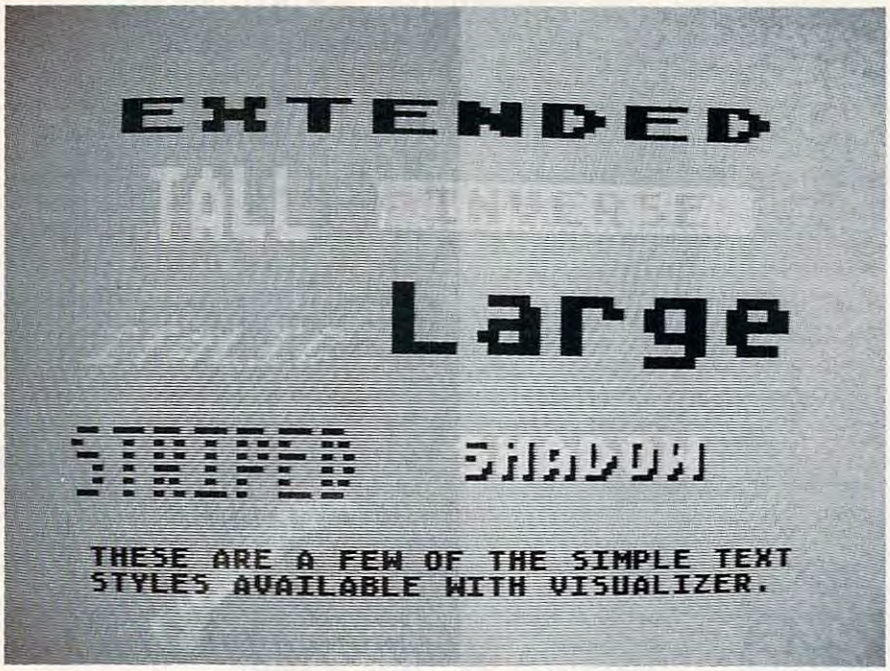
"The goal with *Visualizer* was to create a graphics program completely for the nonprogrammer, which would be useful besides just being a creative outlet," says Beims. "The *Visualizer* gives you the option, in addition to creating slides, of adding animation effects and putting together a slide show using up to 26 screens.

Synchronizing Slides And Sound

"You can synchronize them with an audio track so that you've got a customized audiovisual presentation. You can move the slides ahead manually, or use a timer through the computer," she says. "In addition to being a graphics program, it's useful. You can use it for teaching, training, business and sales presentations, retail advertising, and instructional lessons for the kids at home."

The package uses automatic drawing functions for circles, ovals, boxes, borders, and diagonals, and has 18 different text style options that can be used with graphics. The slides you create can be printed in black and white with an Epson MX (with Graftrax), FX, or RX series printer, or with a C. Itoh (NEC, Prowriter, or other) printer. A joystick is used for drawing, with a variety of colors and brush sizes available.

Two more recent graphics software products which combine usefulness with ease of use are *The Graphics Magician* (on disk for Apple, Atari, and Commodore at $59.95 and for IBM by the end of 1984) and *The Complete Graphics System* (on disk for Apple at $79.95), both from Penguin Software.



The Visualizer *by Maximus, Inc., allows a variety of text faces to appear on the same screen with animation graphics.*

"With *The Complete Graphics System*, I basically wanted to set up an all-in-one tool for people to use to create computer graphics," says Mark Pelczarski, founder and president of Penguin Software.

Hundreds Of Colors And 3-D Too

The package is compatible with most input devices, and allows three-dimensional line drawings to be reproduced on a variety of plotters. There are over 100 available colors and 96 brushes. Portions of any individual screen may be magnified from two to eight times for easier manipulation of pixels. And text may be added with graphics in a variety of ways.

Penguin also sells several programs which can be used in conjunction with *The Complete Graphics System*. *Additional Type Sets* ($19.95) provides 50 extra typefaces and character sets. *Map Pack* ($19.95) includes outline maps of all 50 states, the continents, the U.S., and Canadian provinces. *Transitions* ($49.95) is a presentation system which will let you organize picture disks and turn them into slide shows. More than 35 different screen wipes are available. That is, you may clear the screen from top, bottom, left, or right sides; use geometric-pattern clearing techniques and windshield wiper effects, among others. Finally, *Paper Graphics* ($49.95) is a utility that will let you print any high-resolution graphics screen to your printer.

"*The Graphics Magician* software is actually two different sets of programs. One is a drawing program geared toward people who are going to use it in [creating] other software—like educational software," says Pelczarski. "There's a huge amount of educational software out there that's been done using *The Graphics Magician*."

The Graphics Magician uses machine language animation routines with the same techniques that are used on arcade games. Up to 32 independent objects can be assembled in the animating process. The package also includes a high-resolution picture/object builder, which lets you store hundreds of color pictures on a single disk. More than 100 colors are available for use as well.

Screens A La Mode

Almost all of the top-selling microcomputers have extensive graphics capabilities, but you'll want to spend some time learning your own machine's features.

The Apple IIe, for example, has a high-resolution mode with six colors and 280 pixels horizontally by 192 pixels vertically. There is also a 40 x 48-pixel low-resolution mode with 16 colors. Apple's new Macintosh, which uses a monochrome display, has a whopping 512 x 342-pixel resolution. Obviously, very fine graphic detail is possible with this many pixels.

The Commodore 64 has 16 colors, several modes—including a 320 x 200 graphics mode—and eight independently programmable *sprites* (24 x 21-pixel movable screen objects), which allow you more opportunities to create animation. The VIC-20 also has 16 colors and a graphics resolution of 176 x 184.

The Atari 600XL and 800XL each have 320 x 192 graphics resolutions, as well as 256 colors (16 colors with 16 luminance levels for each color). But the Ataris also have 11 different graphics modes, or varying combinations of colors and pixel densities, which extend its graphics capabilities.

PC Pixels

IBM's PC and PCjr each have the same 320 x 200-pixel, four-color, high-resolution graphics mode, as well as the same 640 x 200, two-color mode. But the PCjr also has three other graphics modes that the PC doesn't: a 160 x 200, 16-color, medium-resolution mode; a 320 x 200, 16-color, high-resolution mode; and a 640 x 200, four-color, high-resolution mode.

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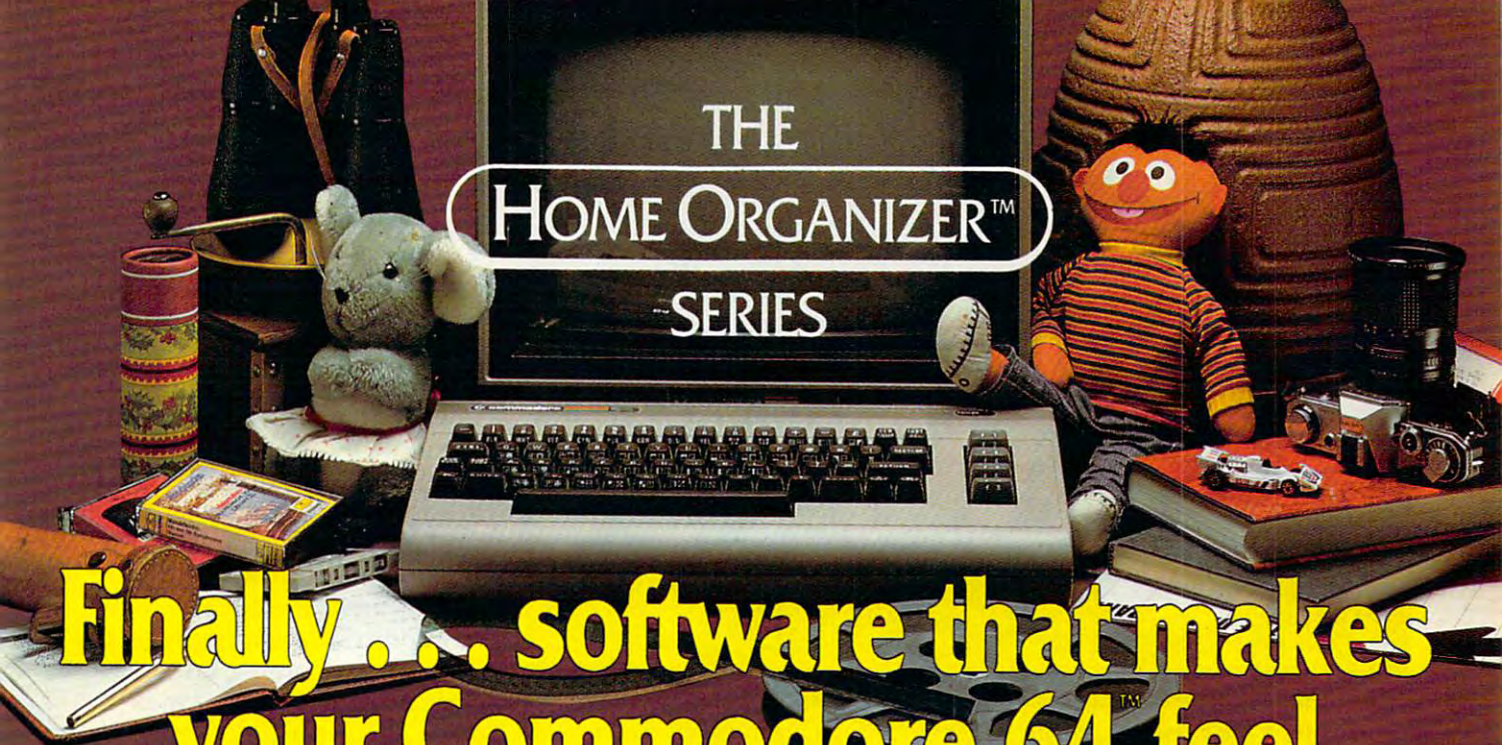

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A scene from the animated graphic adventure, Ring Quest, *which was created with* The Graphics Magician *by Penguin.*

at about a 600 x 500-pixel resolution and go up from there. Color choices and luminance levels can go into the millions. Three-dimensional perspectives and complex simulations of actual processes, such as flying an airplane, are among the complex—and costly—features of some mainframe and mini computers.

A Child's Garden Of Graphics

Two programs by Scarborough Systems, Inc., make use of the computer's ability to create dynamic graphic images in a manner easy enough for a child to accomplish.

Picturewriter, by Dr. George Brackett, is an educational drawing program for children from 4 to 14 years of age, which Scarborough markets for the Apple computers at $39.95 suggested retail price. Its origins, says Brackett, are in work he did teaching children about the Logo programming language. When he asked a little girl one day what she wanted to draw, she suggested a rainbow—not the easiest of images to produce via Logo.

"So I began to think about what kind of program I would like to have that would make it easy for children to draw a rainbow," he says. "And it was pretty clear that it had to have a pointing device, like a joystick, rather than a keyboard. I also felt it had to have fairly extensive editing capabilities."

As children use *Picturewriter*, they can learn about spatial and color relationships, the development of geometric patterns, and the basics of computer programming at the same time that they're creating colorful pictures. A selection of preprogrammed works allow the child to alter the designs and colors as well.

Patterns For Apple, Commodore, And IBM

Another program, which Scarborough demonstrated at the recent Softcon show, is *Patternmaker*, a drawing and pattern-creating program for children six years and older and for adults. The package is scheduled to be available in May for Apple computers and by August for Commodore 64 and IBM machines, at a suggested price of $39.95.

"Its educational value is that it gets children comfortable with symmetry, rotations, transformations, inversions, and so on," says Scarborough President Francis Pandolfi. "It makes it easy for them to use those concepts to make beautiful patterns. Symmetry is a very important concept in many areas of science, not to mention art. And the program's manual brings the child through all areas of art in which symmetry has been important."

As you'll quickly find out when studying what's available for microcomputer graphics, the products are coming fast and furious. Softron, Inc., for example, makes a *Home Decorator* program ($34.95 for Commodore 64; other versions planned soon) that teaches about colors, furniture layout, and decorating theory for your home and office. The package even lets you select carpeting, paint walls, and move furniture.

The Age Of Discovery

Other programs, like Access Software's *Spritemaster* ($34.95 for Commodore 64) and Avant-Garde's *StarSprite* series (for Apple computers), show you how to produce sprites for use in multicolor animation.

There are literally hundreds of other graphics programs currently available. And there are numerous books and magazines which will teach you how to create your own colorful graphics.

"I think more and more people are discovering the graphics capabilities of computers," says Mark Pelczarski. "In the last couple of years, we've learned how to make software more easily understood. And with computers like the Commodore and the Atari really hitting the mass market, a lot of people who never would have dreamed of having a computer five years ago are learning about all the capabilities." ©

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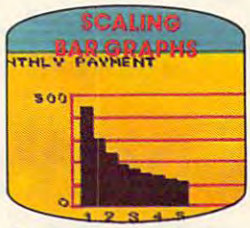

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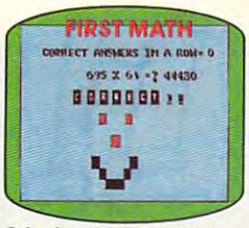

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Light Pens And Graphics Tablets:

New Ways To Communicate With Your Computer

Kathy Yakal, Editorial Assistant

You don't have to be an artist to use them. Or a three-year-old. Or a professional architect, engineer, or fabric designer. Light pens and graphics tablets, along with the software that drives them, are making computing easier for young children and adding new dimensions in graphics for everyone.

Whether or not we admit it, we've probably all responded to our computer's SYNTAX ERROR message by typing "Syntax error? I typed it right!"

We may have jabbed a finger at the monitor to show our word processing program precisely which block of text we wanted moved and where we wanted it placed. Or maybe drawn a picture of a spaceship and held it up to the screen to illustrate exactly what we wanted displayed there after typing in a machine language game for the better part of a weekend.

The computer never seems to understand.

Interacting with a microcomputer can sometimes prove exasperating. You still have to talk to a computer in a language it understands. They don't yet respond to written or spoken English.

Animation Station, a graphics tablet designed by Suncom, offers a number of colors and textures for drawings like this.

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Now we've put everything we've learned from five generations of school children into the most innovative family of educational software available today. Scholastic Wizware.™

Our experience makes Wizware different from all other educational software. It turns learning subjects like geography, writing and spelling into exciting adventures for your children. And because every Wizware game is *interactive,* kids become deeply involved in what they're learning.

What's more, our experience has taught us the importance of teaching things most other educational software leaves out. Like teamwork, imagination, critical thinking and problem solving. You'll find them all in Wizware.

But by far the most important result of our experience is that your children will thoroughly enjoy learning with Wizware.

There are now Wizware programs for teaching everything from creative writing to computer programming. Here are a few of the ways we bring learning into the Computer Age.

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It's the most ingenious way ever devised for teaching spelling and improving reading skills. Deep beneath the sea lie giant words covered by a strange seaweed called lettermoss. Kids must face ferocious sharks and pesky flippernippers to remove the lettermoss and decipher the words.

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Based on the classic game of Capture-the-Flag, this is the most sophisticated and fun strategy game for kids available today. Not only do players learn how to devise complex strategies, they also learn how to work together to solve difficult problems.

Scholastic Wizware. Our experience makes all the difference.

Look for Wizware at your local computer store. Or contact Scholastic Inc., 730 Broadway, New York, NY 10003, 212-505-3000.

Scholastic™ Wizware

Spelldiver, Agent U.S.A. and Bannercatch designed and developed by Tom Snyder Productions, Inc. Story Tree designed and developed by George Brackett.

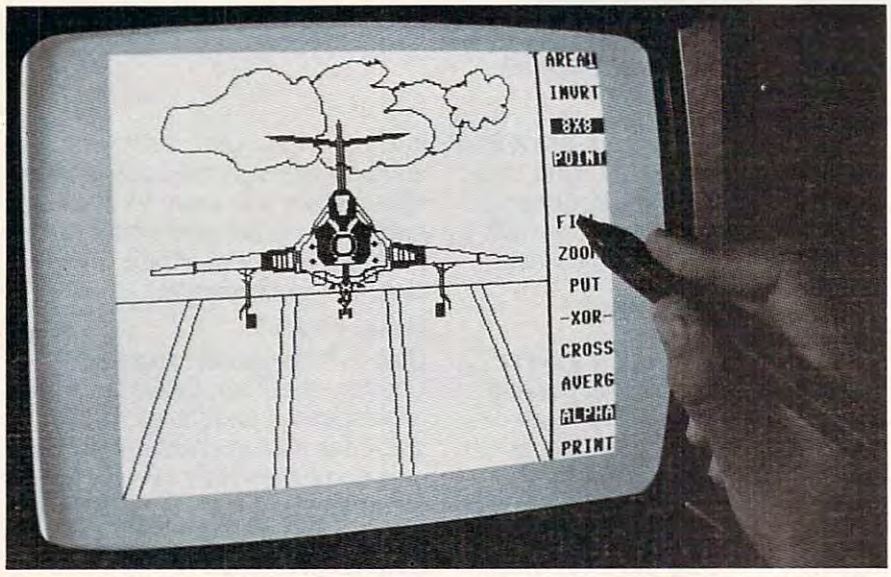
Spelldiver, Agent U.S.A. and Bannercatch available for Atari 800/1200/XL. Commodore, Apple and IBM versions available soon. Story Tree available for Apple.

A Pointer To The Future

But graphics tablets and light pens bring us a step closer to easy communication by allowing information entry to bypass the keyboard. Like mice and joysticks and the keyboard itself, light pens and graphics tablets are input devices, peripherals through which you interact with your computer.

These pens and tablets do basically two things: draw and point. You can use them to select user options in menu-driven software and to create graphics.

A light pen is like a magic wand. It resembles a regular pen in size and shape, and has a cord that plugs into the computer. When you point it at the screen and activate it (either by pressing a switch on the pen itself or a key on the keyboard), it responds to whatever software you're running.



This picture was created by using the draw and fill features of Flexidraw (Inkwell Systems).

Touch-Sensitive Input

A graphics tablet looks a little like an Etch-A-Sketch, though each manufacturer's is a little different. Instead of pointing at the computer screen, you touch the surface of the tablet with your finger or a stylus.

Though light pens and graphics tablets are fairly new on the home computer scene, they've been used as design tools with larger computers for years. The technology is not brand-new.

Where's The Software?

The Edumate Light Pen, from Futurehouse, Inc., comes with introductory software that demonstrates the pen's features. If that's where it ended, the skeptics' claims that these tools are just gimmicks might be true.

But Futurehouse, along with other light pen manufacturers and software publishers, is beginning to design software that can be used with a light pen. "The potential applications are enormous," says Byrne Elliot, president of Inkwell Systems, another pen manufacturer.

"Not just being able to point at a menu option you might want. They'd be great with even things like spreadsheets and word processors. Instead of learning a lot of control commands that can be very frustrating, you can move text and figures around quickly and easily."

Doing What Comes Naturally

If you've ever tried using spray paint to letter a sign or illustrate a big banner, you have an idea of what drawing with a light pen feels like. The stream of color sometimes comes out faster than you can control it.

Drawing on a graphics tablet is not quite so novel a technique to master. It's like drawing on a piece of paper with a pencil, or drawing pictures on a steamy windowpane with your finger.

Using these pens or tablets is, however, intuitive, to a degree. "Among the first skills that everyone learns when they're young is drawing or writing," says Howard Leventhal, president of Suncom, manufacturers of Animation Station. "There are no other input devices that let someone do that in such a friendly way."

This may be why these new input devices are being so highly touted as educational tools. "There's a strong motivation for people to buy for educational purposes," says Leventhal.

Like Being A Kid Again

It's not hard to see why graphics tablets and light pens can open the world of computing for children. These peripherals don't require the hand-eye coordination or knowledge of letters and numbers that a keyboard does.

"Light pens are superb for education. They really expedite the learning process," says Elliot. "They're a good way to get around the intimidation of the keyboard. To respond to software using a keyboard, you have to type in a series of letters and numbers, then return. The light pen is generally 10–15 times faster than that."

Bob Ranson, president of Chalkboard, agrees. "Graphics tablets allow the preliterate child to use a computer without having to deal with a keyboard," he says. "There are lots of two- and

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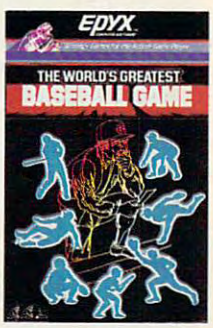

EPYX
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Strategy Games for the Action-Game Player

The Inside Story:

How Graphics Tablets And Light Pens Work

Ottis R. Cowper, Technical Editor

Many programmers find graphics tablets and light pens among the most mysterious of peripherals, but the principles of both are really fairly simple.

The graphics tablet is similar in operation to the more familiar game controller paddles. A paddle consists of a *variable resistor*, a device which can vary the amount of electric current passing through it. For example, rotating the paddle all the way clockwise would allow full current to flow; turning it completely counterclockwise would cut off all current. A computer which accepts paddles must have circuitry which can read the varying current and provide a numeric reading which is proportional to the current, and hence to the position of the paddle knob. This is usually zero when the paddle is rotated all the way in one direction, 255 when the paddle is turned completely in the opposite direction. Joysticks for the Apple, Color Computer, and IBM function in a similar manner, with one resistor on the horizontal axis and another on the vertical.

Graphics Tablet Positions

In a graphics tablet, thin sheets of a special film are used in place of the variable resistors. When you press down on the film, a current flows, with the amount of resistance depending on where on the film you press. For example, if the film is set up to register horizontally from left to right, pressing on the left edge is equivalent to turning the paddle for minimum resistance, while pressing on the right edge is like turning the paddle for maximum resistance.

The working area of the tablet consists of two sheets of this film, one arranged to register horizontally and one arranged for vertical measurements. The same circuitry used to read paddles (or Apple and IBM joysticks) can be used to read the tablet—the computer interprets each of the sheets as a paddle. What would normally be one paddle reading is the horizontal position of the point on the pad being pressed, while the other reading gives the vertical location.

One significance of graphics tablet design is that you should be able to substitute paddles (or the joystick for Apple or IBM) in programs which call for the tablet. Conversely, you might experiment with using the tablet in programs which call for paddles, although the tablet isn't likely to replace paddles for playing *Pong* or *Breakout*.

Holes Of Light

To understand how a light pen works, you must first understand how screen images are created. The chief element of any video display device, television or monitor, is a cathode ray tube (CRT), a sealed glass funnel with an electron "gun" in the narrow end and a specially coated screen across the wide end. The gun shoots electrons at the screen, leaving tiny bullet holes of light where the electrons strike the dark screen.

The shots are not random; they are carefully targeted by powerful electromagnets, the big coils of wire around the throat of the CRT if you've ever looked inside a TV or monitor. Starting at the upper left corner of the screen, the gun is swept across at a constant speed. Shots are fired at the spots that need to be lit up to form part of an image. When the gun has swept all the way across to the right edge, firing is halted while it is aimed at the left edge again, slightly lower than on the first pass. Thus, the spray of

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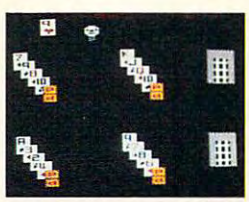

So you think there's no puzzle too tough for you and no video game you can't beat. Welcome to PuzzlePanic—The computer game that's sure to have you crying "uncle." Designed by Ken Uston, blackjack and arcade game player extraordinaire, PuzzlePanic takes you through 49 increasingly difficult screens based on seven different games of action, logic, strategy and challenge. Compared to PuzzlePanic, Rubik's Cube™ is child's play. So put on your thinking hat, grab your joystick, get ready for the contest of your life, and let Ken Uston drive you crazy.

One player; joystick controlled.

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shots forms rows across the screen. Several rows are required to form a character. For example, alphanumeric characters for many computers are eight lines tall. To see this, type some spaces in inverse video. If you look closely, you'll see that the reverse space character is a stack of thin, closely spaced lines rather than a solid block.

The drawing process must be repeated over and over because the bullet holes of light glow for only a fraction of a second before fading away. In most computers, the screen is redrawn every 1/60 second. If you had a very fast stopwatch that you started when the gun began firing at the upper left corner, you could read the elapsed time on the watch when the spray of electrons reached any particular point on the screen and, from this reading, determine how far you were from the starting position at the upper left.

This is the secret of light pen operation. In its simplest form, the pen is a plastic cylinder housing a phototransistor, a light-activated switch. (The phototransistor is what you see behind the lens at the end of the pen.) When the pen is held to the screen, the beam of electrons which light up the screen triggers the phototransistor, causing it to signal the computer that the beam has been detected. The computer must then check its video stopwatch to see how much time has elapsed since it started drawing the screen. It can then compute where on the screen the pen is being held.

If the screen is being drawn many times a second, the pen will detect the spray of electrons each time the screen is drawn. Since the spots of light are so small, the pen may be triggered at a slightly different point each time. The readings you get from simple pens can thus be somewhat unsteady, especially for the horizontal location of the pen. Programs written for simple pens usually require that you touch a key on the keyboard to tell the computer when you want the reading to be accepted.

More sophisticated (and hence more expensive) pens have additional circuitry which allows them to latch after triggering so that the readings do not change every time the screen is drawn. This means the readings will be much more stable, and that you will not need to use the keyboard. A switch in the pen tells it when to hold the current reading. In some, the switch is built into the nose of the pen so that you latch the reading by simply pressing the pen against the screen.

If you want to use a light pen or a graphics tablet with your own programs, keep in mind that they won't draw on the screen for you. Like a joystick or a set of paddles, the pen or pad provides only numeric readings. It's up to you to write the software which will decipher the input from the pen or tablet and then accomplish something in your program.

three-year-olds using them."

Beyond that, graphics tablets and light pens can attract adults as well. "People seem to enjoy being able to sit down and draw," says Ranson. "Graphics tablets meet a fundamental human need—the need to express oneself."

Light Pen Elbow?

The naysayers to these new communication tools complain about physical inconveniences. Your arm can get tired from holding the light pen. The cord can get tangled and caught under things. It can be confusing to look back and forth from the tablet to the screen.

"There is a spatial problem when you're writing or drawing on the screen," says Ranson. "But I don't think it's major." Elliot argues that "Once familiarity sets in, you don't look at the tablet."

A more serious accusation is that they're kids' stuff, that you can't do more than draw pictures of trees and bunnies and houses.

"Granted, they're great for kids," says Byrne Elliot. "I know a lot of kids use Flexidraw for things like making valentines. But I also know of women who use it to design wallpaper and make dress patterns, and professionals who draw up plans for the interiors and exteriors of buildings with it. Graphics is becoming a lot more important to different kinds of people."

Input For The Future

Will a new input device come along that will make pens and tablets or, for that matter, keyboards obsolete? "Voice recognition is not as simple as some people think," says Chalkboard's Ranson. "Say you're a writer and want to sit down and dictate your work. I defy you to read everything you write all day. You'll lose your voice.

"Until we've reached the ultimate, there will be a lot more people exploring how to get into the computer other than QWERTY. We've been existing with joysticks and keyboards for a long time now. There will always be room for more than one input device." ©

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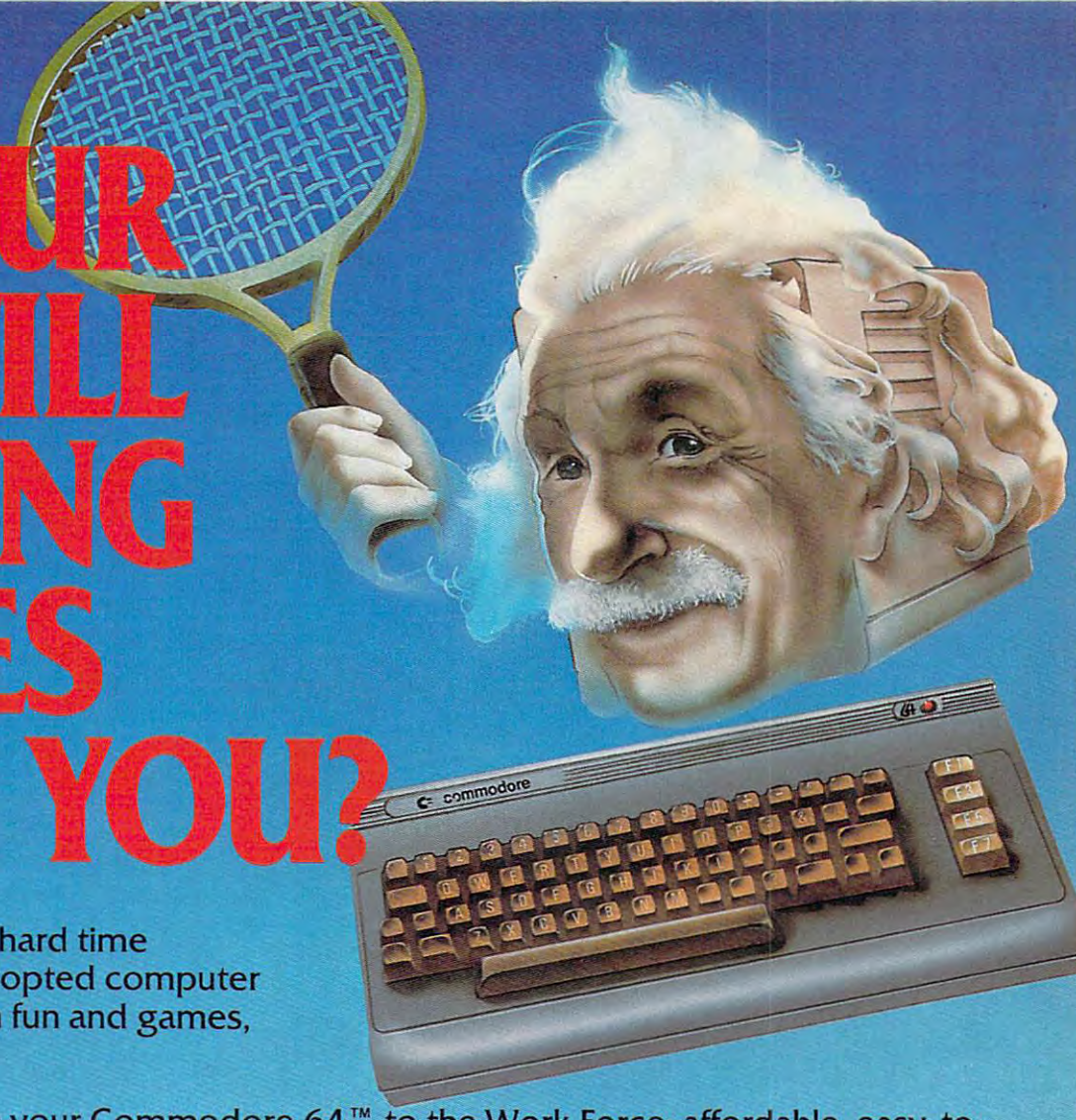

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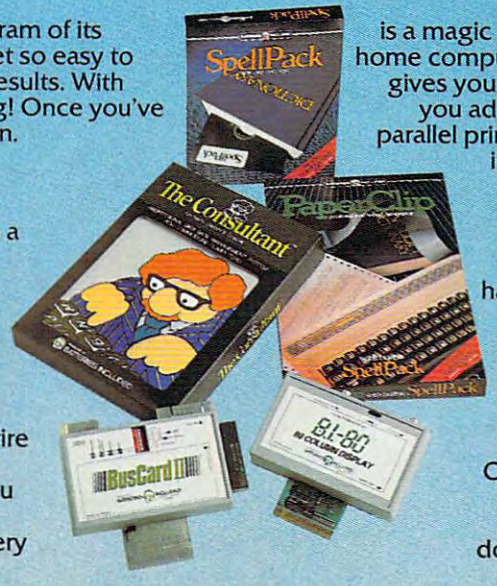

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A Portrait Of The Computer Artist

Realtime Dreaming

With Mike Newman

Selby Bateman
Assistant Editor, Features

"Realtime dreaming" is Mike Newman's description of his computer art. He spoke with us recently about his development as a computer artist and the future of personal computer art.

Newman is quickly becoming one of the recognized masters of computer art. His work has been exhibited worldwide. Many of his computer paintings were featured in Joseph Deken's recent book Computer Images: State of the Art.

Newman, 29, is supervisor of Creative Services for the DICOMED Corporation of Minneapolis, an international leader in precision computer graphics. What started four years ago as a part-time experiment with DICOMED has since blossomed into a full-time commitment to computer art. His paintings were created on a $130,000 state-of-the-art computer design station.

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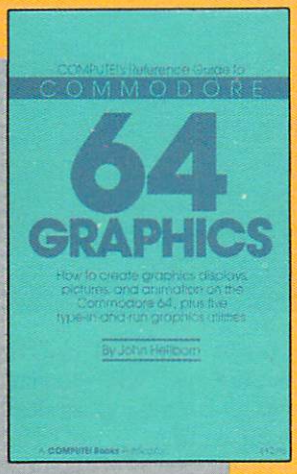

COMPUTE!'s Reference Guide To Commodore 64 Graphics

A complete tutorial on Commodore 64 graphics. Noted Commodore author John Heilborn explains how to program sprites, multicolored screens, animation, custom characters, and more. Beginners will like the step-by-step instructions and clear example programs. Advanced programmers can build up their tool kit with the character editors, sprite editors, screen design program, and other useful utilities.

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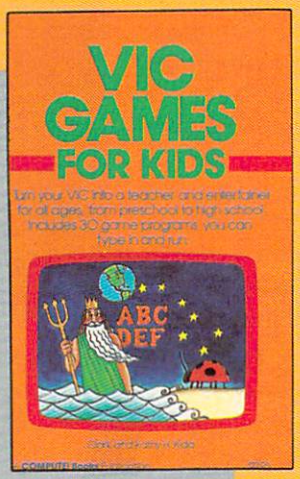

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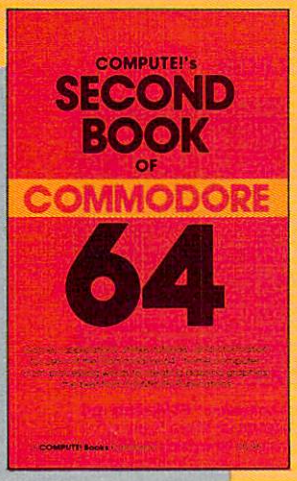

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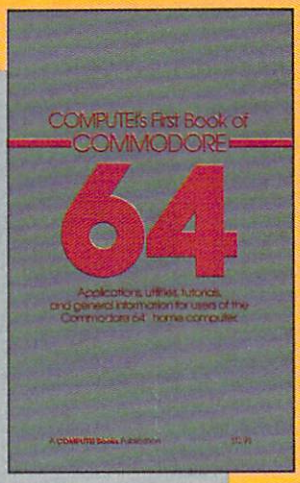

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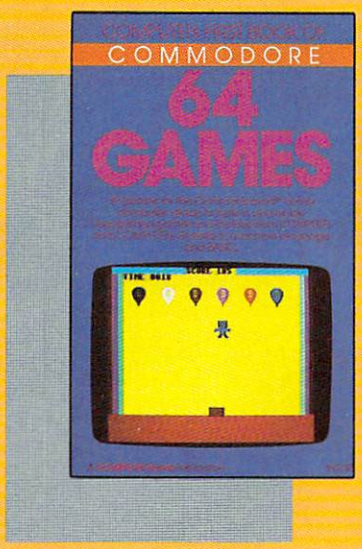

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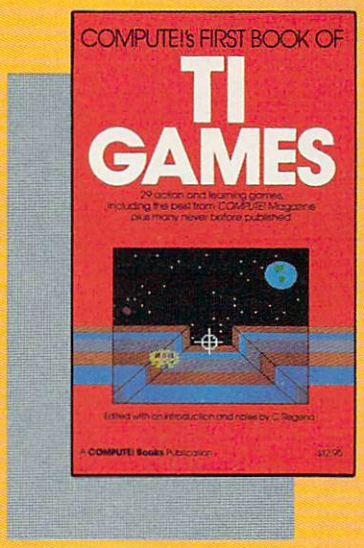

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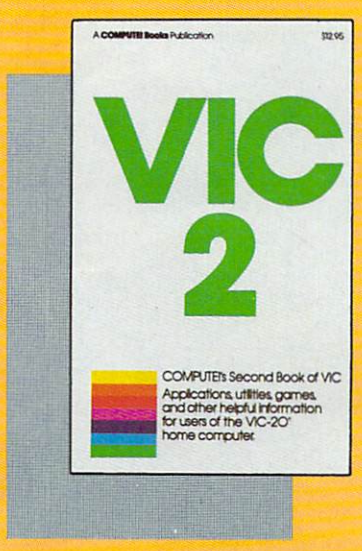

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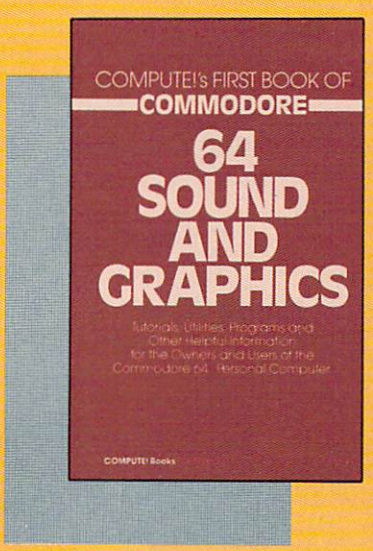

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Clear explanations of the 64's sound and graphics capabilities. Includes many tutorials and example programs: "MusicMaster," a complete music synthesizer; "High-Resolution Sketchpad," an all-machine-language program for making computer art; and "Ultrafont Character Editor," one of the best character editors available. The appendices feature useful reference charts and conversion tables.

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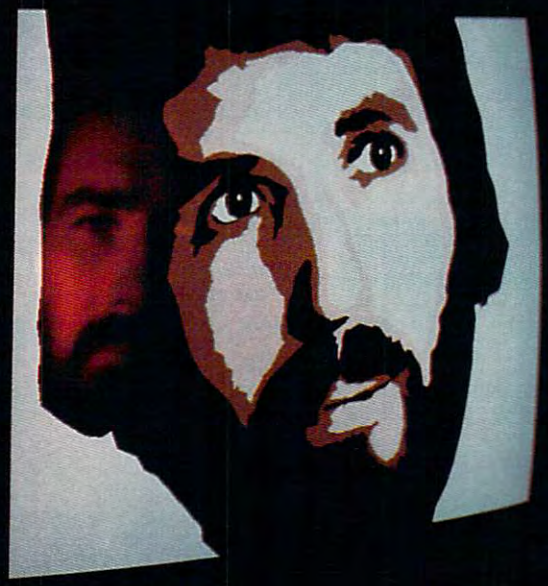

picking these icons, or pictograms. For instance, if you want to examine color and work with the color menu, you'd go to a magnifying glass icon that's perched over a picture of a rainbow. And that means to examine color.

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As an artist, you're generally intensely working on something and the last thing in the world you want to do is to remember to save this or that.

COMPUTE!: What's the attraction of computer art?

Newman: The first thing that attracted me was that it took only about ten minutes to understand that this was just another tool, and that you could put a computer and art together.

Computer artist Mike Newman inspects his own digitized image.

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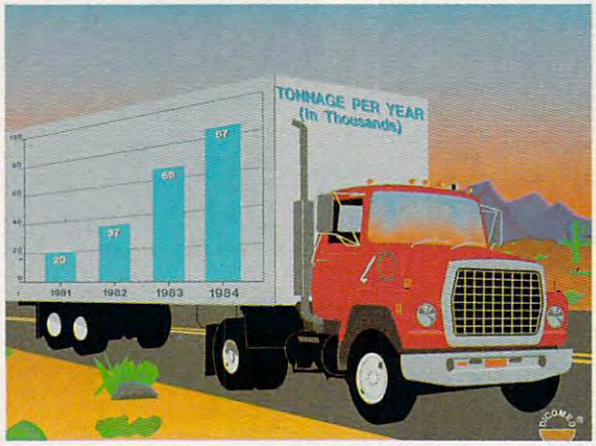
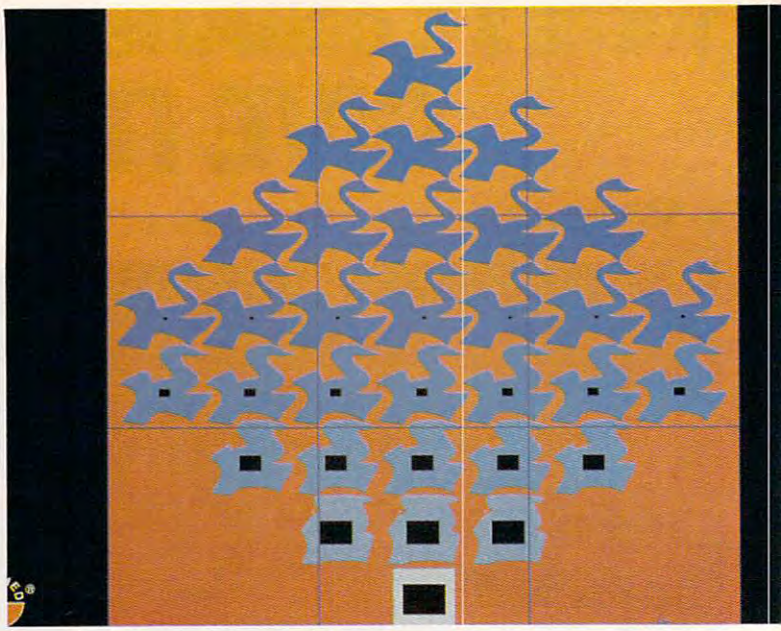
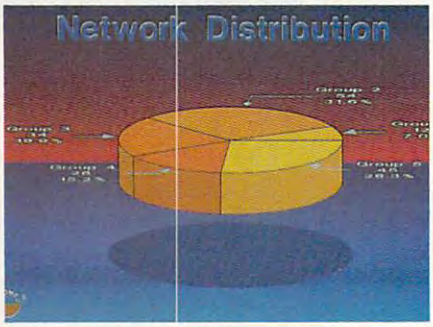
HYTEC SYSTEMS







Newman created the commercial graphics bar chart and surrounding artwork (far left) by using an Apple IIe and the DICOMED D38 and Imaginator design stations. "Geese," (top) an example of computer interpolation in which Escher-style geese and a photographic slide are transformed. The demands of commercial graphics (bottom) have helped to stretch the limits of computer art.

Some people think of the stereotype of a mathematically oriented artist, of which there are very, very few. There are some who do write their own programs and do artwork, but they are in a completely different ballpark. They are artists and scientists at the same time.

I figured if I could do this, then anybody could. It also attracted me that this was not a threat, because the computer wasn't going to do anything without me. It wasn't going to do anything terrific without somebody who knew about art.

COMPUTE!: What made you reach that conclusion?

Newman: When I saw the work that some of the programmers were doing. They weren't doing terrific work [artistically], although one of the programmers does really great graphics because he also likes art.

It became clear very quickly what the benefits were: I could make a piece of art and experiment with it, begin to do things with it, and *see* that instead of just think about it. In conventional graphics you say "I wonder what this would look like if it were smaller, or turned a little bit?" Whatever the changes—color, position, rotation, duplication—instead of thinking about it, with the computer you can try it. You just do it.

It allows the artist to do real-time dreaming, giving you a much stronger sense of design. It's the same thing with color. The best thing I ever did was to take up watercolors because I had to understand what colors were doing when they were on top of one another, when they were mixed together. And the computer just enhances all that.

Now I blend colors in the same way using the computer, but I can see the artwork. After I have the artwork done, I can begin to play with colors and with shapes. It's like working on a painting and the paint never dries. You can still work with it, but it's more permanent than paint because it's digital on a magnetic medium. So, the permanency is neat, but the flexibility is just remarkable.

COMPUTE!: How do you answer critics who say that computer art is not a genuine art form?

Newman: I think that's a real misconception. People get the opinion that computer art is something done by a computer. In fact I'll read that occasionally: "This art was made by computer." Well, that whole concept is wrong. This art was made by a human *using* a computer. You don't say "This photograph was made by a camera." You usually give credit to the photographer, and it's the same thing with a computer. Not only that, but the person who wrote the program for the computer did a lot of creative programming. There's creativity there, too.

If you look at the wide variety of computer artwork, you

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can see that it's not just taking a picture and doing image processing, like distorting a picture. It's starting from nothing, a blank screen. Instead of a piece of paper, you have a video screen. And you work with shapes and colors and light and textures and all of the conventional things that we know about art. And you put these things together.

It has human emotional feelings built-in, just as every art form does. That's what makes it art. My work looks different from somebody else's work. That's because emotions are involved, and that's what computers don't have. Without the artist, it just sits there.

COMPUTE!: What influences have contributed to your computer artwork?

Newman: I take in as much information from as many sources as possible. I like to think that my visual artwork is influenced by music as much as it is by other artists. I don't draw boundaries between dance and literary art and visual art. To me, it's all-encompassing. So I may have a visual depiction of a song, or music may have a certain effect on me that will give me a different sense of color for a particular design.

I am, however, influenced by other artists. I'd say the first computer artist—who was a computer artist without a computer—was M.C. Escher. This gets back to saying that computer art is not necessarily art made by computers. It's art made by humans. If you look at Escher's work, it was made by the "computer" that he carried around with him. To me, he is the first computer artist. The difference is that he didn't have a computer.

Also, I'm very influenced by design technology—the revolutionary. Buckminster Fuller, although he wasn't an artist in the conventional sense, had a lot of influence on my work. And a host of a thousand musicians and other artists. [Laughs] In an unconscious way, I'm affected by everything that I see—Andy Warhol, James Wyeth—I enjoy everything.

COMPUTE!: What advice would you give those who want to get started in computer art?

Newman: The first thing you want to do to be a computer artist is to be a good artist. You can learn the computer part, but it's hard to develop artistically. Whether you do it in art school or on your own, develop the artistic talent first.

I was not willing to become only a fine artist, because I was afraid that I would wind up being a starving artist, and that's not what I wanted in life. Some

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Newman's "Metamorphosis" is another form of computer interpolation. Caterpillar becomes butterfly.

people feel so committed to the work they're doing that they'll take that. Those are conventional decisions you make about art, and they need to be made.

There are some schools in the United States and Canada now that are beginning to have computer graphics programs. They will give you a good overview of the types of systems that are out there, and also give hands-on experience on the equipment so that they know what computer graphics is all about.

COMPUTE!: What are the limitations in computer art?

Newman: There's no medium that does everything. The more painterly aspects of art are hard to simulate. In order to get the high resolution we have, we're based on what we call graphic primitive shapes. You tell the computer you want to make a line, and it knows you want to make a line. You tell it you want to make a perfectly round shape, and it expects you to tell it if you want a full round shape, how big it's going to be, and where it's going to start and stop.

There are other systems that work on a property of more painterly aspects, and these systems are called paint systems. They're more like what you see on personal computers these days. That is, you say you want to make a brush that is *this* fat and you want it to be *this* color, for instance.

The only problem is that you're just concerned with which little lights [pixels] are on and off, and it's hard to translate that into high resolution. You can't just take a display, even if it's a high-resolution display, and, say, double it and expect it to look better.

I do feel, however, that at some point this won't be a problem. I still consider this medium to be in its very beginning stages. We're just coming out of the basement now. All I know is that as an artist who has access to computers, I have a lot to look forward to. And I expect many great things to occur. ©

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3-D Plotting

Tim R. Colvin

How many times have you seen beautiful three-dimensional graphics in the ads for video monitors and printers? Now, with these easy-to-use programs, you can create three-dimensional images of your own. Versions are included for the Commodore 64, Atari, Apple, IBM PC and PCjr.

These two programs, "Rectan" and "Spheri," will plot three-dimensional figures using information which you provide.

You don't really need to delve into the mathematics which produce the images. You can just fiddle with the examples given to produce many effective displays. Let's look at some graphic examples. First type in each program and SAVE it to tape or disk.

Then LOAD Rectan. To have Rectan draw a hyperbolic paraboloid, or "saddle function" (it resembles a riding saddle), replace line 790 with:

```
790 Z=X*X/4-Y*Y/9
```

and give the following inputs:

-2,2,-3,3,25,25,45

For another interesting design, use:

```
790 Z=-1/(X*X+Y*Y+.5)
```

and give the following inputs:

-1,1,-1,1,20,20,45

The program will print SCREEN SCALING IN PROGRESS. The program is scaling the image to fit on the screen, which can require a lot of time. The rule is: The more complicated the description of the surface, the longer this step takes.

The Plotting Begins

When the previous step is completed, the screen will clear and turn cyan. The high-resolution plotting now begins. When the plot is finished, the color of the top left corner of the screen will change color. The program is locked in a loop so you can look at your creation. When you have finished looking at the display hold down RUN/STOP and hit RESTORE.

A Spheri Demonstration

To see a torus (doughnut shape), type NEW to clear memory. Then LOAD Spheri, replace lines 820–840 with:

```
820 XT=(4+C1)*C2
830 YT=(4+C1)*S2
840 ZT=S1
```

and give the following inputs:

0,360,0,360,25,25,45

For a sphere, use:

```
820 XT=C1*C2
830 YT=C1*S2
840 ZT=S1
```

and give the following inputs:

0,360,0,180,15,15,45

An Illusion Of Depth

These programs use *rectangular* and *spherical coordinate systems* to create an illusion of depth in the screen image. You're probably familiar with the X-Y coordinate system used to specify the location of a point on a flat surface. For example, in Figure 1 the point is located five units over on the X axis

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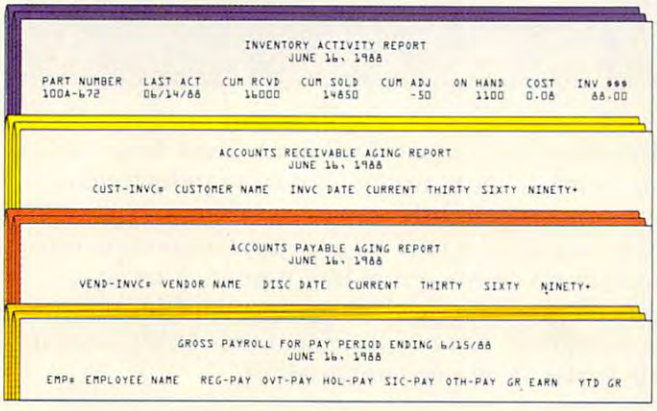

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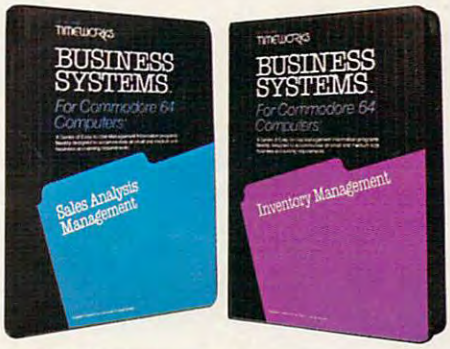

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and six units up on the Y axis. The point is said to be at location 5,6.

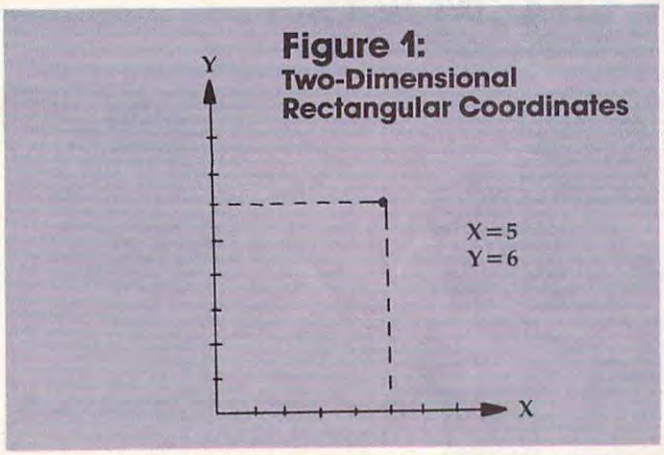

Figure 1:
Two-Dimensional Rectangular Coordinates

This simple system works well for specifying the location of a point in a two-dimensional design on a flat surface, but for 3-D plotting you need a third coordinate.

Several coordinate systems are commonly used to plot three-dimensional surfaces. The particular coordinate system you should use depends on the shape you want to draw. Any system can be used, but if you choose the right system, you can simplify your calculations considerably.

A Simple Solution

The easiest system to understand is just an extension of the rectangular (X-Y) coordinates you are already familiar with. All you need to add is a third coordinate (Z) for the third dimension. For example, the point in Figure 2, below, is located five units out on the X axis, six units over on the Y axis, and four units up on the Z axis. The point is said to be at location 5,6,4.

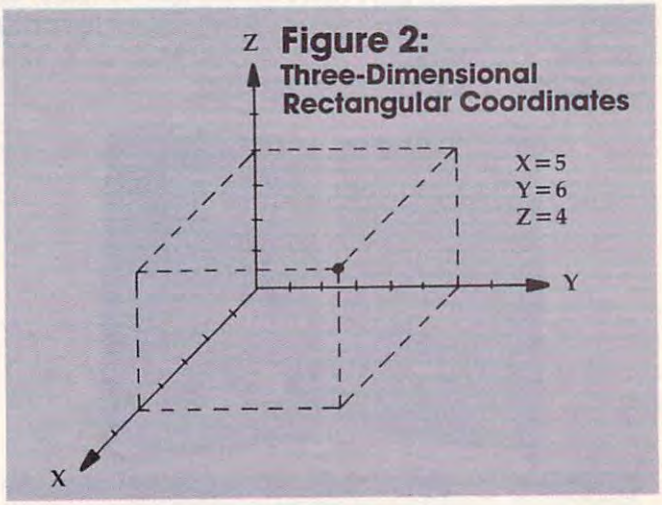

Figure 2:
Three-Dimensional Rectangular Coordinates

A System For The Stars

On the other hand, if the design you wish to draw is roughly the shape of a sphere, you should use *spherical coordinates*. In that system, a point is described by two angles and a distance from the origin. For example, astronomers use spherical coordinates to describe the position of a star relative to the earth. The *azimuthal angle* of the star, designated by the Greek letter theta (θ), is the direction you must face to view the star. If north is taken to be zero degrees, then a star that lies due east has an azimuthal angle of 90 degrees. The *elevation angle*, designated by the Greek letter phi (ϕ), specifies how much you must tilt your head back to look directly at the star. If the horizon is taken to be zero degrees, a star that is directly overhead has an elevation angle of 90 degrees. Finally, the *radial distance*, designated by the letter r, is the distance between the earth and the star.

Using spherical coordinates, the point shown in Figure 2 has an azimuthal angle of 50.2 degrees, an elevation angle of 33.7 degrees, and a radial distance of 8.77 units, as shown in Figure 3.

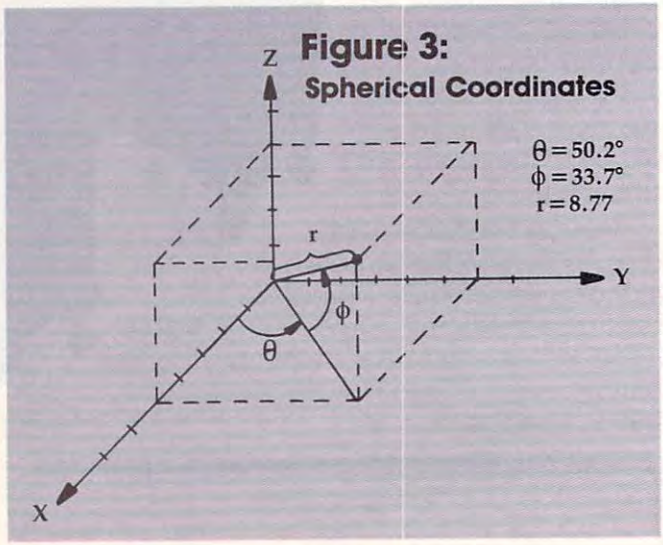

Figure 3:
Spherical Coordinates

Despite the fine graphics they produce, these programs have a couple of limitations. Screen pixels are taller than they are wide, which makes spheres look slightly less round than they should. Also, we see the surface as if it were transparent and contour lines were drawn on it. A more advanced program (such as those available commercially) would remove lines that we couldn't see if the surface were not transparent.

Program 1: Rectan—64 Version

Refer to the "Automatic Proofreader" article before typing this program in.

```
100 REM * THREE-DIMENSIONAL SURFACES *
                                    :rem 253
110 REM * IN RECTANGULAR COORDINATES *
                                    :rem 212
130 PRINT CHR$(147)                  :rem 15
140 PRINT "LOWER X LIMIT ";:INPUT A1
                                    :rem 61
150 PRINT "UPPER X LIMIT ";:INPUT B1
                                    :rem 66
160 PRINT "LOWER Y LIMIT ";:INPUT A2
                                    :rem 65
```

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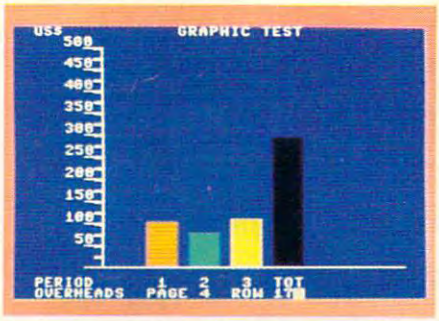

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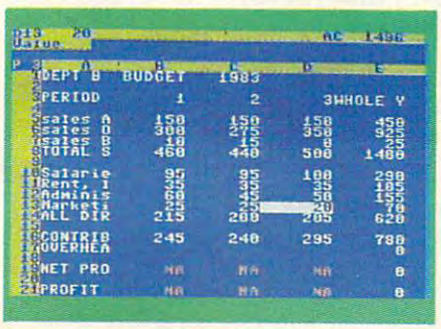

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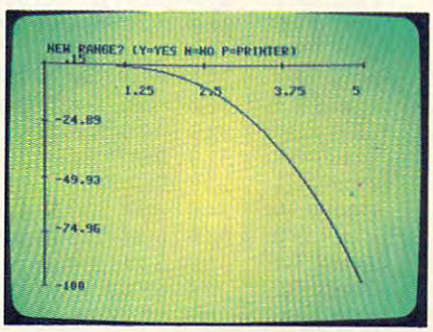

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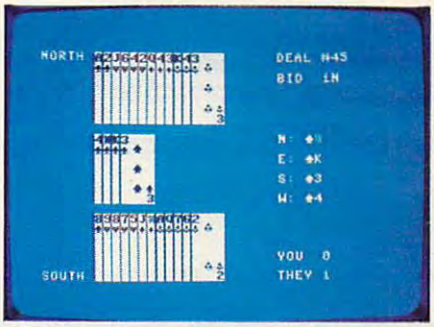

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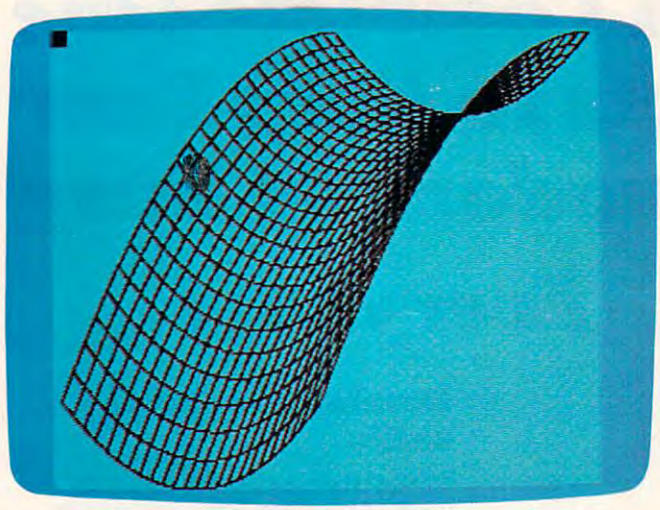

The hyperbolic paraboloid resembles a saddle or a trough curving downward.

```
170 PRINT "UPPER Y LIMIT ";:INPUT B2
                                    :rem 70
180 PRINT "SLICES IN X ";:INPUT N:rem 111
190 PRINT "SLICES IN Y ";:INPUT M:rem 112
200 PRINT "OBSERVATION ANGLE ";:INPUT Q
                                   :rem 108
210 PRINT "SCREEN SCALING IN PROGRESS"
                                    :rem 49
220 Q=Q*.0174532925                :rem 209
230 CS=COS(Q)                      :rem 239
240 SI=SIN(Q)                      :rem 251
250 H1=(B1-A1)/319:H2=(B2-A2)/(N-1)
                                   :rem 254
260 H3=(B1-A1)/(M-1):H4=(B2-A2)/319:rem 2
270 M1=99999999:M2=M1:N1=-M1:N2=N1
                                   :rem 167
280 FOR Y=A2 TO B2 STEP H2          :rem 87
290 FOR X=A1 TO B1 STEP H1          :rem 84
300 GOSUB 610                      :rem 170
310 NEXT X                          :rem 43
320 NEXT Y                          :rem 45
330 FOR X=A1 TO B1 STEP H3          :rem 81
340 FOR Y=A2 TO B2 STEP H4          :rem 86
350 GOSUB 610                      :rem 175
360 NEXT Y                          :rem 49
370 NEXT X                          :rem 49
380 D=8192:POKE 53272,PEEK(53272)OR8
                                   :rem 218
390 POKE 53265,PEEK(53265)OR32     :rem 125
400 FOR I=D TO D+7999:POKE I,0:NEXT I
                                     :rem 9
410 FOR I=1024 TO 2023:POKE I,3:NEXT I
                                     :rem 6
420 T1=(N1-M1)/2                    :rem 52
430 T2=(N2-M2)/2                    :rem 56
440 W=T1/T2                        :rem 102
450 IF W<1.60606061 THEN 480       :rem 126
460 XS=159:ZS=159/W                :rem 106
470 GOTO 490                       :rem 113
480 XS=99*W:ZS=99                   :rem 13
490 FOR Y=A2 TO B2 STEP H2          :rem 90
500 FOR X=A1 TO B1 STEP H1          :rem 78
510 GOSUB 690                      :rem 181
520 NEXT X                          :rem 46
530 NEXT Y                          :rem 48
540 FOR X=A1 TO B1 STEP H3          :rem 84
550 FOR Y=A2 TO B2 STEP H4          :rem 89
560 GOSUB 690                      :rem 186
570 NEXT Y                          :rem 52
580 NEXT X                          :rem 52
590 POKE 1024,16                    :rem 39
600 GOTO 600                       :rem 101
610 GOSUB 790                      :rem 183
620 XT=X-Y*CS                       :rem 31
630 ZT=Z-Y*SI                       :rem 42
640 IF XT>N1 THEN N1=XT             :rem 41
650 IF XT<M1 THEN M1=XT             :rem 38
660 IF ZT>N2 THEN N2=ZT             :rem 49
670 IF ZT<M2 THEN M2=ZT             :rem 46
680 RETURN                         :rem 126
690 GOSUB 790                      :rem 191
700 XT=160+INT(XS*(X-Y*CS-N1+T1)/T1)
                                    :rem 82
710 ZT=100-INT(ZS*(Z-Y*SI-N2+T2)/T2)
                                    :rem 94
720 RO=INT(ZT/8)                   :rem 200
730 CH=INT(XT/8)                   :rem 177
740 LN=(ZT)AND7                    :rem 123
750 BI=7-((XT)AND7)                 :rem 32
760 BY=D+320*RO++8*CH+LN            :rem 76
770 POKE BY,PEEK(BY)OR(2↑BI)       :rem 178
780 RETURN                         :rem 127
790 Z=X*X/4-Y*Y/9                  :rem 229
800 RETURN                         :rem 120
```

Program 2: Spheri—64 Version

Refer to the "Automatic Proofreader" article before typing this program in.

```
100 REM * THREE-DIMENSIONAL SURFACES *
                                   :rem 253
110 REM *{2 SPACES}IN SPHERICAL COORDINAT
    ES{2 SPACES}*                   :rem 55
130 PRINT CHR$(147)                 :rem 15
140 PRINT "LOWER THETA LIMIT ";:INPUT A1
                                    :rem 91
150 PRINT "UPPER THETA LIMIT ";:INPUT B1
                                    :rem 96
160 PRINT "LOWER PHI LIMIT ";:INPUT A2
                                   :rem 201
170 PRINT "UPPER PHI LIMIT ";:INPUT B2
                                   :rem 206
180 PRINT "SLICES IN THETA ";:INPUT N
                                   :rem 141
190 PRINT "SLICES IN PHI ";:INPUT M
                                   :rem 248
200 PRINT "OBSERVATION ANGLE ";:INPUT Q
                                   :rem 108
210 PRINT "SCREEN SCALING IN PROGRESS"
                                    :rem 49
220 U=.0174532925                   :rem 90
230 Q=Q*U                          :rem 243
240 CS=COS(Q)                      :rem 240
250 SI=SIN(Q)                      :rem 252
260 H1=(B1-A1)/319:H2=(B2-A2)/(N-1)
                                   :rem 255
270 H3=(B1-A1)/(M-1):H4=(B2-A2)/319:rem 3
280 M1=99999999:M2=M1:N1=-M1:N2=N1
                                   :rem 168
290 FOR Y=A2 TO B2 STEP H2          :rem 88
300 FOR X=A1 TO B1 STEP H1          :rem 76
310 GOSUB 620                      :rem 172
320 NEXT X                          :rem 44
330 NEXT Y                          :rem 46
340 FOR X=A1 TO B1 STEP H3          :rem 82
350 FOR Y=A2 TO B2 STEP H4          :rem 87
360 GOSUB 620                      :rem 177
370 NEXT Y                          :rem 50
380 NEXT X                          :rem 50
```

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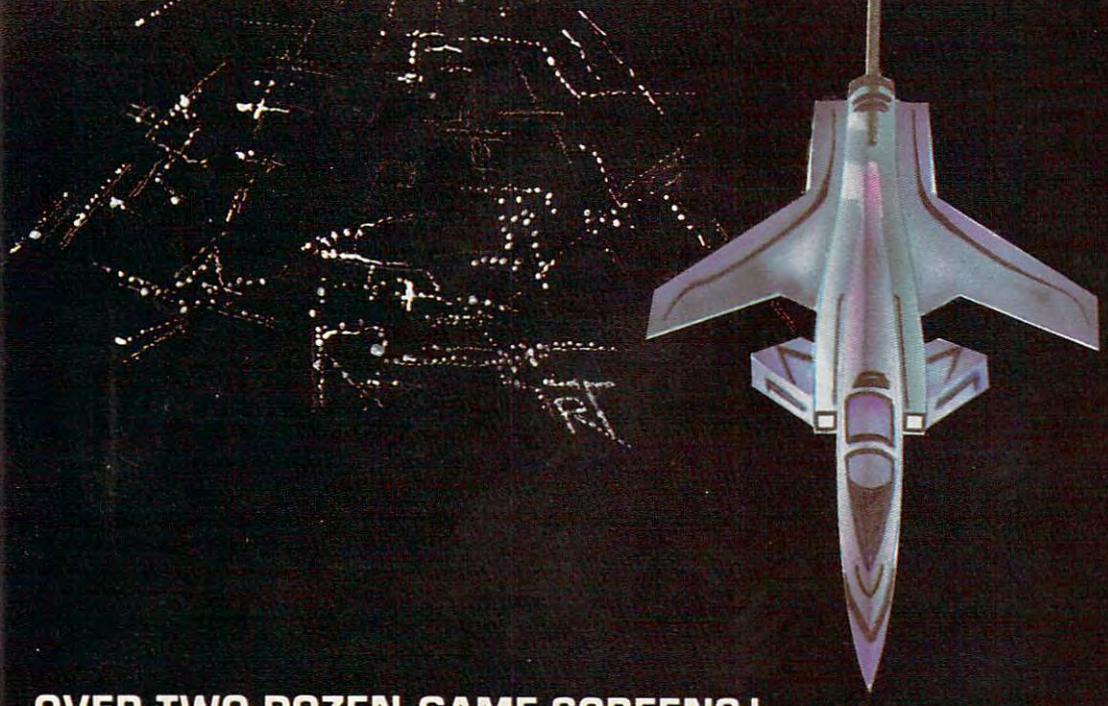

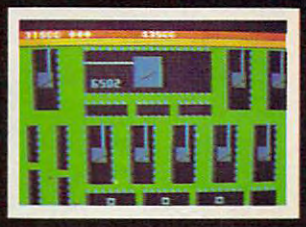

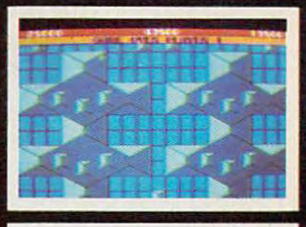

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The Mathematics Of 3-D Plotting

"Rectan" plots surfaces using rectangular coordinates (x,y,z). The values for x and y are specified; the value of z is then given by z = f(x,y) for some function f.

To use Rectan, specify the function f(x,y) in line 790. For example, z = x*x/4–y*y/9 defines a hyperbolic paraboloid.

"Spheri" plots surfaces using spherical coordinates. This method describes a point on the surface using three parameters: radial distance from the origin, r; azimuthal angle, theta (θ); and elevation angle, phi (ϕ).

To use Spheri, specify x,y, and z (called XT,YT, and ZT in lines 820–840) as functions of r, theta, and phi in lines 820–840.

Parameters And Slices

Both programs are structured the same. You specify parameter ranges. In Rectan these are for x and y; in Spheri, for θ and ϕ.

Next enter the number of *slices* for the parameters. Each slice corresponds to a contour line on the surface. A contour line is where one of the parameters is held constant.

Finally, you specify an observation angle. This is the angle which allows you to see a three-dimensional surface on a two-dimensional video screen. The most commonly used angle is 45 degrees.

If you'd like any technical information, or if you have a particular surface in mind but don't know how to write an equation for it, please write to:

Tim R. Colvin
1414 San Remo Dr.
Pacific Palisades, CA 90272

```
390 D=8192:POKE 53272,PEEK(53272)OR8
                                    :rem 219
400 POKE 53265,PEEK(53265)OR32      :rem 117
410 FOR I=D TO D+7999:POKE I,0:NEXT I
                                    :rem 10
420 FOR I=1024 TO 2023:POKE I,3:NEXT I
                                     :rem 7
430 T1=(N1-M1)/2                    :rem 53
440 T2=(N2-M2)/2                    :rem 57
450 W=T1/T2                        :rem 103
460 IF W<1.60606061 THEN 490       :rem 128
470 XS=159:ZS=159/W                :rem 107
480 GOTO 500                       :rem 106
490 XS=99*W:ZS=99                   :rem 14
500 FOR Y=A2 TO B2 STEP H2          :rem 82
510 FOR X=A1 TO B1 STEP H1          :rem 79
520 GOSUB 700                      :rem 174
530 NEXT X                          :rem 47
540 NEXT Y                          :rem 49
550 FOR X=A1 TO B1 STEP H3          :rem 85
560 FOR Y=A2 TO B2 STEP H4          :rem 90
570 GOSUB 700                      :rem 179
580 NEXT Y                          :rem 53
590 NEXT X                          :rem 53
600 POKE 1024,16                    :rem 31
610 GOTO 610                       :rem 103
620 GOSUB 800                      :rem 176
630 XT=XT-YT*CS                    :rem 200
640 ZT=ZT-YT*SI                    :rem 211
650 IF XT>N1 THEN N1=XT             :rem 42
660 IF XT<M1 THEN M1=XT             :rem 39
670 IF ZT>N2 THEN N2=ZT             :rem 50
680 IF ZT<M2 THEN M2=ZT             :rem 47
690 RETURN                         :rem 127
700 GOSUB 800                      :rem 175
710 XT=160+INT(XS*(XT-YT*CS-N1+T1)/T1)
                                   :rem 251
720 ZT=100-INT(ZS*(ZT-YT*SI-N2+T2)/T2)
                                     :rem 7
730 RO=INT(ZT/8)                   :rem 201
740 CH=INT(XT/8)                   :rem 178
750 LN=(ZT)AND7                    :rem 124
760 BI=7-((XT)AND7)                 :rem 33
770 BY=D+320*RO+8*CH+LN             :rem 34
780 POKE BY,PEEK(BY)OR(2↑BI)       :rem 179
790 RETURN                         :rem 128
800 XA=X*U:C1=COS(XA):S1=SIN(XA)   :rem 206
810 YA=Y*U:C2=COS(YA):S2=SIN(YA)   :rem 213
820 XT=(4+C1)*C2                    :rem 70
830 YT=(4+C1)*S2                    :rem 88
840 ZT=S1                           :rem 11
850 RETURN                         :rem 125
```

Program 3: Rectan—Atari Version

Refer to the "Automatic Proofreader" article before typing this program in.

```
BF 130 GRAPHICS 0
QP 140 ? "LOWER X LIMIT";:INPUT A1
PE 150 ? "UPPER X LIMIT";:INPUT B1
PD 160 ? "LOWER Y LIMIT";:INPUT A2
PI 170 ? "UPPER Y LIMIT";:INPUT B2
CB 180 ? "SLICES IN X";:INPUT N
CC 190 ? "SLICES IN Y";:INPUT M
BO 200 ? "OBSERVATION ANGLE";:INPUT Q
OD 210 ? "SCREEN SCALING IN PROGRESS"
IO 215 U=0.0174532925
PC 220 Q=Q*U
QP 230 CS=COS(Q)
PL 240 SI=SIN(Q)
PO 250 H1=(B1-A1)/319:H2=(B2-A2)/(N-1)
AC 260 H3=(B1-A1)/(M-1):H4=(B2-A2)/319
KH 270 M1=99999999:M2=M1:N1=-M1:N2=N1
FH 280 FOR Y=A2 TO B2 STEP H2
FE 290 FOR X=A1 TO B1 STEP H1
KK 300 GOSUB 610
CL 310 NEXT X
CN 320 NEXT Y
FB 330 FOR X=A1 TO B1 STEP H3
FG 340 FOR Y=A2 TO B2 STEP H4
KP 350 GOSUB 610
DB 360 NEXT Y
DB 370 NEXT X
CE 380 GRAPHICS 8
PB 390 SETCOLOR 2,0,0
QL 400 SETCOLOR 4,0,0
CI 410 SETCOLOR 1,9,15
EK 415 COLOR 1
DE 420 T1=(N1-M1)/2
```

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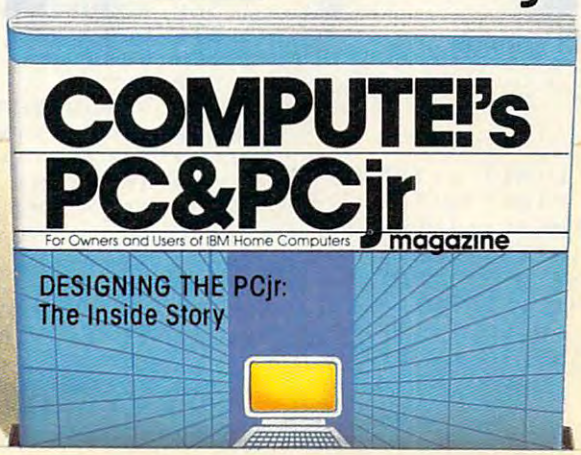

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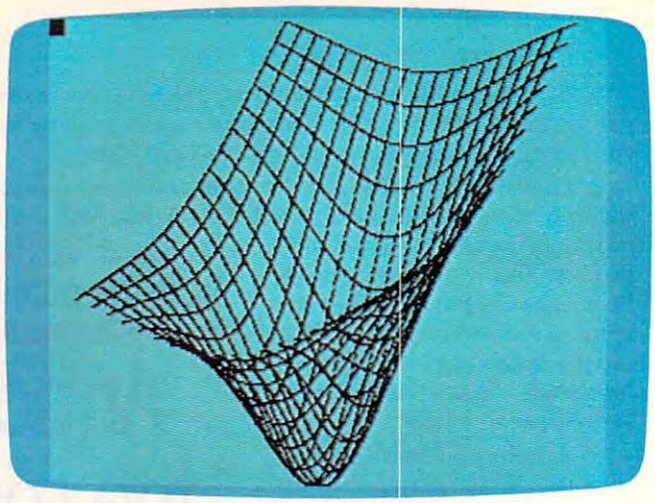
```
DI 430  T2=(N2-M2)/2
GG 440  W=T1/T2
HO 450  IF W<1.60606061 THEN 480
GK 460  XS=159:ZS=159/W
HB 470  GOTO 490
AJ 480  XS=79*W:ZS=79
FK 490  FOR Y=A2 TO B2 STEP H2
EO 500  FOR X=A1 TO B1 STEP H1
LF 510  GOSUB 690
CO 520  NEXT X
DA 530  NEXT Y
FE 540  FOR X=A1 TO B1 STEP H3
FJ 550  FOR Y=A2 TO B2 STEP H4
LK 560  GOSUB 690
DE 570  NEXT Y
DE 580  NEXT X
HF 590  END
LH 610  GOSUB 790
BP 620  XT=X-Y*CS
CK 630  ZT=Z-Y*SI
CJ 640  IF XT>N1 THEN N1=XT
CG 650  IF XT<M1 THEN M1=XT
DB 660  IF ZT>N2 THEN N2=ZT
CO 670  IF ZT<M2 THEN M2=ZT
HO 680  RETURN
LP 690  GOSUB 790
FC 700  XT=160+INT(XS*(X-Y*CS-N1+T1)/T1
        )
DF 710  ZT=80-INT(ZS*(Z-Y*SI-N2+T2)/T2)
FO 720  PLOT XT,ZT
HK 730  RETURN
LE 790  Z=-1/(X*X+Y*Y+0.5)
HI 800  RETURN
```

Program 4: Spheri—Atari Version

Refer to the "Automatic Proofreader" article before typing this program in.

```
BF 130  GRAPHICS 0
AN 140  ? "LOWER THETA LIMIT";:INPUT A1
BC 150  ? "UPPER THETA LIMIT";:INPUT B1
HL 160  ? "LOWER PHI LIMIT";:INPUT A2
IA 170  ? "UPPER PHI LIMIT";:INPUT B2
DP 180  ? "SLICES IN THETA";:INPUT N
KK 190  ? "SLICES IN PHI";:INPUT M
BO 200  ? "OBSERVATION ANGLE";:INPUT Q
OD 210  ? "SCREEN SCALING IN PROGRESS"
IO 215  U=0.0174532925
PC 220  Q=Q*U
OP 230  CS=COS(Q)
PL 240  SI=SIN(Q)
PO 250  H1=(B1-A1)/319:H2=(B2-A2)/(N-1)
AC 260  H3=(B1-A1)/(M-1):H4=(B2-A2)/319
KH 270  M1=99999999:M2=M1:N1=-M1:N2=N1
FH 280  FOR Y=A2 TO B2 STEP H2
FE 290  FOR X=A1 TO B1 STEP H1
KK 300  GOSUB 610
CL 310  NEXT X
CN 320  NEXT Y
FB 330  FOR X=A1 TO B1 STEP H3
FG 340  FOR Y=A2 TO B2 STEP H4
KP 350  GOSUB 610
DB 360  NEXT Y
DB 370  NEXT X
CE 380  GRAPHICS 8
PB 390  SETCOLOR 2,0,0
OL 400  SETCOLOR 4,0,0
CI 410  SETCOLOR 1,9,15
EK 415  COLOR 1
DE 420  T1=(N1-M1)/2
DI 430  T2=(N2-M2)/2
GG 440  W=T1/T2
HO 450  IF W<1.60606061 THEN 480
GK 460  XS=159:ZS=159/W
```



The "Rectan" program was used to create this "fish net."

```
HB 470  GOTO 490
AJ 480  XS=79*W:ZS=79
FK 490  FOR Y=A2 TO B2 STEP H2
EO 500  FOR X=A1 TO B1 STEP H1
LF 510  GOSUB 690
CO 520  NEXT X
DA 530  NEXT Y
FE 540  FOR X=A1 TO B1 STEP H3
FJ 550  FOR Y=A2 TO B2 STEP H4
LK 560  GOSUB 690
DE 570  NEXT Y
DE 580  NEXT X
HF 590  END
LH 610  GOSUB 790
MH 620  XT=XT-YT*CS
NC 630  ZT=ZT-YT*SI
CJ 640  IF XT>N1 THEN N1=XT
CG 650  IF XT<M1 THEN M1=XT
DB 660  IF ZT>N2 THEN N2=ZT
CO 670  IF ZT<M2 THEN M2=ZT
HO 680  RETURN
LP 690  GOSUB 790
PK 700  XT=160+INT(XS*(XT-YT*CS-N1+T1)/
        T1)
NN 710  ZT=80-INT(ZS*(ZT-YT*SI-N2+T2)/T
        2)
FO 720  PLOT XT,ZT
HK 730  RETURN
NG 790  XA=X*U:C1=COS(XA):S1=SIN(XA)
NE 800  YA=Y*U:C2=COS(YA):S2=SIN(YA)
EG 820  XT=(4+C1)*C2
FI 830  YT=(4+C1)*S2
AL 840  ZT=S1
HN 850  RETURN
```

Program 5: Rectan—PC/PCjr Version

```
100 SCREEN 0,0,0:CLS
140 INPUT "Lower X limit ";A1
150 INPUT "Upper X limit ";B1
160 INPUT "Lower Y limit ";A2
170 INPUT "Upper Y limit ";B2
180 INPUT "Slices in X ";N
190 INPUT "Slices in Y ";M
200 INPUT "Observation angle ";Q
210 PRINT "Screen scaling in progress"
220 U=.0174532925#:Q=Q*U
230 CS=COS(Q)
240 SI=SIN(Q)
250 H1=(B1-A1)/639:H2=(B2-A2)/(N-1)
```

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A Mutated Wonderwhisk whisks by. The Spinning Top almost topples him!

Close. But Pogo Joe bounces back. Bouncing from cylinder to cylinder, screen to screen, Pogo Joe racks up point after point.

You guide him from cylinder to cylinder, changing the color on top of each. Change the top of each cylinder on a screen, then you're on to the next.

The more screens you complete, the nastier the monsters you face, and the faster they attack.

Press the fire button! Jump two cylinders to safety. Hop into a transport tube, and then whoosh! Pogo Joe appears across the screen. Jump on an escaping monster. Blam! It's gone in a flash! Only to reappear out of thin air.

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```
260 H3=(B1-A1)/(M-1):H4=(B2-A2)/639
270 M1=99999999#:M2=M1:N1=-M1:N2=N1
280 FOR Y=A2 TO B2 STEP H2
290 FOR X=A1 TO B1 STEP H1
300 GOSUB 610
310 NEXT X
320 NEXT Y
330 FOR X=A1 TO B1 STEP H3
340 FOR Y=A2 TO B2 STEP H4
350 GOSUB 610
360 NEXT Y
370 NEXT X
380 SCREEN 2,1
420 T1=(N1-M1)/2
430 T2=(N2-M2)/2
440 W=T1/T2
450 IF W<3.21212121# THEN 480
460 XS=319:ZS=319/W
470 GOTO 490
480 XS=199*W:ZS=99
490 FOR Y=A2 TO B2 STEP H2
500 FOR X=A1 TO B1 STEP H1
510 GOSUB 690
520 NEXT X
530 NEXT Y
540 FOR X=A1 TO B1 STEP H3
550 FOR Y=A2 TO B2 STEP H4
560 GOSUB 690
570 NEXT Y
580 NEXT X
590 GOTO 590
610 GOSUB 790
620 XT=X-Y*CS
630 ZT=Z-Y*SI
640 IF XT>N1 THEN N1=XT
650 IF XT<M1 THEN M1=XT
660 IF ZT>N2 THEN N2=ZT
670 IF ZT<M2 THEN M2=ZT
680 RETURN
690 GOSUB 790
700 XT=320+INT(XS*(X-Y*CS-N1+T1)/T1)
710 ZT=100-INT(ZS*(Z-Y*SI-N2+T2)/T2)
720 PSET (XT,ZT)
730 RETURN
790 Z=X+Y
800 RETURN
```

Program 6: Spheri—PC/PCjr Version

```
100 SCREEN 0,0,0:CLS
110 KEY OFF
140 INPUT "Lower Theta limit ";A1
150 INPUT "Upper Theta limit ";B1
160 INPUT "Lower Phi limit ";A2
170 INPUT "Upper Phi limit ";B2
180 INPUT "Slices in Theta ";N
190 INPUT "Slices in Phi ";M
200 INPUT "Observation angle ";Q
210 PRINT "Screen scaling in progress"
220 U=.0174532925#:Q=Q*U
230 CS=COS(Q)
240 SI=SIN(Q)
250 H1=(B1-A1)/639:H2=(B2-A2)/(N-1)
260 H3=(B1-A1)/(M-1):H4=(B2-A2)/639
270 M1=99999999#:M2=M1:N1=-M1:N2=N1
280 FOR Y=A2 TO B2 STEP H2
290 FOR X=A1 TO B1 STEP H1
300 GOSUB 610
310 NEXT X
320 NEXT Y
330 FOR X=A1 TO B1 STEP H3
340 FOR Y=A2 TO B2 STEP H4
350 GOSUB 610
360 NEXT Y
370 NEXT X
380 SCREEN 2,1
420 T1=(N1-M1)/2
430 T2=(N2-M2)/2
440 W=T1/T2
450 IF W<3.21212121# THEN 480
460 XS=319:ZS=319/W
470 GOTO 490
480 XS=199*W:ZS=99
490 FOR Y=A2 TO B2 STEP H2
500 FOR X=A1 TO B1 STEP H1
510 GOSUB 690
520 NEXT X
530 NEXT Y
540 FOR X=A1 TO B1 STEP H3
550 FOR Y=A2 TO B2 STEP H4
560 GOSUB 690
570 NEXT Y
580 NEXT X
590 GOTO 590
610 GOSUB 790
620 XT=XT-YT*CS
630 ZT=ZT-YT*SI
640 IF XT>N1 THEN N1=XT
650 IF XT<M1 THEN M1=XT
660 IF ZT>N2 THEN N2=ZT
670 IF ZT<M2 THEN M2=ZT
680 RETURN
690 GOSUB 790
700 XT=320+INT(XS*(XT-YT*CS-N1+T1)/T1)
710 ZT=100-INT(ZS*(ZT-YT*SI-N2+T2)/T2)
720 PSET (XT,ZT)
730 RETURN
790 REM The function
800 XA=X*U:C1=COS(XA):S1=SIN(XA)
810 YA=Y*U:C2=COS(YA):S2=SIN(YA)
820 XT=(4+C1)*C2
830 YT=(4+C1)*S2
840 ZT=S1
850 RETURN
```

Program 7: Rectan—Apple Version

```
100  HCOLOR= 3
130  HOME
140  INPUT "LOWER X LIMIT:";A1
150  INPUT "UPPER X LIMIT:";B1
160  INPUT "LOWER Y LIMIT:";A2
170  INPUT "UPPER Y LIMIT:";B2
180  INPUT "SLICES IN X:";N
190  INPUT "SLICES IN Y:";M
200  INPUT "OBSERVATION ANGLE:";Q
210  PRINT "SCREEN SCALING IN PROGRESS"
215 U = .0174532925
220 Q = Q * U
230 CS =  COS (Q)
240 SI =  SIN (Q)
250 H1 = (B1 - A1) / 279:H2 = (B2 - A2) / (N
     - 1)
260 H3 = (B1 - A1) / (M - 1):H4 = (B2 - A2) /
    279
270 M1 = 9999999:M2 = M1:N1 =  - M1:N2 = N1
280  FOR Y = A2 TO B2 STEP H2
290  FOR X = A1 TO B1 STEP H1
300  GOSUB 610
310  NEXT
320  NEXT
```

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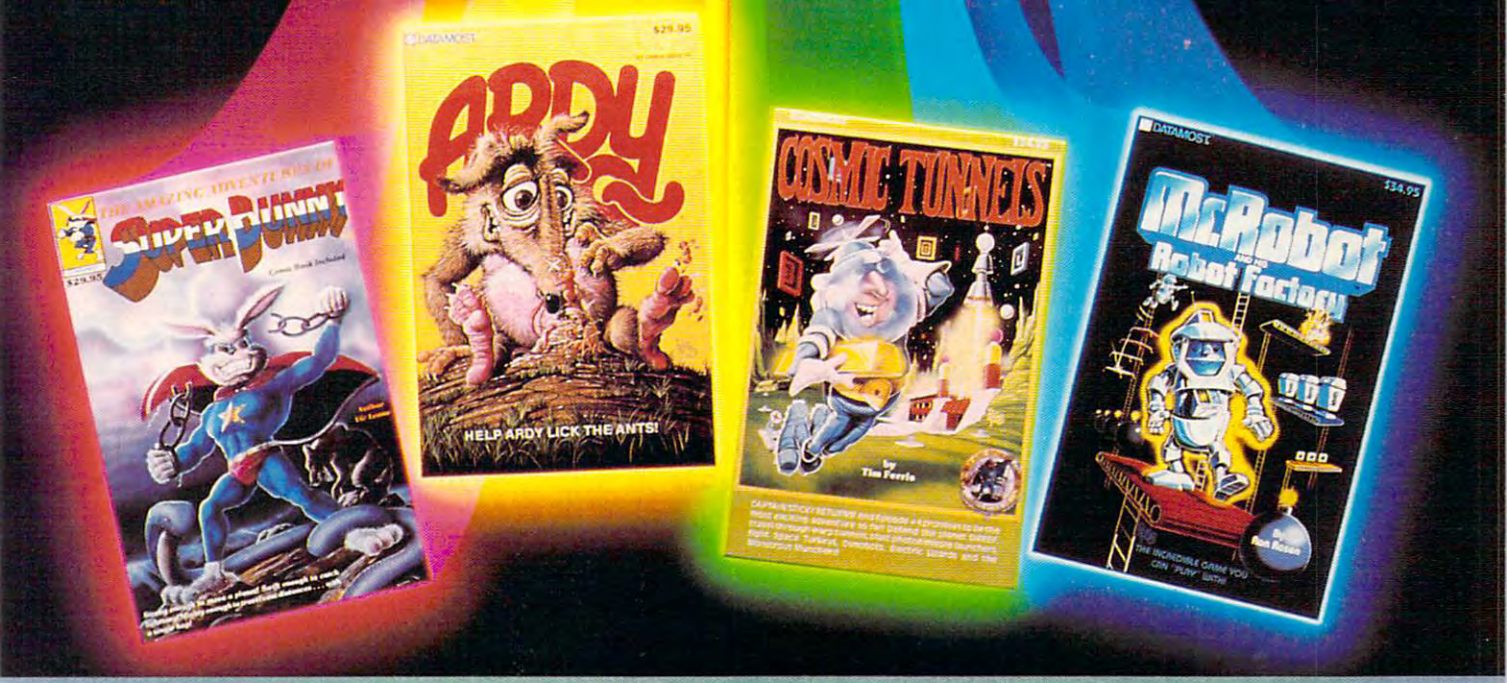

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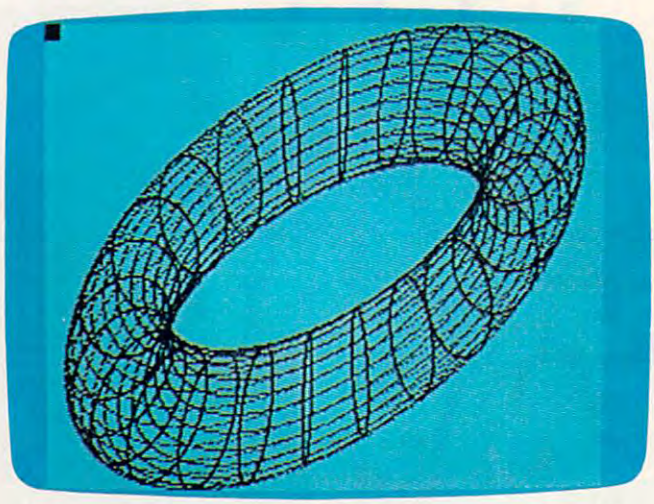
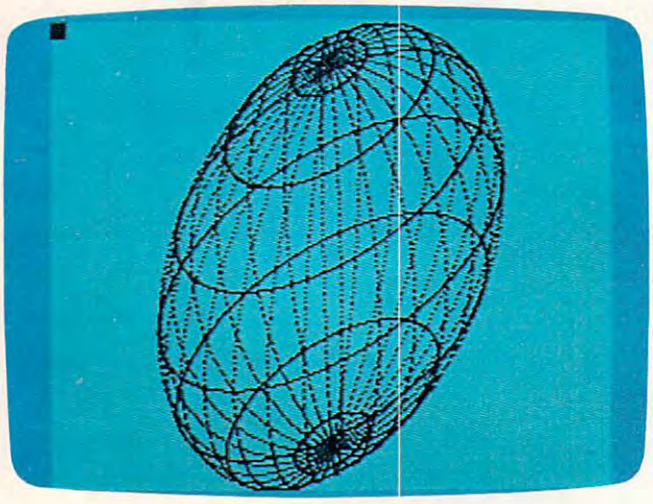


"3-D Plotting" can create spectacular pictures such as this torus or "doughnut."



This sphere was drawn using the "Spheri" program.

```
330  FOR X = A1 TO B1 STEP H3
340  FOR Y = A2 TO B2 STEP H4
350  GOSUB 610
360  NEXT
370  NEXT
380  HGR2
420 T1 = (N1 - M1) / 2
430 T2 = (N2 - M2) / 2
440 W = T1 / T2
450  IF W < 1.46333333 THEN 480
460 XS = 139:ZS = 139 / W
470  GOTO 490
480 XS = 95 * W:ZS = 95
490  FOR Y = A2 TO B2 STEP H2
500  FOR X = A1 TO B1 STEP H1
510  GOSUB 690
520  NEXT
530  NEXT
540  FOR X = A1 TO B1 STEP H3
550  FOR Y = A2 TO B2 STEP H4
560  GOSUB 690
570  NEXT
580  NEXT
600  END
610  GOSUB 790
620 XT = X - Y * CS
630 ZT = Z - Y * SI
640  IF XT > N1 THEN N1 = XT
650  IF XT < M1 THEN M1 = XT
660  IF ZT > N2 THEN N2 = ZT
670  IF ZT < M2 THEN M2 = ZT
680  RETURN
690  GOSUB 790
700 XT = 140 +  INT (XS * (X - Y * CS - N1
    + T1) / T1)
710 ZT = 96 -  INT (ZS * (Z - Y * SI - N2 +
     T2) / T2)
720  HPLOT XT,ZT
780  RETURN
790 Z =  - 1 / (X * X + Y * Y + .5)
800  RETURN
```

Program 8: Spheri—Apple Version

```
100  HCOLOR= 3
130  HOME
140  INPUT "LOWER THETA LIMIT:";A1
150  INPUT "UPPER THETA LIMIT:";B1
160  INPUT "LOWER PHI LIMIT:";A2
170  INPUT "UPPER PHI LIMIT:";B2
180  INPUT "SLICES IN THETA:";N
190  INPUT "SLICES IN PHI:";M
200  INPUT "OBSERVATION ANGLE:";Q
210  PRINT "SCREEN SCALING IN PROGRESS"
215 U = .0174532925
220 Q = Q * U
230 CS =  COS (Q)
240 SI =  SIN (Q)
250 H1 = (B1 - A1) / 279:H2 = (B2 - A2) / (N
    - 1)
260 H3 = (B1 - A1) / (M - 1):H4 = (B2 - A2) /
    279
270 M1 = 99999999:M2 = M1:N1 =  - M1:N2 = N1

280  FOR Y = A2 TO B2 STEP H2
290  FOR X = A1 TO B1 STEP H1
300  GOSUB 610
310  NEXT
320  NEXT
330  FOR X = A1 TO B1 STEP H3
340  FOR Y = A2 TO B2 STEP H4
350  GOSUB 610
360  NEXT
370  NEXT
380  HGR2
420 T1 = (N1 - M1) / 2
430 T2 = (N2 - M2) / 2
440 W = T1 / T2
450  IF W < 1.46333333 THEN 480
460 XS = 139:ZS = 139 / W
470  GOTO 490
480 XS = 95 * W:ZS = 95
490  FOR Y = A2 TO B2 STEP H2
500  FOR X = A1 TO B1 STEP H1
510  GOSUB 690
520  NEXT
530  NEXT
540  FOR X = A1 TO B1 STEP H3
550  FOR Y = A2 TO B2 STEP H4
560  GOSUB 690
570  NEXT
580  NEXT
600  END
610  GOSUB 790
620 XT = XT - YT * CS
630 ZT = ZT - YT * SI
640  IF XT > N1 THEN N1 = XT
650  IF XT < M1 THEN M1 = XT
```

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It was as peaceful a day as New York ever gets, when suddenly the sky went dark and a monstrous droning noise filled the air. Hordes of grotesque aliens were swooping down from all sides, biting into the Big Apple as if they hadn't eaten for days. They were laying eggs, too. Horrible slimy things that got down into the subway tunnels and began clawing their way up. If anyone was going to save the city, it would have to be me. I leapt into my rocket and began blasting away. I thought I stood a fighting chance, but fuel's running low… another wave of invaders on the horizon… signing off…

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```
660  IF ZT > N2 THEN N2 = ZT
670  IF ZT < M2 THEN M2 = ZT
680  RETURN
690  GOSUB 790
700 XT = 140 +  INT (XS * (XT - YT * CS - N
    1  + T1) / T1)
710 ZT = 96 -  INT (ZS * (ZT - YT * SI - N2
    + T2) / T2)
715  IF XT < 0 THEN XT = 0
716  IF XT > 279 THEN XT = 279
720  HPLOT XT,ZT
780  RETURN
790 XA = X * U:C1 =  COS (XA):S1 =  SIN (XA
    )
800 YA = Y * U:C2 =  COS (YA):S2 =  SIN (YA
    )
820 XT = (4 + C1) * C2
830 YT = (4 + C1) * S2
840 ZT = S1
850  RETURN                                  ©
```

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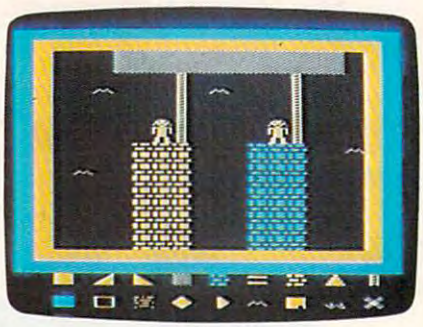

PICTURE PERFECT

For Atari And Commodore 64

Coy V Ison

Construct screen art on the Atari with a joystick and basic shapes formed by redefining characters. You also can save a picture to disk or tape for later viewing. The Commodore 64 version, called "Hi-Res Graphics Editor," employs sprites to transport and transform even the most intricate designs.

"Picture Perfect" is not a game that pits you against the computer, but instead is a way to create pictures, patterns, and designs by using the computer and your imagination.

Type in the listing and SAVE a copy, making sure that line 1520 is exactly as shown. When you run the program, you will be prompted for the filename to be used later when saving or loading your picture file. Tape users should enter C: for the filename. Disk users can enter any legal filename, but it must be prefixed with D:. Once you have selected a valid filename, a picture of a castle will be displayed. Press START, and two rows of nine shapes will appear at the bottom of the screen, below the drawing area.

Touch the OPTION key to see two new rows of shapes, and touch OPTION again to toggle back to the first two rows of shapes. These are redefined characters, to be used in your drawings.

Choose A Shape

A question mark will blink on top of the shape to indicate your position. Using a joystick plugged into port 1, you can move across the two rows of redesigned shapes. To pick up one of the shapes, stop on top of it and touch the joystick button. The question mark will then move to the upper right corner of the drawing screen.

You can now place the redesigned shape anywhere on the screen by touching the joystick button. When you want another redesigned shape, touch the SELECT key. This places your cursor on the two rows of shapes so you can pick up another design.

To erase a shape, move the question mark on top of it and touch the space bar. Should you want to erase a large portion of a picture, touch the E key. A red E will replace the question mark on the screen. By holding down on the joystick button and moving the red E, you will be able to quickly erase a large portion of the screen. To stop erasing, simply press the E key again. If you want to erase the whole screen, touch the CLEAR key.

Storing A Picture

To store a picture on tape, first place a tape in the recorder or your disk in the drive and press PLAY and RECORD, then touch the S key on the keyboard. The program will save the picture on tape for you. When using tape, be sure that you press PLAY and RECORD before you touch the S key. No RETURN is necessary and the saving will start immediately.

To save a picture to disk, first insert the disk in the drive and close the door. Then touch the S key.

Loading Your Picture

If you have a picture already stored on a tape or disk and want to load it into the program, you need to have Picture Perfect in the computer. Place your tape into the recorder (or the disk into the disk drive), press PLAY (for cassette) then touch the L key. When the picture is loaded, it

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will be displayed. Once again, be sure that your tape is ready and that you have the PLAY button pressed before you touch the L key.

If you don't want to type in the program, I will make copies (for the Atari only) on cassette, if you send the usual $3, a cassette, and a stamped, self-addressed mailer to:

Coy Ison
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Conway, AR 72032

Program 1: Atari Picture Perfect

Refer to the "Automatic Proofreader" article before typing this program in.

```
FN 10 GOSUB 2000:DIM SC$(380)
JD 20 GOSUB 1480:GOSUB 970:GOSUB 1260
   :GOTO 130
NC 30 FOR I=0 TO 100 STEP 20
EB 40 SOUND 0,100-I,10,8
ON 50 NEXT I
EG 60 RETURN
HC 70 REM CLEAR SCREEN
FN 80 FOR DO=1 TO 19
EM 90 GOSUB 30
NO 100 POSITION 1,DO:? #6;"
   (18 SPACES)":REM (18 SPACES)
GE 110 NEXT DO
HD 120 RETURN
OG 130 REM JOYSTICK ROUTE FOR RE-SHAP
   ES
DP 140 FOR T=1 TO 100:NEXT T
LH 150 POV=2:PDO=21
PI 160 S=STICK(0):POKE 764,255
PJ 170 DX=(S=7)-(S=11)
CL 180 DY=(S=13)-(S=14)
GJ 190 IF DX<>0 OR DY<>0 THEN GOSUB 3
   0
BE 200 POV=POV+DX+DX:PDO=PDO+DY+DY
EP 210 IF POV<2 THEN POV=18

FC 220 IF POV>18 THEN POV=2
FK 230 IF PDO<21 THEN PDO=23
FN 240 IF PDO>23 THEN PDO=21
MA 250 LOCATE POV,PDO,A
KB 260 POSITION POV,PDO:? #6;"?"
BF 270 FOR T=1 TO 30:NEXT T
LO 280 POSITION POV,PDO:? #6;CHR$(A)
GK 290 IF STRIG(0)=0 THEN 370
JD 300 IF PEEK(53279)=3 THEN GOSUB 13
   70:GOTO 130

KI 310 IF PEEK(53279)=6 THEN DP=1:GOS
   UB 970:GOTO 130
NK 320 IF PEEK(764)=255 THEN 160
KP 330 IF PEEK(764)=62 THEN 780
HC 340 IF PEEK(764)=0 THEN 630
AB 350 IF PEEK(764)=54 THEN GOSUB 70:
   GOTO 130
GJ 360 GOTO 160
FC 370 REM JOYSTICK ROUTE FOR SCREEN
   DRAW
CG 380 FOR T=1 TO 99:NEXT T
FF 390 OV=18:DO=1:POKE 77,0
PF 400 S=STICK(0):POKE 764,255

PG 410 DX=(S=7)-(S=11)
CI 420 DY=(S=13)-(S=14)
GG 430 IF DX<>0 OR DY<>0 THEN GOSUB 3
   0
EL 440 OV=OV+DX:DO=DO+DY
LE 450 IF OV<1 THEN OV=18
LH 460 IF OV>18 THEN OV=1
JD 470 IF DO<1 THEN DO=19
JG 480 IF DO>19 THEN DO=1
DG 490 LOCATE OV,DO,Q
PO 500 POSITION OV,DO:? #6;"?"
GE 505 POSITION POV,PDO:? #6;" "
BA 510 FOR T=1 TO 10:NEXT T
CA 520 POSITION OV,DO:? #6;CHR$(Q)
LF 525 POSITION POV,PDO:? #6;CHR$(A)
EG 530 IF STRIG(0)=0 THEN POSITION OV
   ,DO:? #6;CHR$(A)
JJ 540 IF PEEK(53279)=3 THEN GOSUB 13
   70:GOTO 130
NO 550 IF PEEK(53279)=5 THEN 130
NN 560 IF PEEK(764)=255 THEN 400
OD 565 IF PEEK(764)=42 THEN 1235
LF 570 IF PEEK(764)=62 THEN 780
DP 580 IF PEEK(764)=33 THEN POSITION
   OV,DO:? #6;" "
HJ 590 IF PEEK(764)=0 THEN 630
PF 600 IF PEEK(764)=54 THEN GOSUB 70:
   GOTO 130
NL 610 IF PEEK(53279)=5 THEN 130
GF 620 GOTO 400
LP 630 REM LOADING DATA TAPE
NF 640 SC$=""
GC 650 POSITION 1,20:? #6;"LOADING DA
   TA TAPE"
JO 660 FN=1
FC 670 OPEN #4,4,0,FILE$
EC 680 GET #4,A
BN 690 IF A=63 THEN CLOSE #4:GOTO 720
LI 700 SC$(LEN(SC$)+1)=CHR$(A)
GP 710 GOTO 680
JH 720 FOR LP=1 TO 19
AH 730 POSITION 1,LP:? #6;SC$(FN,FN+1
   7)
JE 740 FN=FN+18
HH 750 NEXT LP
ND 760 POSITION 1,20:? #6;"■■■■■■■■■■■
   ■■■■■■■■"
GL 770 GOTO 130
IP 780 REM SAVING DATA TAPE
NL 790 SC$=""
CK 800 POSITION 2,20:? #6;"SAVING DAT
   A TAPE"
IO 810 FOR DO=1 TO 19
KA 820 FOR OV=1 TO 18
GF 830 LOCATE OV,DO,ZZ:SC$(LEN(SC$)+1
   )=CHR$(ZZ)
AF 840 POSITION OV,DO:? #6;"?"
IJ 850 POSITION OV,DO:? #6;CHR$(ZZ)
IC 860 NEXT OV
HB 870 NEXT DO
FJ 880 OPEN #4,8,0,FILE$
BP 890 FOR LP=1 TO LEN(SC$)
KM 900 PUT #4,ASC(SC$(LP,LP))
HF 910 NEXT LP
IA 920 PUT #4,63
GJ 930 CLOSE #4
DD 940 POSITION 2,20:? #6;"■■■■■■■■■■■
   ■■■■■■■"
GL 950 GOTO 130
GN 960 REM DRAW CASTLE
```

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```
PE 970 POSITION 1,1:? #6;"{18 SPACES}"
KO 980 POSITION 1,2:? #6;"{11 SPACES}\
       {3 SPACES}\  "
HO 990 POSITION 1,3:? #6;"{5 SPACES}*
       {7 SPACES}\{4 SPACES}"
BI 1000 POSITION 1,4:? #6;"
       {18 SPACES}"
BK 1010 POSITION 1,5:? #6;"
       {18 SPACES}"
LF 1020 POSITION 1,6:? #6;"
       {5 SPACES}) #$ ){7 SPACES}"
EM 1030 POSITION 1,7:? #6;"  #$ [ [[
       [ #${4 SPACES}"
HI 1040 POSITION 1,8:? #6;"99[[9[[[[[
       [9[[9999"
LI 1050 POSITION 1,9:? #6;"  [[ [+[[+
       [ [[{4 SPACES}"
CN 1060 POSITION 1,10:? #6;"  [[)[[[[
       [[)[[{4 SPACES}"
HK 1070 POSITION 1,11:? #6;"  +[[[[[[
       [[[[+ #$ "
IH 1080 POSITION 1,12:? #6;"  [[[[[[[
       [[[[[ ,, "
OB 1090 POSITION 1,13:? #6;"  [[ [[[[
       [[ [[{4 SPACES}"
JO 1100 POSITION 1,14:? #6;"  [+ [[^^
       [[ +[))  "
OH 1110 POSITION 1,15:? #6;"  [[ [[^^
       [[ [[;;) "
EN 1120 POSITION 1,16:? #6;" )[[ [[^^
       [[ [[;;;)"
HL 1130 POSITION 1,17:? #6;") [[[[[[[
       [[[[[ ;; "
FC 1140 POSITION 1,18:? #6;"
       {18 SPACES}"
FE 1150 POSITION 1,19:? #6;"
       {18 SPACES}"
KD 1160 IF DP=1 THEN DP=0:RETURN
BE 1170 GOSUB 1280
AF 1180 POSITION 3,1:? #6;"picture pe
       rfect"
HA 1190 POSITION 4,22:? #6;"PRESS STA
       RT"
DP 1200 FOR T=1 TO 30:NEXT T
EJ 1210 POSITION 4,22:? #6;"press sta
       rt"
EB 1220 FOR T=1 TO 30:NEXT T
DK 1230 IF PEEK(53279)=6 THEN POSITIO
       N 2,22:? #6;"{13 SPACES}":GOSU
       B 70:RETURN
ML 1231 GOTO 1190
GJ 1232 REM E KEY ROUTE
HJ 1235 EOV=OV:EDO=DO
CN 1236 S=STICK(0):POKE 764,255
PK 1237 DX=(S=7)-(S=11):DY=(S=13)-(S=
       14)
JF 1238 EOV=EOV+DX:EDO=EDO+DY
HE 1239 IF EOV<1 THEN EOV=18
GO 1240 IF EOV>18 THEN EOV=1
EK 1241 IF EDO<1 THEN EDO=19
EN 1242 IF EDO>19 THEN EDO=1
CN 1243 LOCATE EOV,EDO,EL
GE 1244 POSITION EOV,EDO:? #6;"[]"
EH 1245 FOR T=1 TO 20:NEXT T
CA 1246 POSITION EOV,EDO:? #6;CHR$(EL
       )
LH 1247 IF STRIG(0)=0 THEN POSITION E
       OV,EDO:? #6;" "
NM 1248 IF PEEK(764)=42 THEN 140
NF 1249 GOTO 1236
AG 1259 REM SET UP SCREEN
AA 1260 MN=1:CC=1
BA 1270 GOSUB 1410
MI 1280 FOR LP=0 TO 19
CL 1290 POSITION LP,0:? #6;"[]"
FF 1300 POSITION LP,20:? #6;"[]"
KA 1310 NEXT LP
ME 1320 FOR LP=1 TO 19
CG 1330 POSITION 0,LP:? #6;"[]"
GP 1340 POSITION 19,LP:? #6;"[]"
KE 1350 NEXT LP
KK 1360 RETURN
JO 1370 REM FLIP SHAPES
FD 1380 CC=CC+1:IF CC>2 THEN CC=1
OE 1390 ON CC GOTO 1410,1440
ML 1400 GOTO 1390
FJ 1410 POSITION 2,21:? #6;"! # $ ^ [
       ' ( ) &"
MN 1420 POSITION 2,23:? #6;"[] + , - ]
       \ : ; *"
KI 1430 RETURN
KO 1440 REM SECOND SET OF SHAPES
DC 1450 POSITION 2,21:? #6;"0 1 2 3 [
       > % . /"
ME 1460 POSITION 2,23:? #6;"[] 8 9 < =
       6 5 7 4"
KM 1470 RETURN
BF 1480 REM FAST DUMP
OC 1490 GRAPHICS 1+16
PP 1500 POSITION 4,10:? #6;"ONE MOMEN
       T"
KI 1510 DIM E$(50):RAMTOP=PEEK(106)-8
       :POKE 106,RAMTOP:CHBAS=RAMTOP
       :ADDR=CHBAS*256:PAGE=4
CP 1520 FOR I=1 TO 41:READ UM:E$(I,I)
       =CHR$(UM):NEXT I:A=USR(ADR(E$
       ),ADDR,PAGE)
EF 1521 DATA 104,104,133,207,104,133
EO 1522 DATA 206,104,104,133,212,169
ON 1523 DATA 0,133,204,169,224,133
IJ 1524 DATA 205,162,1,160,0,177
FG 1525 DATA 204,145,206,200,208,249
FB 1526 DATA 230,205,230,207,232,228
PN 1527 DATA 212,208,240,96,0
MD 1530 FOR LP=1 TO 33
AE 1540 READ CHAR
BB 1550 POS=ADDR+(CHAR*8)
FG 1560 FOR X=0 TO 7:READ A:POKE (POS
       +X),A:NEXT X
KI 1570 NEXT LP
FF 1580 POSITION 4,10:? #6;"
       {10 SPACES}"
FK 1590 DATA 1,255,255,255,255,255,25
       5,255,255
HI 1600 DATA 3,1,3,7,15,31,63,127,255
EJ 1610 DATA 4,128,192,224,240,248,25
       2,254,255
BE 1620 DATA 5,24,24,24,255,255,24,24
       ,24
LG 1630 DATA 6,60,36,60,36,60,36,60,3
       6
KM 1640 DATA 7,0,255,255,0,0,255,255,
       0
GC 1650 DATA 8,222,222,0,123,123,0,22
       2,222
IC 1660 DATA 9,24,24,60,60,126,126,25
       5,255
FH 1670 DATA 10,66,165,90,60,60,90,16
       5,66
IL 1680 DATA 11,255,129,129,129,129,1
       29,129,255
```

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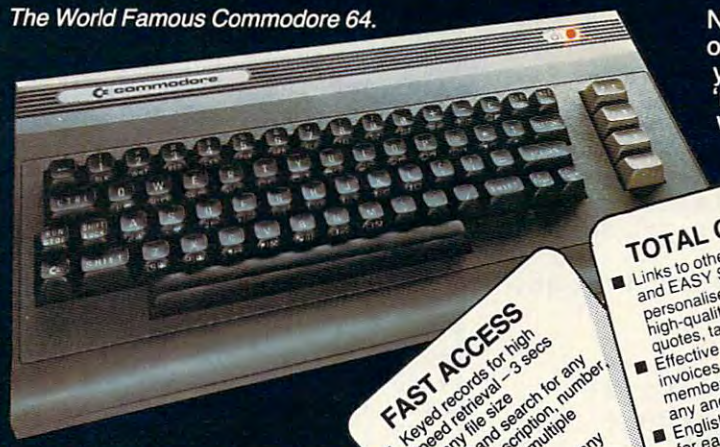

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```
AG 1690 DATA 12,215,0,190,0,221,0,60,
        129
KI 1700 DATA 13,24,60,126,255,255,126
        ,60,24
NI 1710 DATA 14,24,24,24,24,24,24,24,
        24
AC 1720 DATA 15,0,0,0,255,255,0,0,0
JD 1730 DATA 26,255,255,255,255,255,2
        55,249,249
ED 1740 DATA 27,0,0,0,0,34,170,85,35
IH 1750 REM SECOND DATA
BN 1760 DATA 16,60,126,255,255,255,25
        5,126,60
CI 1770 DATA 17,60,255,126,219,126,36
        ,255,189
PN 1780 DATA 18,60,90,126,165,24,255,
        189,189
BE 1790 DATA 19,189,189,60,60,102,102
        ,102,231
KD 1800 DATA 20,24,24,24,248,248,0,0,
        0
KF 1810 DATA 21,0,0,0,248,248,24,24,2
        4
DD 1820 DATA 22,0,0,0,31,31,24,24,24
DF 1830 DATA 23,24,24,24,31,31,0,0,0
KH 1840 DATA 24,24,24,24,255,255,0,0,
        0
KJ 1850 DATA 25,0,0,0,255,255,24,24,2
        4
NP 1860 DATA 28,24,24,24,31,31,24,24,
        24
FF 1870 DATA 29,24,24,24,248,248,24,2
        4,24
II 1880 DATA 30,1,3,6,12,24,48,96,192
PO 1890 DATA 59,128,192,96,48,24,12,6
        ,3
AI 1900 DATA 60,0,0,0,36,90,129,0,0
NK 1910 DATA 61,24,28,30,31,31,30,28,
        24
MC 1920 DATA 62,170,85,170,85,170,85,
        170,85
CL 1930 POKE 756,CHBAS
KO 1940 RETURN
FC 2000 DIM FILE$(15):GRAPHICS 0
DI 2010 TRAP 2060:PRINT "{CLEAR}
        {DOWN}INPUT FILENAME"
JL 2020 PRINT "{DOWN}CASSETTE USERS E
        NTER C:"
OJ 2030 PRINT "{DOWN}DISK USERS ENTER
         FILENAME WITH D:"
JK 2040 INPUT FILE$
LA 2050 IF FILE$(1,2)="C:" OR FILE$(1
        ,2)="D:" THEN TRAP 40000:RETU
        RN
CG 2060 TRAP 2060:PRINT "{BELL}{DOWN}
        ERROR IN FILENAME!":FOR UM=1
        TO 200:NEXT UM:GOTO 2010
```

Program 2:
Machine Language For Hi-Res Graphics Editor

(Use MLX to enter this program.)

```
49152 :032,107,198,169,015,141,150
49158 :226,206,032,013,198,169,082
49164 :128,133,044,141,130,002,078
49170 :169,000,141,000,128,169,113
49176 :200,141,000,208,141,254,200
49182 :206,169,003,141,021,208,010
49188 :169,033,141,212,205,169,197
49194 :000,141,016,208,141,255,035
49200 :206,169,100,141,001,208,105
49206 :141,003,208,173,024,208,043
49212 :041,240,009,008,141,024,011
49218 :208,173,017,208,009,032,201
49224 :141,017,208,169,000,141,236
49230 :238,002,032,182,200,032,252
49236 :107,192,032,004,194,032,133
49242 :186,197,032,239,197,032,205
49248 :186,199,032,008,201,173,127
49254 :238,002,240,230,096,169,053
49260 :032,141,248,007,169,001,194
49266 :141,039,208,238,040,208,220
49272 :173,227,205,201,003,208,113
49278 :018,169,076,141,198,205,165
49284 :169,248,141,197,205,169,237
49290 :014,141,241,002,076,160,004
49296 :192,169,063,141,198,205,088
49302 :169,228,141,197,205,169,235
49308 :025,141,241,002,173,212,182
49314 :205,141,249,007,173,000,169
49320 :220,041,015,141,253,206,020
49326 :056,169,015,237,253,206,086
49332 :141,252,206,160,000,200,115
49338 :204,252,206,208,250,152,178
49344 :010,168,185,204,192,072,255
49350 :185,203,192,072,096,002,180
49356 :194,214,193,218,193,002,194
49362 :194,226,193,230,193,237,203
49368 :193,002,194,222,193,251,247
49374 :193,244,193,002,194,169,193
49380 :050,205,001,208,176,012,112
49386 :173,001,208,056,173,001,078
49392 :208,233,001,141,001,208,008
49398 :096,173,197,205,205,001,099
49404 :208,144,012,173,001,208,230
49410 :024,173,001,208,105,001,002
49416 :141,001,208,096,056,173,171
49422 :254,206,237,198,205,141,231
49428 :253,206,173,255,206,233,066
49434 :001,013,253,206,144,014,145
49440 :173,198,205,141,254,206,185
49446 :169,001,141,255,206,076,118
49452 :063,193,024,173,254,206,189
49458 :105,001,141,254,206,173,162
49464 :255,206,105,000,141,255,250
49470 :206,056,173,254,206,233,166
49476 :000,141,253,206,173,255,072
49482 :206,233,001,013,253,206,218
49488 :144,015,173,016,208,009,133
49494 :001,141,016,208,173,254,111
49500 :206,141,000,208,096,173,148
49506 :016,208,041,254,141,016,006
49512 :208,173,254,206,141,000,062
49518 :208,096,056,173,254,206,079
49524 :237,241,002,141,253,206,172
49530 :173,255,206,233,000,013,234
49536 :253,206,176,017,056,173,241
49542 :241,002,233,001,141,254,238
49548 :206,169,000,141,255,206,093
49554 :076,166,193,056,173,254,040
49560 :206,233,001,141,254,206,169
49566 :173,255,206,233,000,141,142
49572 :255,206,056,173,254,206,034
49578 :233,000,141,253,206,173,152
49584 :255,206,233,001,013,253,113
49590 :206,144,015,173,016,208,176
49596 :009,001,141,016,208,173,224
49602 :254,206,141,000,208,096,075
49608 :173,016,208,041,254,141,009
49614 :016,208,173,254,206,141,180
49620 :000,208,096,032,227,192,199
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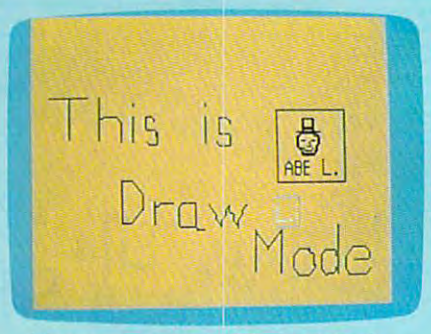
64 Hi-Res Graphics Editor

Gregg Peele, Assistant Programming Supervisor



Just as a word processor allows you to expand your writing skills by giving you power to manipulate text freely, "Hi-Res Graphics Editor" allows you to easily draw, erase, and edit images on the 64's hi-res screen. Once you have finished your drawing, you can even send the results to your 1525 printer.

The Editor expands on the graphics techniques in "Picture Perfect," using the sprite capability of your 64 to create and modify intricate designs on the screen. Parts of pictures can be "imprinted" onto a sprite and "planted" on another area of the screen. You can then enlarge the sprite to full-screen size and edit it more precisely.

Type It In With MLX

Hi-Res Graphics Editor is in two parts. First you must type in Program 2 using the MLX program elsewhere in this issue. After saving Program 2 to disk or tape, reset your machine by turning it off.

Now type in Program 3, the BASIC part of Hi-Res Graphics Editor. SAVE it to disk or tape.

To run the program, first LOAD the file created by MLX with this format:

```
LOAD "your filename",8,1    for disk
LOAD "your filename",1,1    for tape
```

Now enter this line and press RETURN:

```
POKE 642,128:POKE 44,128:POKE 32768,0:NEW
```

This moves BASIC to a safe place in memory—leaving plenty of room for hi-res screens. You must type this line each time before you LOAD Program 3.

Next, LOAD the BASIC program—Program 3. Type RUN, press RETURN, and you are in the Editor.

Set The Joystick Speed

The first prompt in Hi-Res Graphics Editor is for joystick speed. Enter a number from 1 to 10 (10 is fastest). The lower the number, the more control you have over drawing. You can experiment with these numbers to find the best speed for your purposes.

Next, the screen clears and a rectangle appears in the center. This is the sprite cursor. Press the letter D and the box will change into an arrow. You are now in Draw Mode. With a joystick in port 2, you can move this arrow around the screen.

Pressing the fire button draws on the screen. If what you have drawn is invisible, press B to change the background color and F to change the foreground color. Repeat each of these keys to step through the sequence of all possible colors.

Erasing With The Arrow

If you wish to erase what you have drawn, engage the SHIFT LOCK key on the keyboard. Then hold down the fire button and use the joystick to point the arrow at any pixel you want to erase. To start over with a clean slate, just press the f1 key. This clears the screen.

Sprite Mode can be accessed by pressing the A (Add), S (Stamp), C (Copy), or E (Erase) key. Let's explore the most interesting of these, hitting the letter C.

Using the joystick, move the rectangle around the screen until it's superimposed on part of your original drawing. (If you have cleared the screen, you can return to draw mode by pressing D.) Press the fire button, and the contents of the screen "under" the sprite will be copied onto the sprite.

You can enter Add Mode at any time by pressing A. In this mode, you can move your sprite around the screen and "plant" the image anywhere you like. (You *add* the image of the sprite to the images already on the screen.) If you hold the button down while you move the sprite, the sprite's image becomes a wide "brush," which you can use for calligraphy and to create other interesting effects.

A Graphic Stamp

Stamp Mode replaces the contents of the screen with the contents of the sprite. And if you make a mistake in your drawing, use E, Erase Mode. This mode transforms the sprite cursor into a giant eraser which clears any pixels it passes over.

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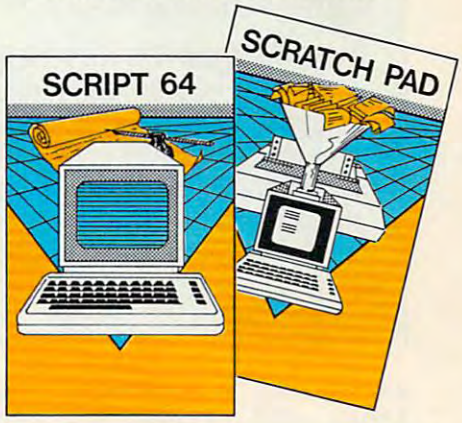

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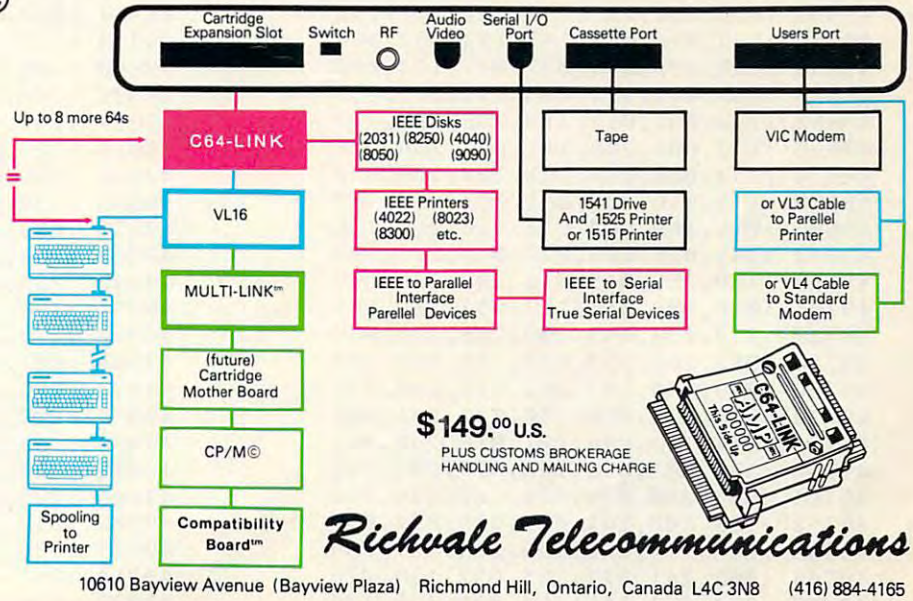

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A Sprite Editor

You can create your own sprites by enlarging the sprite to full screen proportions. Hold down the f7 key briefly. The screen will clear and an enlarged image of the sprite will appear in the upper left corner of the screen. To edit this sprite, press the fire button of the joystick as you move the cursor in this area. Erasing is simple. Just engage the SHIFT/LOCK key, and instead of drawing to the sprite image, you will erase parts of the sprite. The f1 key clears the sprite, just as it cleared the screen in hi-res mode.

If you want to save or load a hi-res screen, you must do it from this sprite definition mode. Hold the CTRL key while you press L for LOAD, and a series of prompts will then appear for loading from disk or tape. Likewise, holding CTRL and S allows you to save to disk or tape.

Anytime you wish to return to hi-res mode, simply hold f7 down for a moment. You can then use the sprite definition you have just created to produce intricate pictures on the hi-res screen.

Two Graphics Screens

The Editor contains a feature which allows you to have two full screens of graphics in memory at one time. Press T to toggle between them. When you first try this function, the screen will fill with garbage if nothing has been created on the alternate screen. (There is undefined data in this area.)

Clear the screen (using the f1 key) to start with a new palette. Draw a new design on this screen, and press T (toggle) to return to the old screen. Pressing T again takes you back to your second creation, and so on.

Printing Your Creation

Since an image created on a computer screen will last only as long as the power is on, a hi-res screen dump is included. Just press the letter P, and your 1525 printer (or 1525 compatible printer) will print the contents (minus the sprite cursors) of the screen.

Here's a summary of the commands in the Hi-Res Graphics Editor:

D	Draw Mode
SHIFT LOCK on	Erase draw (in sprite definition mode, erase parts of sprite)
A	Add Mode; overlay sprite with screen
C	Copy screen to sprite
S	Stamp Mode; replace what is onscreen with sprite image
E	Erase under sprite
F	Sequence through foreground colors
B	Sequence through background colors
T	Toggle between screens
f1	Clear screen (hi-res and sprite definition modes)
f7	Change from hi-res to sprite definition and vice versa
CTRL-L	Load screen from disk or tape; available only from sprite definition mode
CTRL-S	Save screen from disk or tape; available only from sprite definition mode
P	Produce printout on 1525 printer

```
49626 :096,032,247,192,096,032,145
49632 :012,193,096,032,112,193,094
49638 :096,032,227,192,032,112,153
49644 :193,096,032,247,192,032,004
49650 :112,193,096,032,247,192,090
49656 :032,012,193,096,032,227,072
49662 :192,032,012,193,096,096,107
49668 :173,001,208,141,003,208,226
49674 :173,000,208,141,002,208,230
49680 :173,016,208,041,001,240,183
49686 :011,169,002,013,016,208,185
49692 :141,016,208,076,042,194,193
49698 :169,253,045,016,208,141,098
49704 :016,208,056,173,254,206,185
49710 :233,024,141,250,206,173,049
49716 :255,206,233,000,141,251,114
49722 :206,165,197,201,013,240,056
49728 :023,201,010,240,030,201,001
49734 :014,240,046,201,018,240,061
49740 :053,201,020,240,079,201,102
49746 :003,240,025,076,168,194,020
49752 :169,000,141,227,205,032,094
49758 :138,194,076,168,194,169,009
49764 :001,141,227,205,032,138,076
49770 :194,076,168,194,032,138,140
```

```
49776 :194,076,180,199,076,168,237
49782 :194,169,002,141,227,205,032
49788 :032,138,194,076,168,194,158
49794 :169,003,141,227,205,076,183
49800 :168,194,169,172,141,000,212
49806 :208,141,254,206,169,000,096
49812 :141,016,208,141,255,206,091
49818 :169,124,141,001,208,096,125
49824 :169,004,141,227,205,032,170
49830 :138,194,173,227,205,201,024
49836 :003,208,016,169,034,141,231
49842 :212,205,173,021,208,041,014
49848 :254,141,021,208,076,204,064
49854 :194,169,033,141,212,205,120
49860 :173,021,208,009,003,141,239
49866 :021,208,056,173,001,208,101
49872 :233,050,141,248,206,173,235
49878 :000,220,041,016,208,017,204
49884 :169,000,141,224,206,162,098
49890 :000,173,227,205,201,004,012
49896 :208,006,076,243,194,076,011
49902 :018,196,076,125,195,173,253
49908 :250,206,141,218,205,173,157
49914 :251,206,141,219,205,169,161
49920 :128,141,216,205,169,000,091
```

```
49926 :168,170,141,214,205,142,022
49932 :222,205,140,221,205,032,013
49938 :022,196,174,222,205,172,241
49944 :221,205,173,224,205,045,073
49950 :206,207,240,012,173,216,060
49956 :205,025,000,008,153,000,171
49962 :008,076,057,195,173,216,255
49968 :205,073,255,057,000,008,134
49974 :153,000,008,078,216,205,202
49980 :208,006,169,128,141,216,160
49986 :205,200,024,173,250,206,100
49992 :105,001,141,250,206,173,180
49998 :251,206,105,000,141,251,008
50004 :206,232,224,024,208,177,131
50010 :162,000,173,218,205,141,221
50016 :250,206,173,219,205,141,010
50022 :251,206,238,248,206,162,133
50028 :000,238,214,205,173,214,128
50034 :205,201,021,144,148,169,234
50040 :001,141,227,205,096,169,191
50046 :128,141,226,206,172,224,199
50052 :206,185,000,008,045,226,034
50058 :206,240,008,169,001,141,135
50064 :228,206,076,157,195,169,151
50070 :000,141,228,206,076,157,190
50076 :195,173,227,205,201,003,136
50082 :208,039,173,141,002,208,165
50088 :008,169,001,141,228,206,153
50094 :076,182,195,169,000,141,169
50100 :228,206,024,173,250,206,243
50106 :105,011,141,250,206,173,048
50112 :251,206,105,000,141,251,122
50118 :206,032,022,196,096,142,124
50124 :216,206,032,022,196,174,026
50130 :216,206,024,173,250,206,005
50136 :105,001,141,250,206,173,068
50142 :251,206,105,000,141,251,152
50148 :206,110,226,206,208,152,056
50154 :238,224,206,232,224,003,081
50160 :240,003,076,125,195,162,017
50166 :000,238,248,206,056,173,143
50172 :250,206,233,024,141,250,076
50178 :206,173,251,206,233,000,047
50184 :141,251,206,172,224,206,184
50190 :192,063,144,001,096,076,074
50196 :125,195,173,250,206,141,086
50202 :250,207,173,251,206,141,230
50208 :251,207,173,248,206,141,234
50214 :248,207,169,000,141,249,028
50220 :207,173,250,207,141,212,210
50226 :207,173,251,207,141,213,218
50232 :207,173,248,207,141,214,222
50238 :207,173,249,207,141,215,230
50244 :207,173,215,207,074,141,061
50250 :217,207,173,214,207,106,174
50256 :141,216,207,173,217,207,217
50262 :074,141,217,207,173,216,090
50268 :207,106,141,216,207,173,118
50274 :217,207,074,141,217,207,137
50280 :173,216,207,106,141,216,139
50286 :207,173,213,207,074,141,101
50292 :219,207,173,212,207,106,216
50298 :141,218,207,173,219,207,007
50304 :074,141,219,207,173,218,136
50310 :207,106,141,218,207,173,162
50316 :219,207,074,141,219,207,183
50322 :173,218,207,106,141,218,185
50328 :207,173,214,207,041,007,233
50334 :141,220,207,173,216,207,042
50340 :010,046,217,207,010,046,188
50346 :217,207,010,141,210,207,138
50352 :046,217,207,173,217,207,219
50358 :141,211,207,173,210,207,051
50364 :010,046,217,207,010,046,212
50370 :217,207,109,210,207,141,005
50376 :216,207,173,211,207,109,043
50382 :217,207,141,217,207,173,088
50388 :216,207,010,046,217,207,091
50394 :010,046,217,207,010,046,242
50400 :217,207,141,216,207,173,105
50406 :218,207,010,046,219,207,113
50412 :010,046,219,207,010,046,006
50418 :219,207,141,218,207,024,234
50424 :173,216,207,109,218,207,098
50430 :141,208,207,173,217,207,127
50436 :109,219,207,141,209,207,072
50442 :024,173,220,207,109,208,183
50448 :207,141,208,207,169,000,180
50454 :109,209,207,141,209,207,080
50460 :024,169,032,109,209,207,010
50466 :141,209,207,173,208,207,155
50472 :133,251,173,209,207,133,122
50478 :252,173,212,207,041,007,170
50484 :141,225,207,056,169,007,089
50490 :237,225,207,141,225,207,020
50496 :169,000,141,206,207,056,075
50502 :173,225,207,046,206,207,110
50508 :206,225,207,016,245,160,111
50514 :000,173,227,205,201,005,125
50520 :240,090,201,002,240,064,157
50526 :201,004,208,003,076,180,254
50532 :197,173,228,206,240,010,130
50538 :177,251,013,206,207,145,081
50544 :251,076,180,197,173,227,192
50550 :205,201,001,240,018,173,188
50556 :206,207,073,255,141,206,188
50562 :207,177,251,045,206,207,199
50568 :145,251,076,180,197,177,138
50574 :251,045,206,207,240,032,099
50580 :177,251,013,206,207,145,123
50586 :251,076,180,197,177,251,006
50592 :045,206,207,240,015,173,022
50598 :206,207,073,255,141,206,230
50604 :207,177,251,045,206,207,241
50610 :145,251,177,251,141,224,087
50616 :205,096,165,197,201,004,028
50622 :208,046,169,000,133,170,148
50628 :169,032,133,171,160,000,093
50634 :152,145,170,056,165,170,036
50640 :233,255,141,212,206,165,140
50646 :171,233,063,013,212,206,088
50652 :240,016,024,165,170,105,172
50658 :001,133,170,165,171,105,203
50664 :000,133,171,076,200,197,241
50670 :096,165,197,170,201,028,071
50676 :208,008,169,015,141,212,229
50682 :206,076,010,198,201,021,194
50688 :208,104,169,240,141,212,050
50694 :206,076,034,198,238,214,204
50700 :206,173,214,206,045,212,044
50706 :206,201,015,208,035,173,088
50712 :214,206,041,240,141,214,056
50718 :206,076,058,198,024,173,253
50724 :214,206,105,016,141,214,164
50730 :206,045,212,206,201,240,128
50736 :208,008,173,214,206,041,130
50742 :015,141,214,206,169,000,031
50748 :133,170,169,004,133,171,072
50754 :173,214,206,160,000,145,196
50760 :170,056,165,170,233,231,073
50766 :141,212,206,165,171,233,182
50772 :007,013,212,206,176,016,202
```

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50778 :024,165,170,105,001,133,176
50784 :170,165,171,105,000,133,072
50790 :171,076,066,198,096,160,101
50796 :128,185,119,198,153,064,187
50802 :008,136,016,247,096,255,104
50808 :255,255,192,000,003,192,249
50814 :000,003,192,000,003,192,004
50820 :000,003,192,000,003,192,010
50826 :000,003,192,000,003,192,016
50832 :000,003,192,000,003,192,022
50838 :000,003,192,000,003,192,028
50844 :000,003,192,000,003,192,034
50850 :000,003,192,000,003,192,040
50856 :000,003,192,000,003,192,046
50862 :000,003,192,000,003,255,115
50868 :255,255,000,000,048,000,226
50874 :000,060,000,000,063,000,053
50880 :000,062,000,000,055,000,053
50886 :000,003,128,000,001,192,010
50892 :000,000,224,000,000,000,172
50898 :000,000,000,000,000,000,210
50904 :000,000,000,000,000,000,216
50910 :000,000,000,000,000,000,222
50916 :000,000,000,000,000,000,228
50922 :000,000,000,000,000,000,234
50928 :000,000,000,000,000,000,240
50934 :000,000,000,000,000,000,246
50940 :000,169,012,141,033,208,047
50946 :169,147,032,210,255,169,216
50952 :021,141,024,208,169,027,086
50958 :141,017,208,169,000,141,178
50964 :208,205,133,180,141,207,070
50970 :205,141,206,205,133,195,087
50976 :169,216,133,196,169,004,151
50982 :133,181,162,000,160,000,162
50988 :169,128,141,210,205,140,013
50994 :206,205,172,207,205,185,206
51000 :000,008,140,207,205,172,020
51006 :206,205,045,210,205,240,149
51012 :011,169,001,145,195,169,246
51018 :160,145,180,076,088,199,154
51024 :169,000,145,195,169,160,150
51030 :145,180,024,165,195,105,132
51036 :001,133,195,165,196,105,119
51042 :000,133,196,024,165,180,028
51048 :105,001,133,180,165,181,101
51054 :105,000,133,181,078,210,049
51060 :205,173,210,205,240,003,128
51066 :076,049,199,238,207,205,072
51072 :169,128,141,210,205,232,189
51078 :224,003,144,167,024,165,093
51084 :180,105,016,133,180,165,151
51090 :181,105,000,133,181,024,002
51096 :165,195,105,016,133,195,193
51102 :165,196,105,000,133,196,185
51108 :162,000,238,208,205,173,126
51114 :208,205,201,021,176,003,216
51120 :076,049,199,096,169,001,254
51126 :141,238,002,096,165,197,253
51132 :201,041,240,001,096,169,168
51138 :000,032,189,255,169,004,075
51144 :170,160,255,032,186,255,234
51150 :032,192,255,162,004,032,115
51156 :201,255,176,003,076,220,119
51162 :199,096,169,008,032,210,164
51168 :255,169,013,032,210,255,134
51174 :162,000,169,001,141,204,139
51180 :205,169,000,141,250,206,183
51186 :169,000,141,251,206,169,154
51192 :199,141,248,206,169,005,192
51198 :141,227,205,142,242,002,189
51204 :032,022,196,174,242,002,160
51210 :173,224,205,045,206,207,046
51216 :240,012,173,202,205,013,093
51222 :204,205,141,202,205,076,031
51228 :041,200,173,204,205,073,156
51234 :255,045,202,205,141,202,060
51240 :205,014,204,205,173,204,021
51246 :205,201,128,240,020,024,096
51252 :173,250,206,105,001,141,160
51258 :250,206,173,251,206,105,225
51264 :000,141,251,206,076,001,227
51270 :200,173,202,205,009,128,219
51276 :224,045,144,010,173,202,106
51282 :205,041,031,009,128,141,125
51288 :202,205,168,032,210,255,136
51294 :152,032,210,255,169,001,145
51300 :141,204,205,169,000,141,192
51306 :202,205,056,173,250,206,174
51312 :233,006,141,250,206,173,097
51318 :251,206,233,000,141,251,176
51324 :206,206,248,206,173,248,131
51330 :206,201,255,240,003,076,087
51336 :001,200,224,045,176,031,045
51342 :024,173,250,206,105,007,139
51348 :141,250,206,173,251,206,095
51354 :105,000,141,251,206,232,065
51360 :169,199,141,248,206,169,012
51366 :013,032,210,255,076,001,241
51372 :200,169,013,032,210,255,027
51378 :032,231,255,096,174,240,182
51384 :002,160,255,136,208,253,174
51390 :202,208,248,096,173,167,004
51396 :002,174,168,002,160,001,191
51402 :032,186,255,173,169,002,251
51408 :162,172,160,002,032,189,157
51414 :255,169,000,162,000,160,192
51420 :032,032,213,255,096,173,253
51426 :167,002,174,168,002,160,131
51432 :001,032,186,255,173,169,024
51438 :002,162,172,160,002,032,000
51444 :189,255,169,032,133,254,252
51450 :169,000,133,253,169,253,203
51456 :162,255,160,063,032,216,120
51462 :255,096,165,197,201,022,174
51468 :240,001,096,169,000,133,139
51474 :170,169,032,133,171,169,094
51480 :000,133,180,169,096,133,223
51486 :181,160,000,177,170,141,091
51492 :062,003,177,180,141,064,151
51498 :003,173,062,003,145,180,096
51504 :173,064,003,145,170,024,115
51510 :165,170,105,001,133,170,030
51516 :165,171,105,000,133,171,037
51522 :024,165,180,105,001,133,162
51528 :180,165,181,105,000,133,068
51534 :181,056,165,170,233,255,114
51540 :141,200,205,165,171,233,175
51546 :063,013,200,205,144,193,140
51552 :096,013,013,013,013,013,001
```

Program 3:
BASIC Portion Of Hi-Res Graphics Editor

```
5 INPUT "{CLR}JOYSTICK SPEED (1-10)";JS$
                                    :rem 137
6 IF VAL(JS$)<1OR VAL(JS$)>10 THEN5
                                    :rem 192
7 POKE752,11-VAL(JS$)               :rem 180
8 FOR T= 2048TO2048+64:POKET,0:NEXT
                                    :rem 22
```

```
10 SYS50624                              :rem 97
11 SYS49152                              :rem 102
12 GETA$:IF PEEK(197)<>3THEN12           :rem 199
13 FOR T= 1 TO 300:NEXT                  :rem 188
15 SYS50941                              :rem 104
16 VI=53248:POKEVI+21,1:POKEVI,21:POKEVI+
   16,PEEK(VI+16)OR1:POKEVI+1,100        :rem 51
17 POKE2040,32                           :rem 238
20 SC= 1024:PX=0:PY=0:CN=0:OS=55296:OC=PE
   EK(OS)                                :rem 24
30 GET A$:IF A$=""THEN CN=CN+1           :rem 65
31 IF PEEK(197)=4 THEN FOR T=2048TO2048+6
   4:POKET,0:NEXT:SYS50941               :rem 196
32 IF PEEK(197)=3THENPOKE198,0:FORT=1TO30
   0:NEXT:GOTO11                         :rem 62
33 IF A$="{L}"THEN GOSUB 300:SYS51394:GOS
   UB400:SYS50941                        :rem 242
34 IF A$="{HOME}"THEN GOSUB300:SYS51425:G
   OSUB400:SYS50941                      :rem 245
40 IF CN= 2 THEN POKE SC,PEEK(SC)OR128:CN
   =0                                    :rem 147
50 IF CN= 1 THEN POKE SC,PEEK(SC)AND127
                                         :rem 140
60 IF(PEEK(56320)AND16)<>0 THEN 65:rem 58
61 IF PEEK(653)THEN POKESC+54272,0:SH=1:G
   OSUB200:GOTO 65                       :rem 246
63 POKESC+54272,1:SH=0:GOSUB 200         :rem 72
65 IF 15-PEEK(56320)=0 THEN 79           :rem 15
66 FL=0:OC=PEEK(SC+54272):OS=SC+54272
                                         :rem 141
70 ON 15-PEEK(56320)AND15GOSUB 80,90,95,1
   00,120,130,140,150,160,170            :rem 163
72 POKESC,(PEEK(SC)OR128)                :rem 243
75 SC=1024+40*Y+X                        :rem 155
79 GOTO 30                               :rem 12
80 Y =Y+(Y>0):RETURN                     :rem 180
90 Y=Y-(Y<20):RETURN                     :rem 231
95 RETURN                                :rem 78
100 X=X+(X>0):RETURN                     :rem 218
110 RETURN                               :rem 114
120 Y=Y+(Y>0):X=X+(X>0):RETURN           :rem 72
130 Y=Y-(Y<20):X=X+(X>0):RETURN          :rem 123
140 RETURN                               :rem 117
150 X=X-(X<23):RETURN                    :rem 20
160 Y=Y+(Y>-0):X=X-(X<23):RETURN         :rem 174
170 Y=Y-(Y<20):X=X-(X<23):RETURN         :rem 180
200 BO=Y*3+INT(X/8)                      :rem 60
210 BT= 2↑(7-(X-INT(X/8)*8)):P=64*PEEK(20
    40)+BO                               :rem 49
220 IF SH=0 THENPOKEP,PEEK(P)ORBT:GOTO230
                                         :rem 10
225 POKEP,PEEK(P)AND(255-BT):SH=0:rem 207
230 RETURN                               :rem 117
300 PRINT"{BLK}{7 RIGHT}{CLR}{RVS}D{OFF}I
    SK OR {RVS}T{OFF}APE"                :rem 144
301 GET J$:IF J$=""THEN301               :rem 93
302 IF J$<>"D"AND J$<>"T"THEN 301:rem 170
303 INPUT "FILENAME";FI$                 :rem 153
305 IF LEFT$(J$,1)="D"THEN D=8:GOTO310
                                         :rem 70
306 D=1                                  :rem 75
310 FOR T= 684 TO 684+LEN(FI$)-1:POKET,AS
    C(MID$(FI$,T-683,1)):NEXT            :rem 150
320 POKE679,D:POKE680,D:POKE681,LEN(FI$):
    POKE682,172:POKE683,2                :rem 159
325 RETURN                               :rem 122
400 OPEN15,8,15:INPUT#15,A$,B$,C$,D$:PRIN
    TA$;" ";B$" ";C$;" ";C$;" ";D$:rem 52
405 CLOSE15                              :rem 117
410 FOR T= 1TO 3000 :NEXT :RETURN:rem 55©
```

Snertle

Soori Sivakumaran

By making simple selections from a menu, a child can change this arithmetic drill to fit his or her own tutoring needs. Written for the unexpanded VIC, versions also are included for the Commodore 64, Atari, TI-99/4A, Color Computer, Apple, IBM PC, and PCjr.

"Snertle" is designed to help teach children the fundamentals of addition, subtraction, and multiplication. A turtle named Snertle is drawn on the screen to give encouragement and assistance to the player.

An Individual Challenge

Snertle allows children to tailor math problems to fit their individual abilities and weaknesses. Snertle first asks the child to select addition, subtraction, or multiplication problems. If addition or subtraction is selected, the child is then asked to choose the largest and smallest numbers to be used in creating the problems. The largest number that can be chosen is 99 and the smallest number is zero.

If multiplication is chosen, the child can decide to practice a certain "times table," or solve problems created randomly from 0 through the 14 times table.

For example, if the 12 times table is selected, then one number in each question created will always be 12. The other number will be randomly selected from the range 0–14.

If the child chooses to attempt random multiplication problems, he or she must define the range of numbers (within the limits of 0 and 14) from which the problems can be created, similar to the process for random addition or subtraction problems.

Creating The Screen

In Program 1, once the necessary information is entered, the turtle's image is POKEd onto the screen. The two numbers used in the problem are chosen in lines 305, 315, and 1070. The numbers are then displayed on the screen, each digit being four regular characters high and three wide. The large character set is created in a series of subroutines in lines 500–990.

The larger number is always displayed above the smaller number to avoid negative answers to subtraction problems. The appropriate sign for addition, subtraction, or multiplication is drawn on the screen by a subroutine beginning at line 6000. Next, a horizontal line is drawn under the numbers.

Line 394 contains a FOR–NEXT loop that clears the keyboard buffer. This prevents the child from accidentally entering data while the turtle and the problem are being put on the screen.

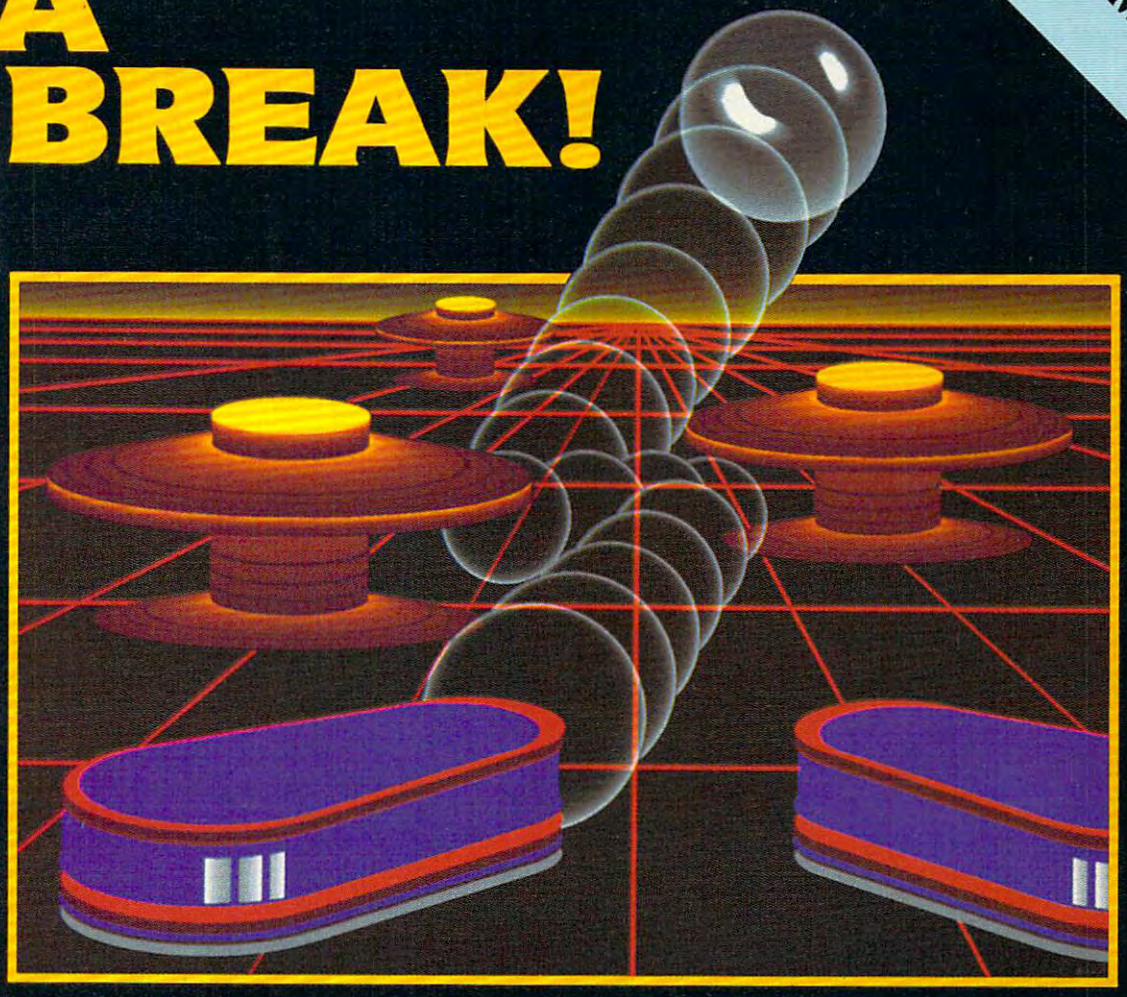
Another FOR–NEXT loop in lines 395–420 enters the user's response to the problem. Because a GET statement is used, the RETURN key does not have to be pressed when entering the response. An arrow will appear at the bottom of the screen to prompt for each digit of the response.

The Turtle Smiles

Once the response is entered, Snertle checks it against the correct answer. If the child's response is correct the turtle will smile, GOOD! will appear on its shell, and a high beep will sound. If the

TAKE A BREAK!

For Apple, Atari, Commodore 64, and IBM-PC



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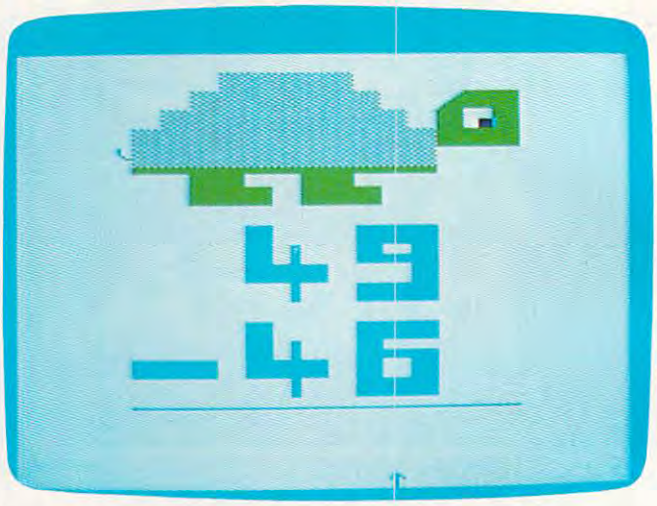
response is incorrect, Snertle the turtle's head will disappear into his shell and the message TRY AGAIN will appear on his side.

The user will be given a second chance. If the new response is correct, Snertle will poke his head out from his shell. If the answer is again incorrect, the correct answer will be displayed on the screen.

The program will keep producing problems until the X key is pressed in response to a problem. The percentage of correctly answered questions is then calculated in line 410, and displayed. This percentage only includes problems answered correctly on the first attempt. Snertle then returns to the menu where the child may END the program or select more problems.

Program 1 uses all but 84 bytes of the unexpanded VIC's memory.



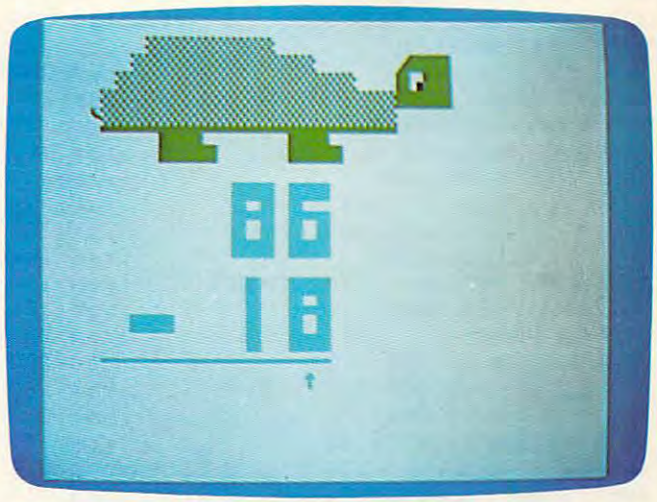
A subtraction problem—"Snertle" for VIC. Other versions similar.

Program 1: Snertle For VIC

Refer to the "Automatic Proofreader" article before typing this program in.

```
100 A$=CHR$(147):B$=CHR$(17):C$=CHR$(29):
    D$=CHR$(18):E$=CHR$(146):Y=160:LL=368
    76                              :rem 62
110 PRINTA$SPC(5)B$B$"**SNERTLE**":POKELL
    +2,15                           :rem 181
120 PRINTB$B$B$B$C$C$ D$"SELECT ONE:"E$
                                    :rem 119
130 PRINTB$"1) ADDITION"            :rem 113
140 PRINTB$"2) SUBTRACTION"         :rem 117
150 PRINTB$"3) MULTIPLICATION"       :rem 87
155 PRINTB$"4) END PROGRAM"          :rem 30
160 PRINTB$"(ENTER 1,2,3 OR 4)";:INPUTQ:I
    FQ>4ORQ<0THEN160                :rem 102
185 C=14:IFQ=1ORQ=2THENC=99         :rem 141
187 IFQ=3THEN1000                   :rem 224
188 IFQ=4THENEND                    :rem 248
190 PRINTA$B$B$"ENTER LARGEST VALUE"
                                    :rem 169
200 PRINT"(MIN.:0 MAX.:";C;")";:INPUTR:IF
    R<0ORR>CTHEN200                 :rem 142
230 PRINTB$B$"ENTER SMALLEST VALUE"
                                    :rem 146
240 PRINT"(MIN.:0 MAX.:";R;")";:INPUTS:IF
    S<0ORS>RTHEN240                 :rem 183
263 PRINTA$B$"PRESS "D$"X"E$" RETURN TO M
    ENU":FORI=1TO750:NEXTI           :rem 6
265 PRINTA$                         :rem 143
270 Z=0:ZZ=0:GOSUB2000               :rem 55
275 GOSUB1100:GOSUB1170:GOSUB1230:GOSUB12
    60                              :rem 102
301 TR=0:ZZ=ZZ+1                    :rem 226
305 L=INT(RND(1)*(R-S+1))+S         :rem 234
310 IFQ=3ANDT=1THEN320               :rem 61
315 K=INT(RND(1)*(R-S+1))+S         :rem 234
320 F$=STR$(K):W=0                  :rem 243
325 IFK<LTHENW=110                   :rem 81
330 GOSUB3000                       :rem 217
335 W=110                           :rem 193
337 IFL>KTHENW=0                    :rem 244
340 F$=STR$(L)                      :rem 248
345 GOSUB3000                       :rem 223
346 ONQGOSUB6000,6000,6004          :rem 185
350 IFQ=1THENM=K+L                   :rem 97
355 IFQ=2ANDK>=LTHENM=K-L            :rem 78
360 IFQ=2ANDK<LTHENM=L-K             :rem 11
365 IFQ=3THENM=K*L                  :rem 104
380 GOSUB740:MM=1:IFM>9THENMM=2     :rem 189
385 IFM>99THENMM=3                  :rem 101
390 GOSUB740                        :rem 183
393 V=0:GOSUB1100                   :rem 222
394 FORI=631TO640:POKEI,0:NEXTI     :rem 180
395 FORJ=0 TO MM-1                  :rem 218
397 POKE8177-(4*J),30                :rem 94
400 GETH$                           :rem 224
405 IFH$=""THEN400                  :rem 216
407 IFH$="X"ANDZZ=1THEN100           :rem 36
410 IFH$="X"THENPRINTA$"PERCENTAGE:";INT(
    Z/(ZZ-1)*100):GOTO120           :rem 10
412 FORO=8164TO8168:POKEO,32:NEXTO
                                    :rem 104
415 P=VAL(H$)                       :rem 199
420 V=V+(P*10↑J):X=8110-(4*J):GOSUB480:NE
    XTJ                             :rem 86
450 IFM=VTHEN470                    :rem 210
451 POKELL,160:FORI=1TO500:NEXTI:POKELL,0
                                    :rem 83
452 FORI=8098TO8186:POKEI,32:NEXTI:rem 96
456 IFTR=1THEN460                    :rem 11
458 TR=1:GOSUB1500:GOSUB770:GOTO393
                                    :rem 159
460 M$=STR$(M)                       :rem 3
461 FORI=1TO22-MM:READA:NEXTI        :rem 96
462 FOROO=1TOMM                     :rem 204
464 P=VAL(MID$(M$,(OO+1),1))        :rem 243
465 READX:GOSUB480:NEXTOO:RESTORE:rem 222
470 GOSUB1230:IFTR=0THENGOSUB2500:GOSUB75
    5:Z=Z+1:GOSUB6500               :rem 154
471 GOSUB2225:GOTO301               :rem 238
480 IFP=0THENGOSUB720                :rem 48
485 ONPGOSUB 500,525,555,585,610,633,660,
    680,700:RETURN                  :rem 254
500 FORI=0TO66STEP22:POKEX+I+1,Y:NEXTI:RE
    TURN                            :rem 211
525 GOSUB990:GOSUB980:POKEX+44,Y:GOSUB970
    :RETURN                         :rem 102
555 GOSUB990:GOSUB980:POKEX+46,Y:GOSUB970
    :RETURN                         :rem 107
585 POKEX,Y:POKEX+22,160            :rem 193
595 FORI=44TO46:POKEI+X,Y:NEXTI       :rem 1
600 POKEX+23,118:POKEX+67,118:RETURN
                                    :rem 172
610 GOSUB990                        :rem 185
```

```
620 POKEX+22,Y:POKEX+23,98:POKEX+24,98:PO
    KEX+46,Y:GOSUB970:RETURN      :rem 95
633 GOSUB990                      :rem 190
640 POKEX+22,Y:POKEX+23,98:POKEX+24,98,
                                  :rem 18
645 POKEX+44,Y:POKEX+46,Y:GOSUB970:RETURN
                                  :rem 141
660 GOSUB990                      :rem 190
670 POKEX+24,Y:POKEX+45,Y:POKEX+46,97:POK
    EX+67,Y:RETURN                :rem 254
680 GOSUB525                      :rem 186
690 POKEX+22,Y:POKEX+46,Y:RETURN  :rem 47
700 GOSUB680:POKEX+44,32:RETURN   :rem 180
720 GOSUB680:POKEX+23,32:RETURN   :rem 179
740 FORI=8080TO8093:POKEI,64:NEXTI:RETURN
                                  :rem 115
755 POKE7753,7:POKE7754,15:POKE7755,15:PO
    KE7756,4:POKE7757,33          :rem 37
760 POKE7753,7:POKE7754,15:POKE7755,15:PO
    KE7756,4:POKE7757,33:RETURN   :rem 59
770 POKE7732,20:POKE7733,18:POKE7734,25
                                  :rem 209
780 POKE7753,1:POKE7754,7:POKE7755,1:POKE
    7756,9:POKE7757,14:POKE7758,33
                                  :rem 147
785 FORI=1TO750:NEXTI:RETURN      :rem 93
960 FORI=0TO66STEP22:POKE I+X,160:NEXTI:R
    ETURN                         :rem 191
970 FORI=0TO2:POKEI+66+X,160:NEXTI:RETURN
                                  :rem 125
980 POKEX+22,98:POKEX+23,98:POKEX+24,160:
    RETURN                        :rem 113
990 FORI=0TO2:POKEX+I,160:NEXTI:RETURN
                                  :rem 232
1000 PRINTA$B$B$SPC(2)"DO YOU WISH TO:"
                                  :rem 212
1010 PRINTB$SPC(3)"1) PRACTICE TIMES"
                                  :rem 138
1015 PRINT"TABLES"                :rem 83
1020 PRINTB$SPC(3)"2) RANDOM NUMBERS"
                                  :rem 156
1030 PRINT"(ENTER 1 OR 2)";:INPUTT:IFT<0O
    RT>2THEN1030                  :rem 162
1050 IFT=2THENGOTO190             :rem 26
1060 PRINTA$B$B$SPC(2)"ENTER TIMES TABLE"
                                  :rem 154
1070 PRINTB$SPC(3)"(1-14)";:INPUTK:IFK<1O
    RK>14THEN1070                 :rem 212
1090 S=0:R=14:GOTO263             :rem 198
1100 FORI=7702TO7790STEP22        :rem 25
1110 READA:READB                  :rem 184
1120 FORJ=1TOB                    :rem 72
1130 POKE (I+A+J),102             :rem 46
1140 NEXTJ:NEXTI:RESTORE:RETURN   :rem 137
1170 FORI=1TO11                   :rem 108
1180 POKE(7815+I),120             :rem 82
1190 NEXTI                        :rem 83
1200 POKE7793,74                  :rem 99
1210 RETURN                       :rem 164
1230 FORI=1TO10:READA:NEXTI       :rem 193
1232 FORI=7724TO7768STEP 22       :rem 40
1234 FORJ=15TO17                  :rem 169
1235 READA:POKEI+J,A:NEXTJ:NEXTI:RESTORE:
    RETURN                        :rem 185
1260 FORI=1TO2                    :rem 60
1270 POKE7817+I,Y:POKE7821+I,Y:NEXTI
                                  :rem 191
1300 FORI=1TO3                    :rem 56
1310 POKE7839+I,Y                 :rem 200
1320 POKE7843+I,Y                 :rem 196
1330 NEXTI:RETURN                 :rem 105
1500 FORI=7724TO7768STEP 22       :rem 38
1510 FORJ=15TO17:POKEI+J,32:NEXTJ:NEXTI:R
    ETURN                         :rem 253
2000 FORI=38400TO38575            :rem 221
2001 POKEI,5:NEXTI                :rem 94
2003 POKE38482,6:FORI=38576TO38905:POKEI,
    1+Q:NEXTI:RETURN              :rem 38
2225 FORI=7878TO8185:POKEI,32:NEXTI:RETUR
    N                             :rem 174
2500 POKE7785,202:RETURN          :rem 171
3000 IFLEN(F$)>2THEN3030          :rem 81
3015 P=VAL(MID$(F$,2,1))          :rem 254
3020 X=7890+W:GOSUB480            :rem 10
3025 RETURN                       :rem 170
3030 P=VAL(MID$(F$,2,1))          :rem 251
3035 X=7886+W:GOSUB480            :rem 21
3040 P=VAL(MID$(F$,3,1))          :rem 253
3045 X=7890+W:GOSUB 480           :rem 17
3050 RETURN                       :rem 168
5000 DATA 6,5,5,7,4,9,3,11,3,11,233,160,1
    60,160,108,160,160,160,160,8102,8106
    ,8110                         :rem 159
6000 POKE8015,Y:POKE8036,Y:POKE8037,Y:POK
    E8038,Y:POKE8059,Y            :rem 76
6002 IFQ=2THENPOKE8015,32:POKE8059,32
                                  :rem 164
6003 RETURN                       :rem 169
6004 POKE8014,Y:POKE8016,Y:POKE8037,Y:POK
    E8058,Y:POKE8060,Y:RETURN     :rem 97
6500 POKELL,207:FORI=1TO150:NEXTI:POKELL,
    215:FORI=1TO175:NEXTI:POKELL,0:RETUR
    N                             :rem 64
```



Subtraction, 64 version of "Snertle." Other versions similar.

Program 2: Snertle For Commodore 64

Refer to the "Automatic Proofreader" article before typing this program in.

```
90 FOR I=54272 TO 54296:POKEI,0:NEXTI
                                  :rem 87
100 A$=CHR$(147):B$=CHR$(17):C$=CHR$(29):
    D$=CHR$(18):E$=CHR$(146):Y=160:rem 33
105 LL=54272:POKELL+5,1:POKELL+6,241:POKE
    LL+24,15                      :rem 118
110 PRINTA$SPC(15)B$B$"**SNERTLE**":POKE5
    3281,1                        :rem 191
120 PRINTTAB(13)B$B$B$B$C$C$ D$"SELECT ON
    E:"E$                         :rem 3
130 PRINTTAB(13)B$"1) ADDITION"   :rem 253
```

```
140 PRINTTAB(13)B$"2) SUBTRACTION" :rem 1
150 PRINTTAB(13)B$"3) MULTIPLICATION"
                                   :rem 227
155 PRINTTAB(13)B$"4) END PROGRAM"
                                   :rem 170
160 PRINT"{HOME}{16 DOWN}"TAB(13)B$"(ENTE
    R 1,2,3 OR 4)";:INPUTQ         :rem 169
170 IFQ>4ORQ<1THEN160               :rem 15
185 C=14:IFQ=1ORQ=2THENC=99        :rem 141
187 IFQ=3THEN1000                  :rem 224
188 IFQ=4THENPRINT"{CLR}":END      :rem 150
190 PRINTA$B$B$TAB(10)"ENTER LARGEST VALU
    E"                             :rem 50
200 PRINT"{HOME}{3 DOWN}"TAB(10)"(MIN.:1
    {SPACE}MAX.:";C;")";:INPUTR:IFR<1ORR>
    CTHEN200                       :rem 163
230 PRINTB$B$TAB(10)"ENTER SMALLEST VALUE
    "                              :rem 27
240 PRINT"{HOME}{8 DOWN}"TAB(10)"(MIN.:0
    {SPACE}MAX.:";R;")";:INPUTS:IFS<0ORS>
    RTHEN240                       :rem 31
263 PRINTA$B$B$B$B$B$B$TAB(8)"PRESS "D$"X
    "E$" RETURN TO MENU":FORI=1TO1500:NEX
    T                              :rem 69
265 PRINTA$                        :rem 143
270 Z=0:ZZ=0:GOSUB2000              :rem 55
275 GOSUB1100:GOSUB1170:GOSUB1230:GOSUB12
    60                             :rem 102
301 TR=0:ZZ=ZZ+1                   :rem 226
305 L=INT(RND(1)*(R-S+1))+S        :rem 234
310 IFQ=3ANDT=1THEN320              :rem 61
315 K=INT(RND(1)*(R-S+1))+S        :rem 234
320 F$=STR$(K):W=0                 :rem 243
325 IFK<LANDQ=2 THEN305             :rem 86
330 W=5:GOSUB3000                  :rem 220
337 IFL>KTHENW=0                   :rem 244
340 F$=STR$(L)                     :rem 248
345 W=205:GOSUB3000                 :rem 68
346 ONQGOSUB6000,6000,6004         :rem 185
350 IFQ=1THENM=K+L                  :rem 97
355 IFQ=2ANDK>=LTHENM=K-L           :rem 78
360 IFQ=2ANDK<LTHENM=L-K            :rem 11
365 IFQ=3THENM=K*L                 :rem 104
380 GOSUB740:MM=1:IFM>9THENMM=2    :rem 189
385 IFM>99THENMM=3                 :rem 101
390 GOSUB740                       :rem 183
393 V=0:GOSUB1100                  :rem 222
394 FORI=631TO640:POKEI,0:NEXTI    :rem 180
395 FORJ=0 TO MM-1                 :rem 218
397 POKE1802-(4*J),30               :rem 82
400 GETH$                          :rem 224
405 IFH$=""THEN400                 :rem 216
407 IFH$="X"ANDZZ=1THEN100          :rem 36
410 IFH$="X"THENPRINTA$B$B$SPC(13)"PERCEN
    TAGE:";INT(Z/(ZZ-1)*100):GOTO120
                                   :rem 113
411 IF H$<>"0"AND VAL(H$)=0 THEN 400
                                   :rem 34
412 FORO=1984TO2023:POKEO,32:NEXTO:rem 91
415 P=VAL(H$)                      :rem 199
420 V=V+(P*10↑J):X=1801-(4*J):GOSUB480:NE
    XTJ                            :rem 86
450 IFM=VTHEN470                   :rem 210
451 GOSUB 6600                     :rem 230
452 FORI=1792TO1943:POKEI,32:NEXTI:rem 84
456 IFTR=1THEN:GOTO460             :rem 126
458 TR=1:GOSUB1500:GOSUB770:GOTO393
                                   :rem 159
460 M$=STR$(M)                      :rem 3
461 FORI=1TO25-MM:READA:NEXTI      :rem 99
462 FOROO=1TOMM                    :rem 204
464 P=VAL(MID$(M$,(OO+1),1))       :rem 243
465 READX:GOSUB480:NEXTOO:RESTORE:rem 222
470 GOSUB1230:IFTR=0THENGOSUB2500:GOSUB75
    5:Z=Z+1:GOSUB6500              :rem 154
471 GOSUB2225:GOTO301              :rem 238
480 IFP=0THENGOSUB720               :rem 48
485 ONPGOSUB 500,525,555,585,610,633,660,
    680,700:RETURN                 :rem 254
500 FORI=0TO120STEP40:POKEX+I+1,Y:NEXTI:R
    ETURN                          :rem 250
525 GOSUB990:GOSUB980:POKEX+80,Y:GOSUB970
    :RETURN                        :rem 102
555 GOSUB990:GOSUB980:POKEX+82,Y:GOSUB970
    :RETURN                        :rem 107
585 POKEX,Y:POKEX+40,160           :rem 193
595 FORI=80TO82:POKEI+X,Y:NEXTI      :rem 1
600 FORI=1TO2:POKEX+I,118:POKEX+40+I,118:
    POKEX+120+I,118:RETURN          :rem 97
610 GOSUB990                       :rem 185
620 POKEX+40,Y:POKEX+41,98:POKEX+42,98:PO
    KEX+82,Y:GOSUB970:RETURN       :rem 95
633 GOSUB990                       :rem 190
640 POKEX+40,Y:POKEX+41,98:POKEX+42,98
                                   :rem 18
645 POKEX+80,Y:POKEX+82,Y:GOSUB970:RETURN
                                   :rem 141
660 GOSUB990                       :rem 190
670 POKEX+42,Y:POKEX+81,Y:POKEX+82,97:POK
    EX+121,Y:RETURN                 :rem 37
680 GOSUB525                       :rem 186
690 POKEX+40,Y:POKEX+82,Y:RETURN    :rem 47
700 GOSUB680:POKEX+80,32:RETURN    :rem 180
720 GOSUB680:POKEX+41,32:RETURN    :rem 179
740 FORI=1748TO1763:POKEI,64:NEXTI:RETURN
                                   :rem 116
755 POKE1151,7:POKE1152,15:POKE1153,15:PO
    KE1154,4:POKE1155,33           :rem 223
760 POKE1151,7:POKE1152,15:POKE1153,15:PO
    KE1154,4:POKE1155,33:RETURN    :rem 245
770 POKE1112,20:POKE1113,18:POKE1114,25
                                   :rem 167
780 POKE1151,1:POKE1152,7:POKE1153,1:POKE
    1154,9:POKE1155,14:POKE1156,33:rem 63
785 FORI=1TO250:NEXTI:RETURN        :rem 88
960 FORI=0TO120STEP40:POKE I+X,160:NEXTI:
    RETURN                         :rem 230
970 FORI=0TO2:POKEI+120+X,160:NEXTI:RETUR
    N                              :rem 164
980 POKEX+40,98:POKEX+41,98:POKEX+42,160:
    RETURN                         :rem 113
990 FORI=0TO2:POKEX+I,160:NEXTI:RETURN
                                   :rem 232
1000 PRINTA$B$B$SPC(11)"DO YOU WISH TO:"
                                    :rem 4
1010 PRINTB$SPC(11)"1) PRACTICE TIMES TAB
     LES"                          :rem 116
1020 PRINTB$SPC(11)"2) RANDOM NUMBERS"
                                   :rem 203
1030 PRINT"{HOME}{7 DOWN}"B$SPC(11)"(ENTE
     R 1 OR 2)";:INPUTT            :rem 142
1040 IFT<1ORT>2THEN1030            :rem 109
1050 IFT=2THENGOTO190               :rem 26
1060 PRINTA$B$B$SPC(11)"ENTER TIMES TABLE
     "                             :rem 202
1070 PRINT"{HOME}{3 DOWN}"B$SPC(11)"(1-14
     )";:INPUTK:IFK<1ORK>14THEN1070
                                   :rem 141
1090 S=0:R=14:GOTO263              :rem 198
1100 FORI=1064TO1224STEP40           :rem 6
1110 READA:READB                   :rem 184
1120 FORJ=1TOB*2-1                   :rem 2
```

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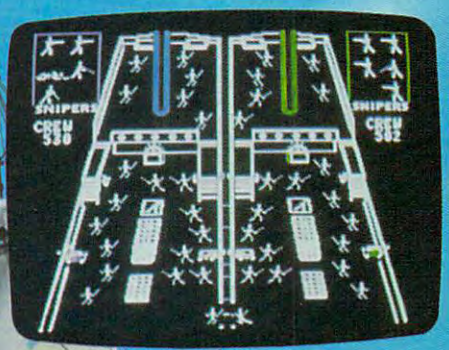

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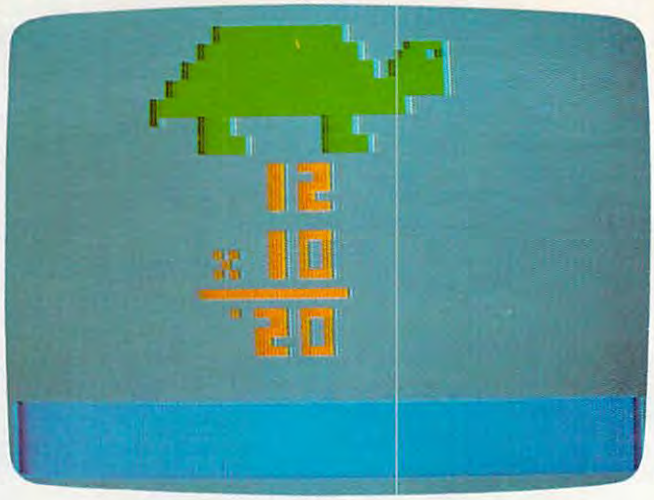
```
1130 POKE (I+A+J),102                :rem 46
1140 NEXTJ:NEXTI:RESTORE:RETURN      :rem 137
1170 FORI=1TO21                      :rem 109
1180 POKE(1267+I),120                :rem 77
1190 NEXTI                           :rem 83
1200 POKE1227,74                     :rem 85
1210 RETURN                          :rem 164
1230 FORI=1TO10:READA:NEXTI          :rem 193
1232 FORI=1104TO1184STEP 40          :rem 12
1234 FORJ=25TO28                     :rem 172
1235 READA:POKEI+J,A:NEXTJ:NEXTI:RESTORE:
     RETURN                          :rem 185
1260 FORI=1TO3                       :rem 61
1270 POKE1271+I,Y:POKE1280+I,Y:NEXTI
                                     :rem 172
1300 FORI=1TO4                       :rem 57
1310 POKE1311+I,Y                    :rem 179
1320 POKE1320+I,Y                    :rem 180
1330 NEXTI:RETURN                    :rem 105
1500 FORI=1064 TO 1224STEP 40        :rem 10
1510 FORJ=25TO28:POKEI+J,32:NEXTJ:NEXTI:R
     ETURN                           :rem 0
2000 FORI=55296TO55615               :rem 227
2001 POKEI,5:NEXTI                   :rem 94
2003 POKE55442,6:FORI=55616TO56256:POKEI,
     1+Q:NEXTI:RETURN                :rem 26
2225 FORI=1384TO2023:POKEI,32:NEXTI:RETUR
     N                               :rem 145
2500 POKE1212,202:RETURN             :rem 150
2600 FORI=1TO24:POKELL+I,0:NEXTI:POKELL+5
     ,240:POKELL+6,72:POKEV,72:RETURN
                                     :rem 138
3000 IFLEN(F$)>2THEN3030             :rem 81
3015 P=VAL(MID$(F$,2,1))             :rem 254
3020 X=1396+W:GOSUB480               :rem 5
3025 RETURN                          :rem 170
3030 P=VAL(MID$(F$,2,1))             :rem 251
3035 X=1392+W:GOSUB480               :rem 7
3040 P=VAL(MID$(F$,3,1))             :rem 253
3045 X=1396+W:GOSUB 480              :rem 12
3050 RETURN                          :rem 168
5000 DATA 6,5,5,7,4,9,3,11,3,11,233,160,1
     60,160,160,108,160,160          :rem 244
5010 DATA 160,160,160,160,1793,1797,1801
                                     :rem 186
6000 POKE1631,Y:POKE1670,Y:POKE1671,Y:POK
     E1672,Y:POKE1711,Y              :rem 52
6002 IFQ=2THENPOKE1631,32:POKE1711,32
                                     :rem 149
6003 RETURN                          :rem 169
6004 POKE1630,Y:POKE1632,Y:POKE1671,Y:POK
     E1710,Y:POKE1712,Y:RETURN       :rem 73
6500 POKE LL+4,33:POKELL+1,21:POKELL,31:F
     ORI=1TO200:NEXTI:POKELL+1,25:POKELL,
     30                              :rem 79
6510 FORI=1TO600:NEXTI:POKELL+4,32:FORI=1
     TO1000:NEXTI:POKELL+4,8:RETURN
                                     :rem 50
6600 POKE LL+4,33:POKELL+1,10:POKELL,143:
     FORI=1TO1500:NEXTI:POKELL+4,32
                                     :rem 39
6610 FOR I=1TO1000:NEXTI:POKELL+4,8:RETUR
     N                               :rem 111
```

Program 3: Snertle For Atari

Refer to the "Automatic Proofreader" article before typing this program in.

```
ME 90 DIM F$(4),M$(3):OPEN #1,4,0,"K:"
DL 100 GRAPHICS 17:SETCOLOR 0,12,10
KN 110 POSITION 3,1:? #6;"**SNERTLE**"
```



The final digit is just beginning to appear onscreen, Atari version of "Snertle." Other versions similar.

```
MI 120 POSITION 3,4:? #6;"SELECT ONE:"
JG 130 POSITION 3,7:? #6;"1) ADDITION"
JM 140 POSITION 3,9:? #6;"2) SUBTRACTI
       ON"
KH 150 POSITION 3,11:? #6;"3) MULTIPLI
       CATION"
GM 160 POSITION 3,13:? #6;"4) END PROG
       RAM"
PM 170 POSITION 1,17:? #6;"( ENTER 1,2
       ,3 OR 4)";:GET #1,Q:IF Q<49 OR
       Q>52 THEN 170
DP 185 Q=Q-48:C=14:IF Q=1 OR Q=2 THEN
       C=99
OA 187 IF Q=3 THEN 1000
PI 188 IF Q=4 THEN END
OP 190 GRAPHICS 17:POSITION 0,3:? #6;"
       ENTER LARGEST VALUE"
KM 200 ? #6;"MIN.:1  MAX.:";C;" ";
GL 203 GET #1,R:IF R<48 OR R>57 THEN 2
       03
JA 205 ? #6;R-48;
IL 210 GET #1,RR:IF (RR<48 OR RR>57) A
       ND (RR<>155) THEN 210
GG 211 IF RR=155 THEN 215
KF 212 ? #6;RR-48
DK 215 IF RR=155 THEN RR=R:R=48
GI 220 R=10*(R-48)+RR-48:IF R<1 OR R>C
        THEN PRINT #6:GOTO 200
HM 230 POSITION 0,14:? #6;"ENTER SMALL
       EST VALUE"
LO 240 ? #6;"MIN.:0  MAX.:";R;" ";
HE 242 GET #1,S:IF S<48 OR S>57 THEN 2
       42
JE 244 ? #6;S-48;
JM 250 GET #1,SS:IF (SS<48 OR SS>58) A
       ND (SS<>155) THEN 250
EN 251 IF SS=155 THEN SS=S:S=48:GOTO 2
       53
KL 252 ? #6;SS-48
IG 253 S=10*(S-48)+SS-48:IF S<0 OR S>R
        THEN PRINT #6:GOTO 240
OK 263 GRAPHICS 17:POSITION 2,8:? #6;"
       ENTER X TO RETURN":POSITION 6,1
       0:? #6;"TO MENU":FOR I=1 TO 500
       :NEXT I:? "{CLEAR}"
NP 270 Z=0:ZZ=0:GRAPHICS 5:POKE 752,1
OD 275 GOSUB 1100:GOSUB 1170:GOSUB 123
       0
OC 301 TR=0:ZZ=ZZ+1
OK 305 L=INT(RND(1)*(R-S+1))+S
```

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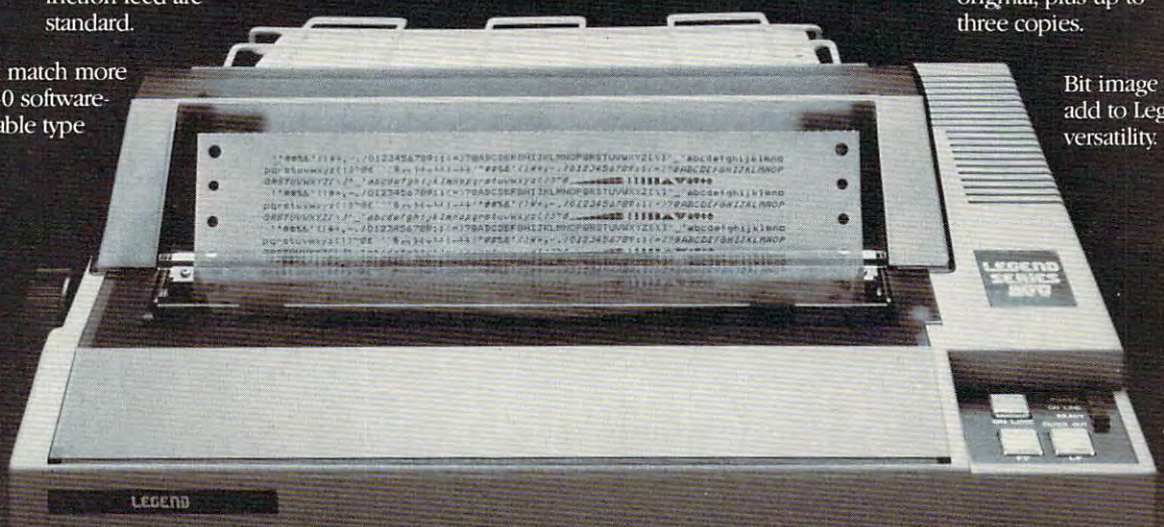

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```
HJ 310  IF Q=3 AND T=49 THEN 320
OK 315  K=INT(RND(1)*(R-S+1))+S
CJ 320  F$=STR$(K):W=15
CD 325  IF K<L THEN W=22
NJ 330  GOSUB 3000
JD 335  W=22
CI 337  IF K<L THEN W=15
PI 340  F$=STR$(L)
NP 345  GOSUB 3000
LL 346  ON Q GOSUB 6000,6002,6004
GB 350  IF Q=1 THEN M=K+L
AL 360  IF Q=2 AND L<K THEN M=K-L
AN 362  IF Q=2 AND K<L THEN M=L-K
GI 365  IF Q=3 THEN M=K*L
PH 380  ? "{CLEAR}":GOSUB 740:MM=1:IF M
        >9 THEN MM=2
GF 385  IF M>99 THEN MM=3
GC 393  V=0
NK 395  FOR J=0 TO MM-1
KM 397  PLOT 40-J*6,30
BG 400  POKE 764,255:GET #1,P
CJ 401  IF (P<>88) AND (P<48 OR P>57) T
        HEN 400
NM 407  IF P=88 AND ZZ=1 THEN 100
DP 408  IF P=88 AND TR=1 THEN ZZ=ZZ+1
IK 410  IF P=88 THEN GRAPHICS 17:SETCOL
        OR 0,12,10:? #6;"  PERCENTAGE="
        ;INT(Z/(ZZ-1)*100):GOTO 120
EB 415  P=P-48:W=30
HK 417  COLOR 0:PLOT 40-J*6,30:COLOR 3
JH 420  V=V+INT((P*10^J)+0.1):X=40-6*J:
        GOSUB 480:NEXT J
NC 450  IF M=V THEN 470
AI 451  SOUND 2,200,12,12:FOR I=1 TO 10
        0:NEXT I:SOUND 2,0,0,0
EM 452  COLOR 0:FOR Y=30 TO 35:FOR I=24
         TO 42:PLOT I,Y:NEXT I:NEXT Y:C
        OLOR 3
AL 456  IF TR=1 THEN 460
HH 458  TR=1:COLOR 0:GOSUB 1170:COLOR 3
        :GOSUB 770:GOTO 393
KB 460  M$=STR$(M):IF MM=3 THEN 462
CP 461  FOR I=1 TO 3-MM:READ A:NEXT I
MM 462  FOR OO=1 TO MM
IJ 464  P=VAL(M$(OO,OO))
NO 465  READ X:GOSUB 480:NEXT OO:RESTOR
        E
MC 470  ? "{CLEAR}":COLOR 2:GOSUB 1170:
        IF TR=0 THEN GOSUB 2500:GOSUB 7
        55:Z=Z+1:GOSUB 6500
FF 471  GOSUB 2225:POKE 198,0:GOTO 301
BK 480  COLOR 1:IF P=0 THEN GOSUB 720
PP 485  ON P GOSUB 500,525,530,555,585,
        610,633,660,680:RETURN
GD 500  PLOT X,W:DRAWTO X,W+4:PLOT X-1,
        W:DRAWTO X-1,W+4:RETURN
AO 525  PLOT X,W:DRAWTO X-3,W:PLOT X-1,
        W+1:PLOT X,W+1:PLOT X,W+2:DRAWT
        O X-3,W+2
PJ 527  PLOT X-3,W+3:PLOT X-2,W+3:PLOT
        X-3,W+4:DRAWTO X,W+4:RETURN
LD 530  PLOT X,W:DRAWTO X,W+4:PLOT X-1,
        W:DRAWTO X-1,W+4:PLOT X-3,W:PLO
        T X-2,W
LP 540  PLOT X-3,W+2:PLOT X-2,W+2:PLOT
        X-3,W+4:PLOT X-2,W+4:RETURN
EI 555  PLOT X-3,W:DRAWTO X-3,W+2:PLOT
        X-1,W+1:DRAWTO X-1,W+4:PLOT X,W
        +2:PLOT X-2,W+2:RETURN
KO 585  PLOT X-3,W:DRAWTO X,W:PLOT X-3,
        W+2:DRAWTO X,W+2:PLOT X-3,W+4:D
        RAWTO X,W+4
FP 590  PLOT X-3,W+1:PLOT X-2,W+1:PLOT
        X-1,W+3:PLOT X,W+3:RETURN
DD 610  PLOT X-3,W:DRAWTO X-3,W+4:PLOT
        X-1,W:PLOT X,W:PLOT X-2,W:DRAWT
        O X-2,W+4:PLOT X-1,W+2:PLOT X-1
        ,W+4
HC 615  PLOT X,W+2:DRAWTO X,W+4:RETURN
GL 633  PLOT X,W:DRAWTO X-3,W:PLOT X,W+
        1:DRAWTO X-3,W+4:RETURN
OO 660  GOSUB 720:PLOT X-2,W+2:PLOT X-1
        ,W+2:RETURN
IL 680  PLOT X-3,W+4:DRAWTO X,W+4:DRAWT
        O X,W:DRAWTO X-3,W:DRAWTO X-3,W
        +2
CE 685  DRAWTO X-1,W+2:RETURN
OD 720  PLOT X,W:DRAWTO X,W+4:DRAWTO X-
        3,W+4:DRAWTO X-3,W:DRAWTO X,W:R
        ETURN
KL 740  FOR I=24 TO 42:PLOT I,28:NEXT I
        :RETURN
GH 755  ? "{12 SPACES}GOOD":RETURN
JK 770  ? "{10 SPACES}TRY AGAIN":RETURN
KE 1000 GRAPHICS 17:SETCOLOR 1,12,10:P
        OSITION 2,2:? #6;"DO YOU WISH
        TO:"
JB 1010 POSITION 2,5:? #6;"1) PRACTICE
         TIMES":POSITION 2,6:? #6;"TAB
        LES"
FH 1020 POSITION 2,8:? #6;"2) RANDOM N
        UMBERS"
BM 1030 POSITION 2,10:? #6;"(ENTER 1 O
        R 2)"
ML 1040 GET #1,T:IF T<49 OR T>50 THEN
        1040
BE 1050 IF T=50 THEN 190
EE 1060 POSITION 2,12:? #6;"ENTER TIME
        S TABLES";
BL 1065 K=0:P=0:? #6;"  (1-14) ";
MN 1070 GET #1,Z:IF (Z<48 OR Z>57) AND
         (Z<>155) THEN 1070
MN 1073 IF Z=155 THEN K=ZZ-48:GOTO 109
        0
MO 1075 ? #6;Z-48;
BB 1080 P=P+1:IF P=1 AND Z<>155 THEN K
        =(Z-48)*10:ZZ=Z:GOTO 1070
MN 1085 K=K+(Z-48):IF K>14 THEN ? #6:G
        OTO 1065
MG 1090 S=0:R=14:GOTO 263
GF 1100 COLOR 2:A=40:B=28:FOR I=0 TO 9
ME 1110 IF I/2=INT(I/2) THEN A=A+2:B=B
        -2
DN 1120 PLOT B,I:DRAWTO A,I:NEXT I
NF 1130 PLOT B,I:RETURN
IH 1170 FOR I=51 TO 55:PLOT I,2:NEXT I
        :FOR I=50 TO 55:PLOT I,3:NEXT
        I
CE 1180 FOR I=4 TO 7:FOR J=49 TO 55:PL
        OT J,I:NEXT J:NEXT I
NF 1190 COLOR 0:PLOT 54,3:RETURN
DI 1230 COLOR 2:Y=24:FOR X=Y TO Y+3:PL
        OT X,10:DRAWTO X,13:NEXT X
EM 1240 Y=40:FOR X=Y TO Y+3:PLOT X,10:
        DRAWTO X,13:NEXT X
FK 1250 PLOT 28,12:PLOT 28,13:PLOT 29,
        12:PLOT 29,13
GN 1260 PLOT 44,12:PLOT 44,13:PLOT 45,
        12:PLOT 45,13:RETURN
JJ 2225 COLOR 0:FOR Y=15 TO 35:FOR I=2
        4 TO 42:PLOT I,Y:NEXT I:NEXT Y
        :COLOR 3:RETURN
AE 2500 COLOR 0:PLOT 54,7:PLOT 53,6:CO
        LOR 3:RETURN
FA 3000 IF LEN(F$)>1 THEN 3030
ND 3015 P=VAL(F$(1,1))
BE 3020 X=40:GOSUB 480
```

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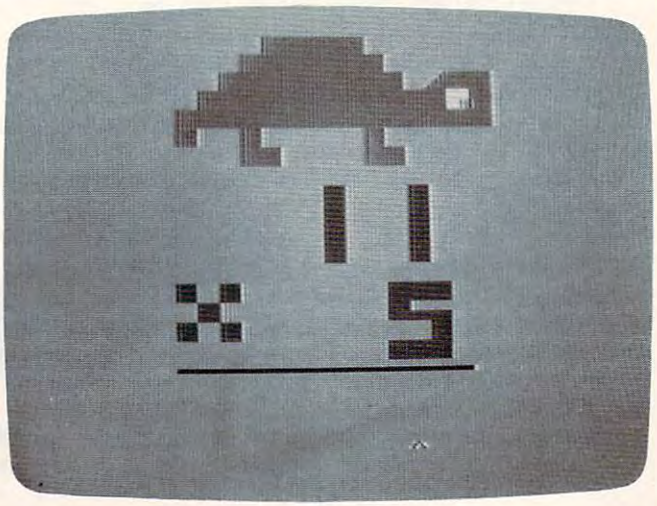
```
KK 3025 RETURN
NA 3030 P=VAL(F$(1,1))
BN 3035 X=34:GOSUB 480
ND 3040 P=VAL(F$(2,2))
BL 3045 X=40:GOSUB 480
KI 3050 RETURN
JO 6000 PLOT 27,24:DRAWTO 27,26:PLOT 2
        6,25:DRAWTO 28,25:RETURN
CE 6002 PLOT 26,25:DRAWTO 28,25:RETURN

PD 6004 PLOT 26,24:PLOT 28,24:PLOT 27,
        25:PLOT 26,26:PLOT 28,26:RETUR
        N
JO 6500 SOUND 2,150,10,10:FOR I=1 TO 5
        0:NEXT I:SOUND 2,125,10,12:FOR
         I=1 TO 50:NEXT I:SOUND 2,0,0,
        0:RETURN
DJ 6510 REM SOUND
GP 8000 DATA 28,34,40
```

Program 4: Snertle For TI-99/4A

```
100 GOTO 150
110 FOR I=1 TO LEN(H$)
120 CALL HCHAR(ROW,COL+I,ASC(SEG$(H
    $,I,1)))
130 NEXT I
140 RETURN
150 GOSUB 2710
160 CALL CLEAR
170 CALL SCREEN(12)
180 PRINT TAB(5);"** S N E R T L E
    **":::::
190 PRINT "SELECT ONE:"::
200 PRINT TAB(3);"1) ADDITION"::
210 PRINT TAB(3);"2) SUBTRACTION"::
220 PRINT TAB(3);"3) MULTIPLICATION
    "::
230 PRINT TAB(3);"4) END PROGRAM"::
    ::::
240 PRINT "(ENTER 1, 2, 3, OR 4)";
250 CALL KEY(0,Q,ST)
260 IF ST=0 THEN 250
270 Q=Q-48
280 IF (Q>4)+(Q<1)THEN 250
290 KOL=Q
300 IF Q<>2 THEN 320
310 KOL=10
320 CALL COLOR(11,KOL+4,1)
```



"Snertle," TI version.

```
330 C=14
340 IF (Q<>1)*(Q<>2)THEN 360
350 C=99
360 IF Q=3 THEN 2210
370 IF Q=4 THEN 3100
380 CALL CLEAR
390 CALL SCREEN(4)
400 PRINT TAB(4);"ENTER LARGEST VAL
    UE:"::
410 PRINT " (LOWEST :1  HIGHEST:";C
    ;")"::
420 INPUT R
430 IF (R<1)+(R>C)THEN 420
440 PRINT ::
450 PRINT TAB(4);"ENTER SMALLEST VA
    LUE"::
460 PRINT " (LOWEST :0  HIGHEST:";R
    ;")"::
470 INPUT S
480 IF (S<0)+(S>R)THEN 470

490 CALL CLEAR
500 CALL SCREEN(10)
510 PRINT "PRESS 'X' TO RETURN TO M
    ENU":::::::::::
520 FOR I=1 TO 400
530 NEXT I
540 CALL CLEAR
550 CALL SCREEN(12)
560 Z=0
570 ZZ=0
580 GOSUB 2410
590 GOSUB 2510
600 GOSUB 2580
610 TR=0
620 ZZ=ZZ+1
630 RANDOMIZE
640 L=INT(RND*(R-S+1))+S
650 IF (Q=3)*(T=1)THEN 670
660 K=INT(RND*(R-S+1))+S
670 F$=STR$(K)
680 Y=9
690 W=15
700 IF K>=L THEN 720
710 Y=14
720 GOSUB 2840
730 Y=14
740 IF L<=K THEN 760
750 Y=9
760 F$=STR$(L)
770 GOSUB 2840
780 ON Q GOSUB 2960,2960,3040
790 IF Q<>1 THEN 810
800 M=K+L
810 IF (Q<>2)+(K<L)THEN 830
820 M=K-L
830 IF (Q<>2)+(K>=L)THEN 850
840 M=L-K
850 IF Q<>3 THEN 870
860 M=K*L
870 CALL HCHAR(18,9,104,14)
880 MM=1
890 IF M<=9 THEN 910
900 MM=2
910 IF M<=99 THEN 930
920 MM=3
930 V=0
940 GOSUB 2410
950 FOR J=0 TO MM-1
960 CALL HCHAR(22,20-4*J,94)
970 CALL KEY(0,K1,ST)
980 IF ST=0 THEN 970
```

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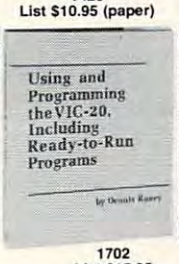

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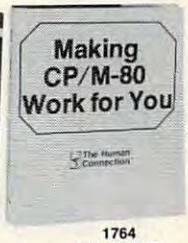

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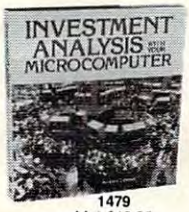

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```
990 IF ((K1<48)+(K1>57))*(K1<>88)TH
    EN 970
1000 IF (K1=88)*(ZZ=1)THEN 460
1010 IF K1<>88 THEN 1060
1020 CALL CLEAR
1030 PRINT TAB(3);"PERCENTAGE :";IN
     T(Z/(ZZ-1)*100)
1040 PRINT ::::
1050 GOTO 190
1060 CALL HCHAR(22,20-4*J,32)
1070 P=K1-48
1080 V=V+(P*10^J)
1090 X=19-4*J
1100 Y=20
1110 GOSUB 1430
1120 NEXT J
1130 IF M=V THEN 1310
1140 CALL SOUND(300,110,2)
1150 FOR I=20 TO 24
1160 CALL HCHAR(I,1,32,30)
1170 NEXT I
1180 IF TR=1 THEN 1230
1190 TR=1
1200 GOSUB 2660
1210 GOSUB 2010
1220 GOTO 930
1230 M$=STR$(M)
1240 FOR OO=1 TO MM
1250 P=VAL(SEG$(M$,OO,1))
1260 X=19-(MM-OO)*4
1270 GOSUB 1430
1280 NEXT OO
1290 FOR T=1 TO 400
1300 NEXT T
1310 GOSUB 2510
1320 IF TR<>0 THEN 1390
1330 CALL HCHAR(5,23,136)
1340 GOSUB 1950
1350 Z=Z+1
1360 CALL SOUND(200,196,2)
1370 CALL SOUND(200,262,2)
1380 CALL SOUND(200,294,2)
1390 FOR I=9 TO 24
1400 CALL HCHAR(I,2,32,30)
1410 NEXT I
1420 GOTO 610
1430 IF P<>0 THEN 1460
1440 GOSUB 1920
1450 RETURN
1460 ON P GOSUB 1480,1500,1550,1600
     ,1650,1710,1790,1850,1890
1470 RETURN
1480 CALL VCHAR(Y,X+1,115,4)
1490 RETURN
1500 GOSUB 2190
1510 GOSUB 2160
1520 CALL HCHAR(Y+2,X,115)
1530 GOSUB 2140
1540 RETURN
1550 GOSUB 2190
1560 GOSUB 2160
1570 CALL HCHAR(Y+2,X+2,115)
1580 GOSUB 2140
1590 RETURN
1600 CALL VCHAR(Y,X,115,2)
1610 CALL HCHAR(Y+2,X,115,3)
1620 CALL HCHAR(Y+1,X+1,114)
1630 CALL HCHAR(Y+3,X+1,114)
1640 RETURN
1650 GOSUB 2190
1660 CALL HCHAR(Y+1,X,115)
1670 CALL HCHAR(Y+1,X+1,112,2)
1680 CALL HCHAR(Y+2,X+2,115)
1690 GOSUB 2140
1700 RETURN
1710 GOSUB 2190
1720 CALL HCHAR(Y+2,X+2,115)
1730 CALL HCHAR(Y+1,X,115)
1740 CALL HCHAR(Y+1,X+1,112,2)
1750 CALL HCHAR(Y+2,X,115)
1760 CALL HCHAR(Y+2,X+2,115)
1770 GOSUB 2140
1780 RETURN
1790 GOSUB 2190
1800 CALL HCHAR(Y+1,X+2,115)
1810 CALL HCHAR(Y+2,X+1,115)
1820 CALL HCHAR(Y+2,X+2,113)
1830 CALL HCHAR(Y+3,X+1,115)
1840 RETURN
1850 GOSUB 1500
1860 CALL HCHAR(Y+1,X,115)
1870 CALL HCHAR(Y+2,X+2,115)
1880 RETURN

1890 GOSUB 1850
1900 CALL HCHAR(Y+2,X,32)
1910 RETURN
1920 GOSUB 1850
1930 CALL HCHAR(Y+1,X+1,32)
1940 RETURN
1950 H$="GOOD!"
1960 ROW=3
1970 COL=12
1980 GOSUB 110
1990 RETURN
2000 REM  CORRECT
2010 H$="TRY"
2020 ROW=2
2030 COL=13
2040 GOSUB 110
2050 H$="AGAIN"
2060 ROW=3
2070 COL=12
2080 GOSUB 110
2090 FOR I=1 TO 200
2100 NEXT I
2110 RETURN
2120 CALL VCHAR(Y,X,115,4)
2130 RETURN
2140 CALL HCHAR(Y+3,X,115,3)
2150 RETURN
2160 CALL HCHAR(Y+1,X,112,2)
2170 CALL HCHAR(Y+1,X+2,115)
2180 RETURN
2190 CALL HCHAR(Y,X,115,3)
2200 RETURN
2210 CALL CLEAR
2220 CALL SCREEN(4)
2230 PRINT "DO YOU WISH TO PRACTICE
     :":::::
2240 PRINT TAB(3);"1) TIMES TABLES,
      OR"::
2250 PRINT TAB(3);"2) RANDOM NUMBER
     S ?":::::::::
2260 PRINT TAB(5);"(ENTER 1 OR 2)"
2270 CALL KEY(0,K1,ST)
2280 IF ST=0 THEN 2270
2290 IF (K1<>49)*(K1<>50)THEN 2270
2300 T=K1-48
2310 IF T=2 THEN 380
2320 CALL CLEAR
2330 PRINT TAB(6);"ENTER TIMES TABL
     E"::
```