



TOPO the robot flanked by D'Ignazio family (from left): Catie, Fred, Janet, Eric
Credit: Roanoke Times & World-News. Photo by Wayne Deel

is made of hard, black plastic. And his eyes flash when he is turned on. But, to Eric, Little Denby is like a teddy bear. He is Eric's link to his friend Big Denby. And few people—biological or mechanical—ever made as deep an impression on Eric as Big Denby.

My Best Wishes To Everybody!

Learning to live intimately with a robot has not exactly been easy.

When Eric and I returned from Chicago, he continued taking Little Denby to bed with him every night. I remember nights when I would wake up and hear Eric crying in his bedroom. I would rush in and Eric would sob and tell me "Denby hit me" or "Denby stuck me." Eric had rolled over on Denby in his sleep. Denby is hard with lots of angles and bumps. He is not the kind of robot you can snuggle with and escape unbruised.

One night shortly after Eric and I returned from Chicago, my wife Janet and I were sound

asleep in our room when I heard a loud *clunk!* come from Eric's bedroom.

Then came a loud, shrill air-raid siren.

Janet and I sat up in bed, alarmed and confused. We began climbing out of bed, and the siren stopped. Then, real loud, a buzzing, mechanical voice announced, "I am the atomic robot! My best wishes to *everybody!*"

It was Denby. He had fallen out of Eric's bed and landed on his head. On Denby's head is a yellow button. When you press the button (even when Denby is turned off), Denby makes an air-raid siren noise and tells every one who he is and wishes them his best. And Denby doesn't just say these things. He blasts them out like a bullhorn.

This is an okay feature for a robot to have during the daylight hours, but when a robot does this at two in the morning it can make you come unglued.

One further qualification: Robots should only be seen and not heard in the middle of the night or *in a car*. I don't know how many car trips we've taken where we have had to confiscate Denby from Eric and my daughter Catie. When Denby shouts out his greetings from the back

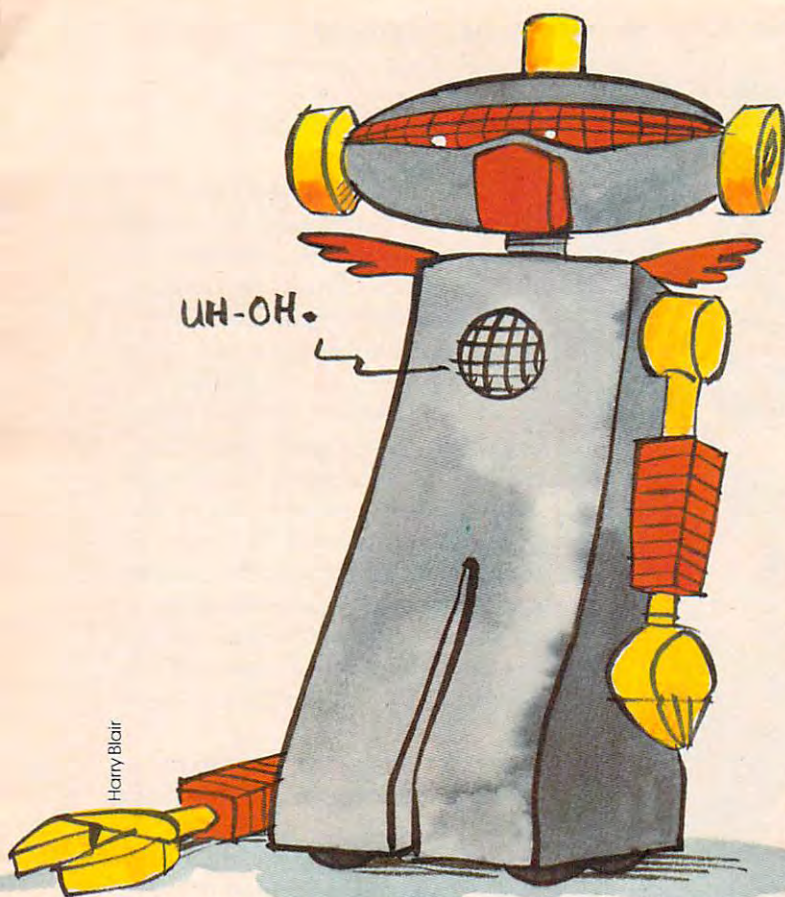
seat, and, worse, when his alarm goes off unexpectedly, it takes all the self-control I've got to keep from swerving the car into a tree.

The One-Armed Robot

When children fall in love with dolls, blankets, and stuffed animals, they carry them around everywhere. Eventually the object of the child's affection begins to take on a very different look. It looks more and more faded, pummelled, mauled, unpleasant, and unhygienic.

My daughter, for example, had a mouse ("Mousie") that had been hugged and carried so much its skin grew so thin that its stuffing started leaking through. And she had a blue blanket ("Ni-Ni") that, despite frequent washings, took on a greasy gray color and looked more like a shredded garbage bag than a child's blanket.

The same is true of robots. Except they're more sturdy. Eventually, however, all that love and affection begins to get to them. After a while they begin to look as ragged as a favorite stuffed



doll or blanket.

Denby is a very tough little robot. For several months he continued to look as good as new. Then, one day, Eric decided to "walk" Denby down the basement stairs. Denby is only ten inches high, and he has no legs—just wheels. He made it to the top of the first stair, then he turned into a robotic pogo stick and bounced his way down the remaining stairs.

That was how Denby lost his arm.

(The arm still sits, forlorn looking, in a small demitasse coffee cup in the kitchen. Janet has performed several surgical operations with Krazy Glue and Miracle Glue to try to reattach the arm to Denby. The arm stays on Denby for a short time, to Eric's acute joy and pleasure. Eventually, however, the arm ends up back in the coffee cup.)

On that same trip down the basement stairs the little door on Denby's bottom burst open and spilled Denby's batteries all over the basement floor.

Today Denby wears a truss—three arcade-store game tokens underneath four layers of masking tape fastened to his bottom. The tokens and the tape keep Denby's batteries inside his body where they belong. But they don't always work, and this makes Denby sort of cranky and unpredictable. Sometimes he races around the kitchen floor, but sometimes he just sits on the floor and makes his air-raid siren in slow motion. It sounds a lot like a whine.

TOPO, The Bag Lady

We recently acquired a new member of our family—TOPO the robot from Androbot (101 East Daggett Drive, San Jose, CA 95134, 408/BOB-TOPO). Now we are a three-robot family (including the robot turtle who lives in the piano room).

I think TOPO looks fine just the way he came out of the packing crate from the factory—like a little white snowman. But my kids think differently. He must look naked to them, because ever since we first got him they have been dressing him up.

At different times TOPO has worn capes, shawls, cowboy guns, hats, flags, bracelets, and rainbow-colored Smurf belts. But my favorite is the time my kids dressed TOPO as a bag lady.

One night, very late, I was going around the house turning off lights and making sure all the doors were locked. I went into my daughter Catie's room. She was sleeping soundly. Then I went into Eric's room.

I got the shock of my life!

Looming over Eric's bed was a small figure dressed in a shawl, a scarf, and a faded purple skirt. It looked like a pygmy bag lady. The bag lady carried a bulging paper sack in each arm. Large, tacky, plastic bracelets dangled from her wrists.

And there was more. In the darkened bedroom she seemed somehow ominous and threatening. I think it must have been the white plastic Dracula teeth taped to her mouth.

I was relieved when I finally realized that the creature in my son's room was TOPO the robot. Then I grew amused. It was that "Look what I've gotten myself into" feeling that I often get when I hang around Catie and Eric. You see, when we got TOPO I didn't realize what we were doing. I thought we were acquiring a robot. But we weren't acquiring a robot, we were adopting a pygmy bag lady—a pygmy bag lady *vampire*.

Just what every family needs.

Now You Can Be Real To Everyone

When I was a kid one of my favorite stories was *The Velveteen Rabbit* by Margery Williams. The story is fairly well known, but the subtitle is less familiar: *How Toys Become Real*.

Denby and TOPO remind me of the velveteen rabbit. When they first arrived they were just "things." But before long they became vital members of our family. Now we talk about them as if they have personalities, ideas, and feelings. We act as if they are *real*.

On ABC-TV's *World News* program last night, Peter Jennings, the show's anchor person, went to a teddy-bear convention. The title of the piece was "America Is Bullish on Bears." Hundreds of people had come to this convention with their favorite teddy bears. There were fat bears, beauti-

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ful bears, dumpy bears, big bears, and bears the size of pins and match sticks. There were wise bears, silly bears, watch bears, and guard bears.

The people who own teddy bears love them as much as we love our robots, maybe even more. To those people, the bears are alive. They are real.

How do robots and bears become members of your family? How do toys become real?

They become real when we project our ideas, thoughts, personalities, and feelings into them. It's the same thing novelists do when they create characters with words on paper. They create life-like beings who inhabit the pages of their books.

And, almost as soon as we project lifelike traits into them, our toys become independent from their creators. They seem to have an identity all their own. They seem to exist whether or not we are around to project life into them. We never know what to expect from them. Their thoughts, feelings, and imaginary actions are always a surprise. We can't predict what they'll do next. All their actions are consistent with the personality that they have evolved, but they are not preprogrammed or "mechanical."

The reality of the teddy bear or robot is greatly heightened when its personality becomes a shared fantasy among several family members or friends. Then it becomes an ongoing "joint invention" of several people. When we hear other people talk about these creatures as if they were real, we come to accept their reality even more than before.

Robot Maids And Butlers

All of this brings me to the conclusion that the real reason we will buy robots by the thousands and millions is *not* so they can become our household servants. Instead we will buy them so they can become our pets, our companions, and our friends—just like a dog, a cat, a blanket, a teddy bear, or a velveteen rabbit.

According to most robotics experts, we are a couple of decades away from general-purpose household-servant robots. The sensors and computers in today's robots are too primitive for a robot maid or butler to survive in the hubbub and chaos of the average home.

Yet there are a dozen companies which are already marketing relatively low-cost "consumer" robots destined for the classroom or the home.

In *People* magazine and on TV talk shows, we see robot owners and their robots acting out our fantasies about what we'd do if we had our own personal robot. The robots are shown walking the dog, washing a window, or bringing the man of the house a beer while he reads the evening paper or watches a football game on TV.

This is silly!

How do you program a blind, wheeled robot who only accepts hexadecimal commands to walk

a dog around the neighborhood?

How do you get a two-foot-high robot who can't pick up a dishcloth to go to the refrigerator, open the door, pick out a beer, and somehow find the TV room?

Even robot sentries and guard dogs are pure fantasy—a dangerous fantasy. I know how much trouble my parents and their friends have with their computerized security alarms they have purchased for their homes. They are constantly setting off the alarms and sending the police and the fire trucks to their homes by accident.

How would *you* like to face a guard-dog robot armed with mace, tear gas, or an electrified snout? Would you trust that robot to consistently distinguish you from a burglar or robber? Would you trust that robot alone with your children?

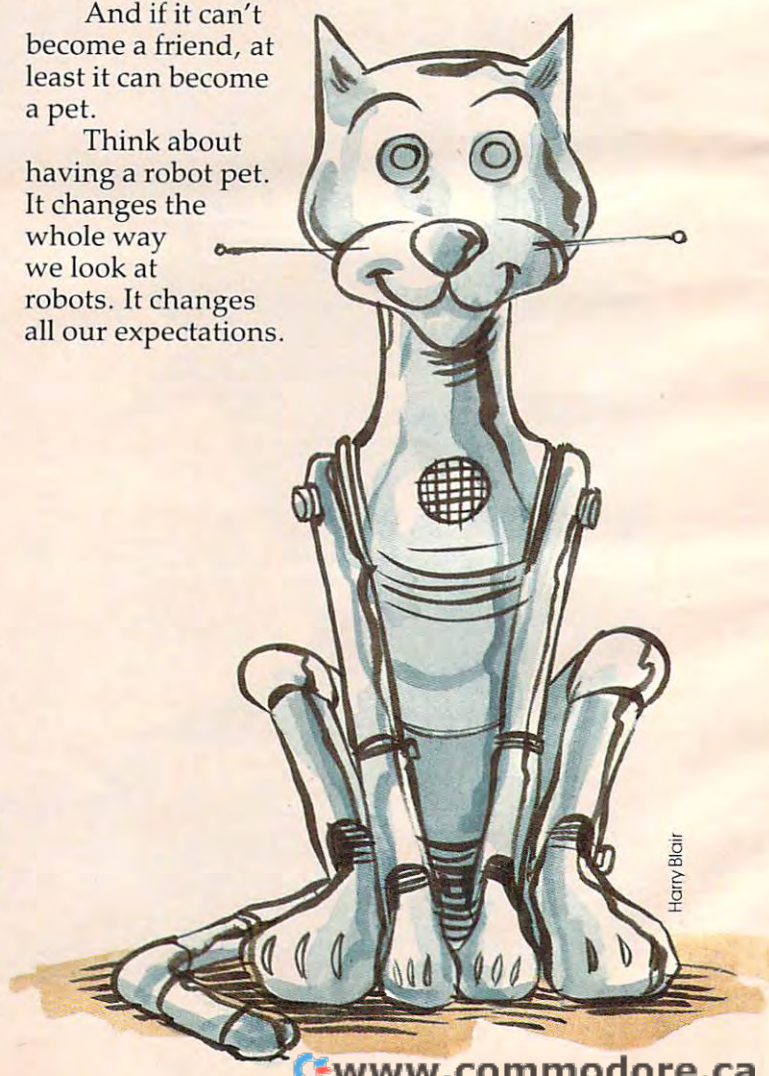
Why Buy A Robot?

Several months ago I wrote a number of columns about a "computer friend" that parents could program for their children. I said that, ultimately, user-friendly computers would evolve into computer friends, and not just for our children.

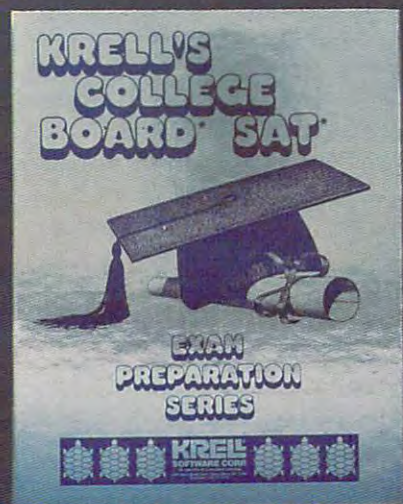
Now I think that the biggest justification for buying a robot is that it can become a friend—to our children and to us.

And if it can't become a friend, at least it can become a pet.

Think about having a robot pet. It changes the whole way we look at robots. It changes all our expectations.



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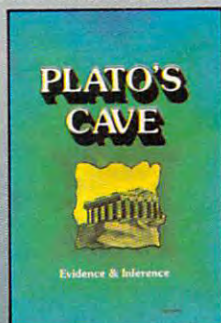
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If we look at robots as servants, we expect them to be convenient, hardworking, labor-saving devices. This, robots emphatically are not.

But if we expect robots to act like pets—like the family cat, dog, guinea pig, or goldfish—then we have a whole new set of expectations. And we can define a whole new set of standards. These standards can be just as rigorous as the standards for a robot maid or butler. But they can also be a lot more realistic.

We don't expect our dog or cat to wash dishes or take out the trash. We sometimes expect them to guard and protect us, but their performance in this area (as anyone who has ever had a watchdog will attest) is notoriously spotty. Our fearless watchdog might lick a burglar's hand, then turn around and bite the newspaper boy on the seat of the pants.

What can we expect from robot pets?

First, we can expect them to be lovable. To be lovable they should be cuddly, fuzzy, and huggable. They should be small enough so we can pick them up and carry them around with us. They should be "lap robots."

Also, they shouldn't be perfect. They should be just as quirky and silly as our cat or our pet gerbil. On occasion, they should be naughty, they should pout, they should be perverse and impossible. Or they should at least give the right appearance. We can easily imagine the rest.

Second, they should be teachable. We should be able to "imprint" ourselves as much on them as they do on us. They should learn our names, our favorite interests, jokes, and whimsies. They should be nice to us. They should be like the big old dog who acts like he is excited to see us when we come through the front door, or like the cat who can't wait to hop in our lap the moment we sit down.

Third, they should be tough. They should wear more like Denby than like a teddy bear or a blanket. They should be survivors of a lot of rough-and-tumble affection.

Fourth, they should be portable. They should be able to go on car, train, and plane rides. They should be able to go on vacations to the beach and still work even though they have sand in their sensors.

Fifth, they should teach us. They can teach us formal things like arithmetic, the names of countries and presidents, and the spelling of polysyllabic words. But they should also teach us little intangible things, like loyalty, affection, trust, ethics, and values. They should learn our values then echo them to our children and our friends.

They Could Become Friends

We should remember that robots are, above all, creatures of our imaginations. That is why we find them so fascinating. The more a robot en-

courages us to use our imagination when we deal with it, the more successful that robot will be. On the other hand, the more a robot tries to act like a mobile appliance, the more it will set us up for frustration and disappointment.

After all, what is a robot? I'm not sure I can answer my own question. But I do know that a robot is something more than an average machine like a dishwasher or vacuum cleaner. We project a great deal of ourselves into robots. We do not do this with vacuum cleaners and dishwashers.

What else do we project ourselves into? We project ourselves into pets, dolls, and toys. This is why we value these creatures more than our vacuum cleaners and dishwashers. It would be a shame if we were to build robots to imitate common household appliances. Then we would devalue our robots and they could never realize their potential. They could never be truly real.

If we want robots to become real, we should stop trying to get them to "grow up" and become common appliances. Instead we should direct them toward their greatest potential—to become mirrors of our minds, our feelings, and our imaginations. Today, using current technology, robots cannot become our household servants. But today's robots can become our toys and our pets. And, perhaps someday they may become our friends. ©



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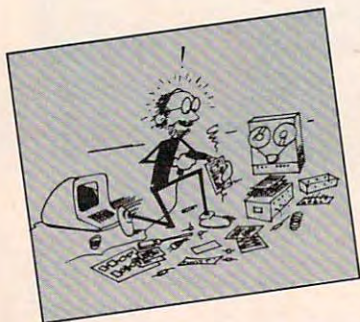


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Computer Popcorn

Fred D'Ignazio, Associate Editor



Last night I woke up in the dark with my head spinning. I turned to the digital clock beside the bed. It said 3:00 a.m. Musical notes and rainbow-colored rubber bands bounced around inside my mind. Over and over, a little voice

inside me kept repeating two words: "Computer popcorn. Computer popcorn. Computer popcorn."

The voice told me that I was supposed to get out of my warm bed and go into my dark, cold study. And what was I supposed to do when I got there? I was supposed to write about *computer popcorn*.

When I protested that it was the middle of the night and that I didn't want to get out of bed, the voice became surly. "If you don't get out of bed," it said, "you'll forget everything by morning."

"Forget what?" I thought.

"Computer popcorn," said the voice. "Computer popcorn is a computer program that is so good you can't put it down. You can't stop thinking about it. You even dream about it."

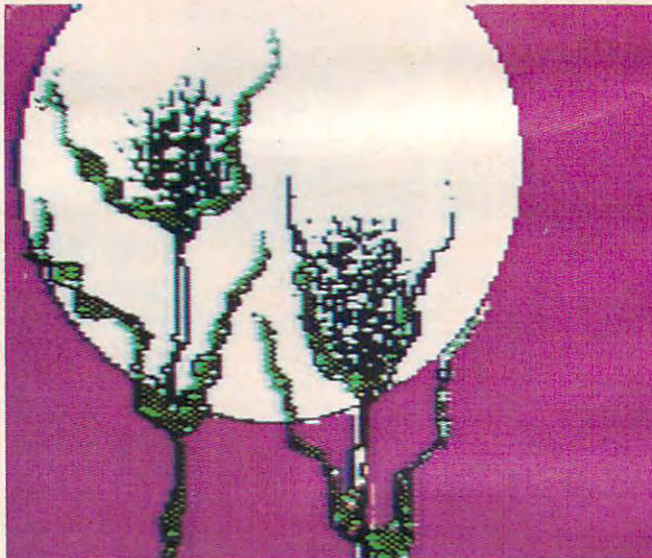
Fred D'Ignazio is a computer enthusiast and author of several books on computers for young people. His books include Katie and the Computer (Creative Computing), Chip Mitchell: The Case of the Stolen Computer Brains (Dutton/Lodestar), The Star Wars Question and Answer Book About Computers (Random House), and How To Get Intimate With Your Computer (A 10-Step Plan To Conquer Computer Anxiety) (McGraw-Hill).

As the father of two young children, Fred has become concerned with introducing the computer to children as a wonderful tool rather than as a forbidding electronic device. His column appears monthly in COMPUTE!.

Dreaming In French

At different periods of my life I have become so obsessed by and so immersed in a new subject that I can't stop thinking about it. I even take it to bed with me at night.

For example, I spent a couple of months backpacking around Europe one summer when I was in college. I spent the first night away from home in a hostel in Paris with a lot of my college



friends. The next morning they all yelled at me. "You kept us awake all night," they complained. "We don't know what you said, but it was all in French."

I used to be an international relations major. I learned a lot of languages and visited a lot of countries. When I visited Mexico I dreamed in Spanish. When I went to Brazil I dreamed in Portuguese.

I doubt if my French, my Spanish, and my Portuguese were grammatically correct, and I'm

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sure my pronunciation was not perfect. But the important thing is that I was excited about exploring a country and a new culture—so excited that I continued my exploration even while I was asleep.

Doorways Into New Worlds

This experience is a little like a religious conversion. It is a sense of rapture that you feel when you throw open a door and see endless vistas you've never imagined. Then you step through the door.

This is the feeling I've gotten recently from some of the new programs and computer peripherals I've been reviewing. In this article I'll take a look at one of these programs (*The Music Construction Set* from Electronic Arts) and a combined program/peripheral (the KoalaPad and the *Micro Illustrator* program from Koala Technologies).

Mechanical Drawing

When I was in high school, I took two classes that I thought were particularly painful. One class was mechanical drawing. The other was geometry. I found these classes so agonizing because they both involved the painstaking, *precise* drawing of geometric figures. In geometry class we mostly stuck to two-dimensional figures like squares, triangles, circles, and polygons. In mechanical drawing we began with blocks and cubes, and ended up drawing spaceship nose cones, automobile crankshafts, and "exploded" watch gears.

Surprisingly, I got good grades in both classes. I got the grades because I was such a perfectionist. I would struggle with the assignments for hours and finally turn out a beautiful, finished drawing.

But I hated every minute of it. By the time I finished doing the drawings my arm, wrist, and finger muscles felt so cramped I thought I would go crazy.

And I never thought about what I had drawn. I was too exhausted just getting the shapes down on the paper. The engineering and mathematical concepts underlying these drawings went right over my head. I never even considered them.

Rainbow-Colored Rubber Bands

With images of nose cones and polygons floating through my mind, I sat down for the first time and tried a new product, the KoalaPad from Koala Technologies (4962 El Camino Real, Suite 125, Los Altos, CA 94022, 415/964-2992).

You can buy a KoalaPad for \$125 and all supporting software packages for less than \$50. Different versions of the KoalaPad are made for the IBM PC; the Apple II, II+, and IIe; the Commodore 64; and the Atari 400, 800, and XL computers.

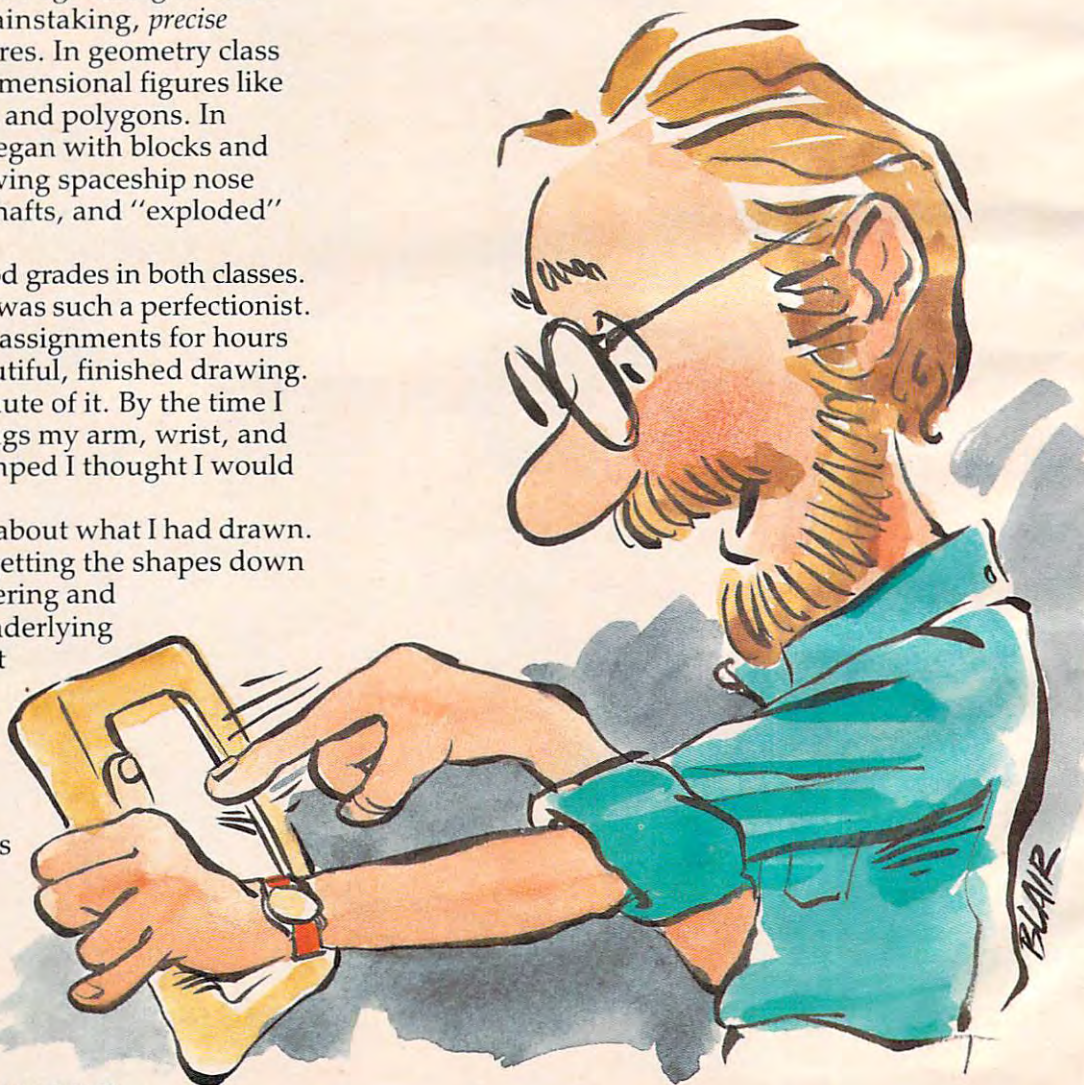
The pad is smaller than a TV dinner and weighs about as much as a paperback book. You plug the pad into the joystick port of your computer, and you hold it in your hand or lap while you draw, using either your finger or a plastic stylus that comes with the pad.

The KoalaPad comes with the *Micro Illustrator* program from Island Graphics (for the basic price of \$125).

"Growing" Circles And Boxes

The KoalaPad and *Micro Illustrator* are computer popcorn. They're delicious! Once you and your family start using them, you won't be able to stop.

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With a KoalaPad and *Micro Illustrator*, all of a sudden making geometric figures is easy. *Micro Illustrator* encourages you to make figures of great beauty and complexity. It's seductive. It's so easy to draw elaborate, symmetrical shapes that you keep thinking: What if? What if I connected these two lines, or what if I created some circles over here? What if I rotated this figure and colored it in?



With *Micro Illustrator*, drawing geometric shapes and figures is easy. The program, which is used with a touch tablet, makes picture creation effortless. This menu screen allows you to choose various brushes and colors.

My family and I have only had the KoalaPad and *Micro Illustrator* for a week, but, already, each of us has used them for several hours apiece.

And we still haven't explored all the features. I love the circle, disc, box, and frame commands. Using these commands you can "grow" geometric shapes in seconds.

Our favorite feature is the mirror. The mirror lets you draw simultaneously in four directions. Combine the mirror command and the line command and you can create glowing rubber-band lines that stretch like a net across the screen. Tack the circle command onto the mirror command and you can draw hosts of rotating circles. In no time at all you can create beautiful patchwork quilts, ornate tiles, bug-eyed aliens, and solar systems full of planets and moons.

The KoalaPad and *Micro Illustrator* are mar-

velous skill and imagination amplifiers. They allow me and my family to do things we could never do on paper. And they make it so effortless that we don't have to concentrate on the mechanical aspect of creating new shapes and pictures. We are free to create and to discover, and when we're finished, we're still fresh enough to be amazed.

The proof of how amazing these products are is how proud we are of what we create. The person on the computer is always calling to the other members of the family: "Come here, everybody! Look what I've drawn! You've got to see this one!"

Mechanical Bach

When I was seven years old, my mother started me on piano lessons. Maybe I wanted to learn about the piano at the time. I really can't remember, because the original joy of making music was quickly submerged by the daily grind of practicing and the weekly pilgrimage to the music studio where I suffered under the harsh tutelage of a nonstop stream of boring and unimaginative music teachers.

The teachers weren't really so bad. It was the method I hated. Like any kid, I had aspirations to create my own music, to make beautiful, original sounds that expressed how I felt and what I thought. But all I ever did was mechanically translate the printed musical notes of mediocre songs from the scores onto the piano keyboard.

I never realized that my teachers weren't treating me like a human being. They were treating me like a machine—a music player, like a player piano. I learned how to read other people's "frozen" music and then miserably try to reproduce it on the piano keyboard. The problem was that I didn't care for the music I was playing, and the sounds I made rarely pleased me. If I liked music (as I did) it was a lot easier to go to a record store and buy a record. Then I could hear the music I liked and it sounded right.

At some level I realized that my original purpose had been perverted. And, like any decent human being, I made a very bad machine. I repeatedly showed up for class late, I never practiced, and I never played a piece the way it was written.

This used to drive piano teachers crazy, and they never lost the opportunity to tell me how little musical talent I had.

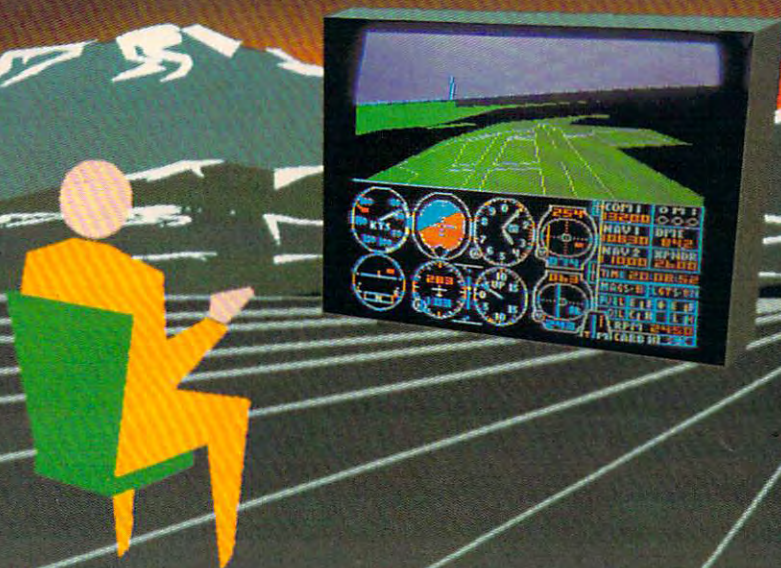
I didn't care. I would rather have been playing baseball or touch football. Anything rather than have to practice the G major scale for another half hour.

The Music Construction Set

The *Music Construction Set* is Will Harvey's response to piano teachers who teach their pupils

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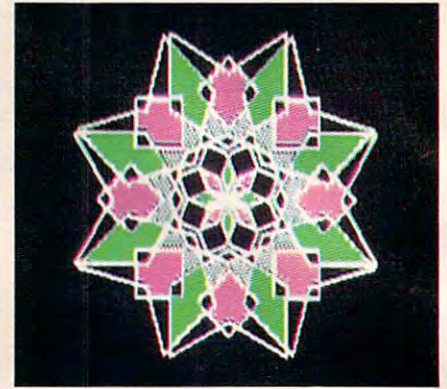
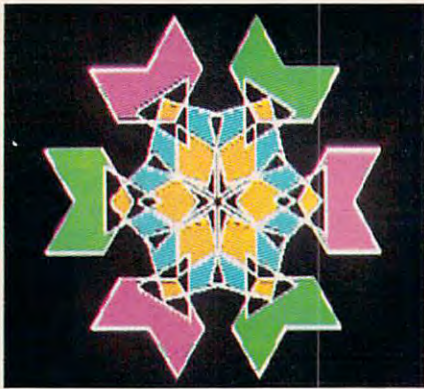
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to pretend they are machines. Will Harvey is a 16-year-old from Uplands High School in Foster City, California. When asked why he wrote *Music Construction Set*, Will replied: "It was something that needed to be done. I wanted someone who didn't know anything about music to be able to learn it simply and have a lot of fun doing it. I also thought it would be great if you could save what you wrote."

According to Will, his program is "simple, hot, and deep." By this he means that it is easy to use, it appeals to a person's senses, and it can grow with a person. The program is enchanting to musical novices as well as musicologists and musicians.

Music Construction Set (MCS) retails for \$40 and is published by Electronic Arts (2755 Campus Drive, San Mateo, CA 94403, 415/571-7171).

MCS currently runs on the Apple IIe and the Commodore 64 and will soon run on the Atari computers.

If you plan to use MCS on an Apple, you should consider a special offer by Electronic Arts. You can buy a Mockingboard stereo sound card for \$100 (\$25 off the regular price of \$125). The Mockingboard lets you create polyphonic sound on the Apple. That means you can create chords with up to six notes playing at the same time.

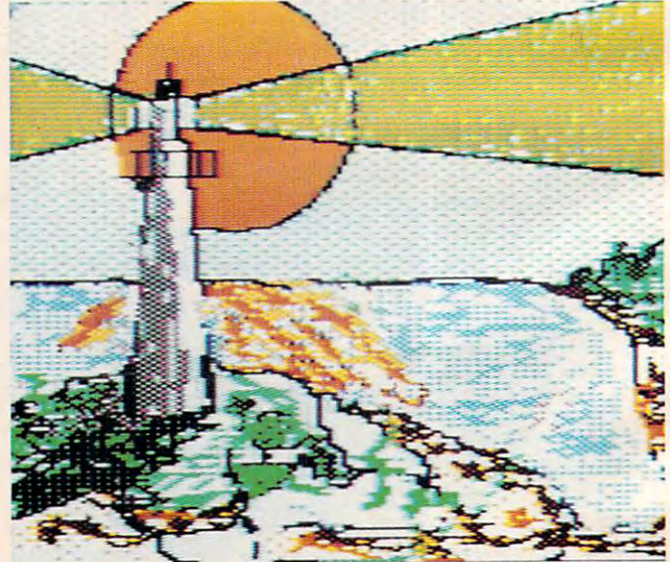
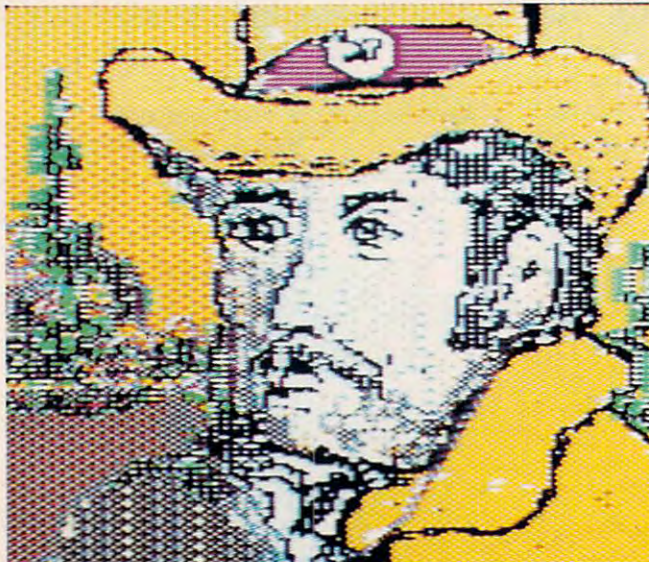
And you get stereo, too. Sweet Micro Systems is at 150 Chestnut Street, Providence, RI 02903 (401/273-5333).

If you have the Commodore 64, you have the SID (sound synthesis) chip, and you don't need the Mockingboard. When you run MCS on the Commodore 64, you will be able to compose and play music with up to three notes playing at a time. On the Atari, you will be able to create music with up to four notes playing at a time.

The other add-on to MCS that I enthusiastically recommend is the KoalaPad from Koala Technologies (see review above). You use the KoalaPad to move the notes and other musical symbols around on the picture screen. You can also move symbols using a joystick or the keyboard. But the *easiest* and *fastest* way to move musical symbols is using the KoalaPad.

This is how MCS works—on the Apple II+ with the Mockingboard and the KoalaPad:

First, you boot up the MCS disk, and you see empty musical staves at the top of the screen and a pictorial menu on the lower half of the screen. If you do nothing, the computer starts playing music itself, as if you have just put a record on your stereo. You hear ten songs, including Pachelbel's "Canon," Rimsky-Korsakov's "Flight of the Bumblebee," and the "Pat the Hat" rag by Douglas



Fulton. Then the music starts again. It will keep playing until you press the RETURN button.

Since you're into creating your own music, you immediately press RETURN. The next thing you do is press the plastic stylus on the KoalaPad down on the pad. Immediately a pointing-hand "icon" appears on the screen. You use the hand to "build" your song.

You move the stylus point across the pad and the hand moves across the screen. When the hand on the screen gets to an eighth note (there are also whole notes, half notes, quarter notes, sixteenth notes, and thirty-second notes), you press the top left-hand button on the KoalaPad. The note "jumps" into the hand. You move the hand onto the empty musical staves and position the note in the E-note position on the treble clef. When you let go of the KoalaPad button, the note falls out of the hand and glues itself to the staff.

You can do all this in just a couple of seconds.

Then you move the hand back to the menu of notes, rests, sharps, flats, ties, octave raisers, and time signatures, and pick them up, one at a time, and deposit them on the staves.

When you are finished creating some music—up to 1400 notes and up to 70 measures—you move the hand across the screen to point at the picture of the little house ("Home") and press the KoalaPad button. The musical score on the picture screen scrolls to the left, back to the first measure—the beginning of the music. Then you move your hand to point at the picture of the grand piano. You press the button, and the song you just created plays—in stereo.

This is just the beginning.

Cut And Paste

Now that you have created a song, you can play with it. By moving the hand around the screen and pressing the KoalaPad button, you can speed the music up, raise or lower the volume of each speaker, change the type of sound from regular to smooth, to vibrato, to drum-like. With the push of a button, you can transpose the music to other keys and replay the music in each key.

And you can use MCS like a word processor to cut and paste measures of music. On the screen is a little pair of scissors and a paste pot. Using them, you can cut up to nine measures out of the beginning part of your song and move them forward or backward in your song.

This is one of the most exciting parts of MCS. As I said earlier, when you play your music, the measures filled with notes scroll by on the picture screen, from right to left. As you listen to the notes you also watch them scroll by. Playing music becomes an effortless experience that is visual as well as auditory. You can concentrate on hearing and seeing the notes, not just playing them. It's a

great joy (to an ex-player piano like myself) not to have to concentrate on stretching your hands and positioning your fingers to get each note right. The computer takes care of these details for you.

Since music now becomes a visual experience, you can begin perceiving patterns visually as well as by sound. And, if you like certain patterns, you can repeat them in the music by using the hand and the scissors to cut the measures in which they appear and "paste" them into other places in the music.

When you are done creating your own music, you can fool around with it. Then you can save it on disk. And, if you have a printer, you can print out a copy of the score.

Poppin' Hot

Now you see why I have trouble sleeping at night. You can see why I go to bed and dream about rainbow-colored rubber bands and dancing musical notes.

Perhaps you can also see why the little voice inside my head so persistently kept telling me to write about "computer popcorn." The KoalaPad, Micro Illustrator, and Music Construction Set are like popcorn. They are so much fun and taste so good, once you start with them you just can't stop.

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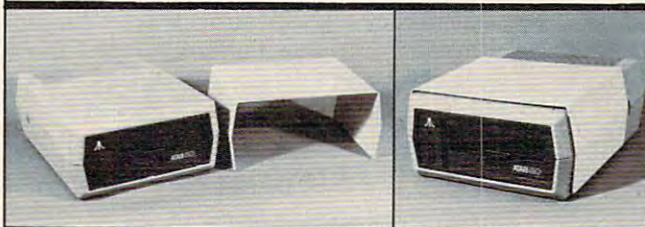
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THE BEGINNER'S PAGE

Richard Mansfield, Senior Editor

Canned Calculations

Many of the personal computer's most useful home applications could also be worked out on a \$3 calculator. Why use a computer?

The best answer is that a computer does far more of the work for you than a calculator. Once you teach your computer how to solve a problem, it can remember the method and apply it to a whole class of similar problems. Instead of having to go through all the mathematics each time, you can just give the computer the numbers (the *data*) and it will automatically perform all the necessary steps on its own. That's why computers are sometimes called *data processors*.

Let's see what this means with a practical example. Most home improvements involve the same kind of estimate: How many gallons of paint will I need to repaint the bedroom? Or bags of fertilizer for the lawn, or squares of tile for the floor? To figure paint, you've first got to find out how many square feet you're trying to cover, then decide how many square feet a single can of paint covers, then how much each can costs.

Figuring square feet is the hard part. The computer can ask questions, though, and find the answer for nearly any situation. After the square feet are calculated, it's easy. Just ask for coverage and cost and the estimate is complete.

Valuable Techniques

Take a look at the program. There are some interesting techniques to learn. First, we want the program to be as generally useful as possible. It should be able to calculate all kinds of home improvements. So we have the user give a name to the problem in line 10. Then, as a reminder, lines 30–

70 define how to go about gathering the data that the program needs to reach a solution. After the user has told the computer how many rectangles are involved in the area to be painted, it guides him or her through the necessary number of inputs. This guidance takes place between lines 100–190 within a *loop*.

The computer cycles the user through the length-width question as many times as necessary. It counts up until each rectangle has been accounted for. The variable `RECTS` in line 100 governs the loop. Line 190's `NEXT` keeps bouncing us back up to line 100 until the information is completely entered.

There's a convenience feature in line 140. If you were estimating a typical bedroom, it's likely that two, or even all four, of the walls would have identical measurements. Rather than having to enter the same numbers over and over, you can just answer 0 to the question `LENGTH ?` and the computer will skip down to line 180. This is possible because the previous answers are calculated in line 170 and are held in the variable `LATEST`. If we skip over this line, `LATEST` will still be holding the amount calculated from the previous entries. So, the calculation in line 180 will add the size of the previous rectangle into our running total of square feet, `SFEET`.

It's Not Algebra

Notice that variables in computers are handled somewhat differently than you might remember them from algebra class. The equals sign in line 180 does not make this group of numbers, these variables, into an equation. Rather, the line is

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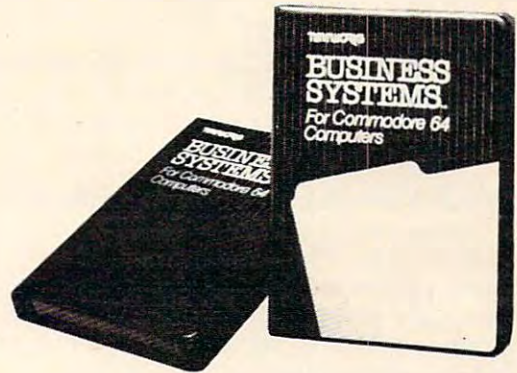



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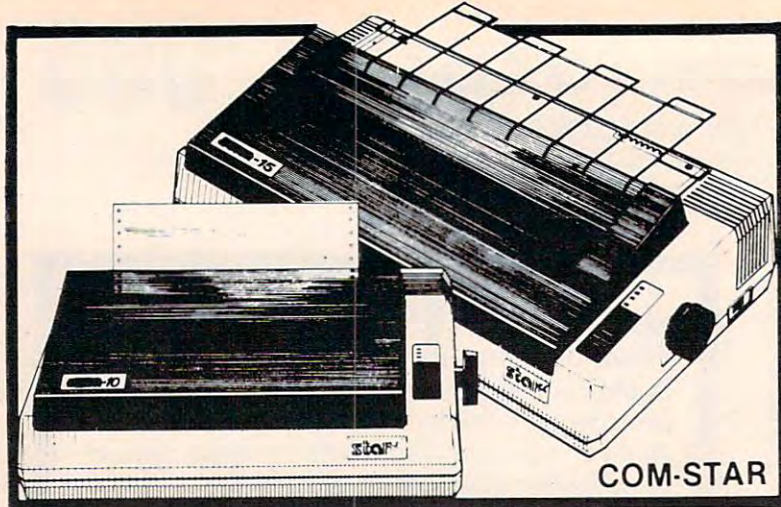
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assigning a value to the variable SFEET.

You read such lines from left to right to understand their meaning. To put line 180 into words: The current amount in (the number "held by") the variable SFEET is now added to the current amount in the variable LATEST. And then this total is placed into the variable SFEET (SFEET is a running total). In other words, SFEET is being changed in this line. Before line 180 executes, the SFEET on the right holds the number resulting from the previous execution of line 180. And after the line executes, the SFEET on the left is going to hold a larger number than it did before. The same thing happens to the variable PRICE in line 290.

Lines 200-230 are pretty straightforward. Here, we're just gathering our last two pieces of information: coverage and cost. Line 240 isn't necessary; it just clears the screen so we can print out the answers on a clean screen.

Since SFEET has been keeping a running total of square feet for us, we can just print SFEET in line 250 without any further calculations. Line 260 calculates the total number of cans of paint you'll need to buy. It divides the total number of square feet to be painted by how many square feet each can of paint covers. Then line 270 reports these results.

The total cost is figured in line 290 by multiplying the price of each can by the number of cans needed. This line also figures in the tax (6 percent in this example) by multiplying the result of the mathematics within the parentheses by 1.06. If your state charges 4 percent, just change it to 1.04.

It's important to remember that when you are performing two or more mathematical operations, sometimes one operation must be performed before another. When you put something inside parentheses, it will be worked on first. We want the whole result multiplied by 1.06, not just AMOUNT. So, we put $\text{AMOUNT} * \text{PRICE}$ within parentheses and that gets figured out before the 1.06 is even looked at.

Stripping With INT

Finally, line 300 rounds off the PRICE to dollars and cents. It's possible to get results like \$12.080993 if you leave out the rounding off functions in this line. How does this work? Imagine that the computer gets a final result of \$12.080993 for PRICE. First it's multiplied by 100 since that's inside the parentheses and since multiplication is performed before addition. (When parentheses aren't involved, the order in which things are performed is My Dear Aunt Sally—multiplication, division, addition, subtraction.)

Anyway, after $*100$, our 12.080993 becomes 1208.0993. Next, .5 is added, which makes it 1208.5993. Then the INT takes effect and INT

doesn't really round anything off, it just strips away the decimal. That is, $\text{INT}(5.9999)$ would result in 5. To make it round accurately, we have to add .5 to a number before INTing it. In this way, if the fraction part of a number were .5 or higher, when we add .5 we effectively add 1 to the integer part of the number. $5.9999 + .5$ becomes 6.4999 and when that's stripped with INT, it's 6, the accurately rounded result.

So $\text{INT}(1208.5993)$ becomes 1208. Finally, we move the decimal point back over two places by $/100$ for our final answer: \$12.08.

This estimating program will provide answers for various types of home improvements. And it can be extended to ask more questions and give more answers. One of the most powerful aspects of computers is the ease with which you can modify a program like this to make it solve all kinds of other problems for you. For example, why not try modifying line 250 to also give you the results in square meters? (1 meter = 3.281 feet.)

Home Improvements

```
10 PRINT "WHAT DO YOU NEED TO BUY? (CANS O
   F PAINT, ROOFING TILES, ETC.)"
20 INPUT ITEMS$
30 PRINT "WE NEED TO MEASURE THE AREA YOU'
   RE GOING TO COVER."
40 PRINT "THE EASIEST WAY IS TO DIVIDE THE
   AREA INTO RECTANGLES."
50 PRINT "FOR EXAMPLE, TO PAINT THE BEDROO
   M, YOU'LL HAVE 5 RECTANGLES:"
60 PRINT "THE FOUR WALLS AND THE CEILING."
70 PRINT "SO, FIRST, HOW MANY RECTANGLES A
   RE INVOLVED IN THIS JOB"
80 INPUT RECTS
90 PRINT "NOW, FOR EACH RECTANGLE, ENTER I
   TS LENGTH AND WIDTH:"
100 FOR I = 1 TO RECTS
110 PRINT "{14 SPACES}RECTANGLE #";I
120 PRINT "LENGTH"
130 INPUT L
140 IF L = 0 THEN 180
150 PRINT "WIDTH"
160 INPUT W
170 LATEST = L * W
180 SFEET = SFEET + LATEST
190 NEXT I
200 PRINT "HOW MANY SQUARE FEET DOES EACH
   {SPACE}OF THESE ";ITEMS$;" COVER"
210 INPUT COVERAGE
220 PRINT "HOW MUCH DOES EACH OF THESE ";I
   TEMS$;" COST"
230 INPUT PRICE
240 PRINT "{CLR}":REM CLEAR THE SCREEN
250 PRINT "YOU ARE GOING TO BE COVERING ";
   SFEET;" SQUARE FEET OF AREA"
260 AMOUNT = SFEET/COVERAGE
270 PRINT "YOU WILL NEED "; AMOUNT; ITEMS$
280 PRINT "TOTAL COST (INCLUDING TAX)-- $"
   ;
290 PRICE = {2 SPACES}1.06 * (AMOUNT * PRI
   CE)
300 PRINT INT (PRICE * 100+.5)/100
```

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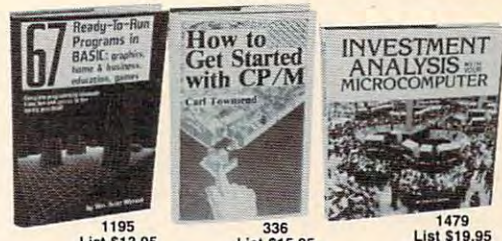
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Computers And Society

David D. Thornburg, Associate Editor

Computers And The Arts

From time to time I have used the space of this column to explore the use of computer technology in the fine arts. Because of continuing activity in this area, I want to address this issue again.

As I look back on 1983, I feel that one of the more significant developments in the use of personal computers has been in the application of computers as tools for personal expression. Whether this expression is through writing (for which word processors are most valuable) or in the visual or auditory arts, many thousands of computer users are finding that this technology is a powerful tool with which to unleash creative energies.

On the surface, it may seem strange to think of an analytical tool such as the computer as a medium by which creative energies can be unleashed, but the reasons that computers can (and should) be used in this fashion are quite clear.

Much of the effort involved in the expression of creative ideas requires tedious work that is not directly related to the creative task. The unpleasant job of transcription, for example, can interfere with creative writing.

And yet the computer brings something else to the creative act. Rather than being just a tool through which creativity can be expressed, the computer can be the creative medium itself. In this fashion the computer serves as far more than a simple transcription tool and is transformed into a tool with which totally new ideas can be developed and expressed.

Genesis II

A new book, *Genesis II*, by Dale Peterson, deals with this very topic. Peterson acknowledges that a literal comparison between his book and the biblical account of the origins of the world is inappropriate. He says instead that while the original Genesis tells of a universal creation, his book deals with the creative possibilities of a tool which also might have universal applications. The subtitle of his book, *Creation and Recreation with Computers*, is

an accurate assessment of its content. The book is divided into four major sections involving creation in: light, sound, symbol, and recreation.

I have met people who feel that it is inappropriate for an artist to use high technology. As Peterson points out, however, artists have always depended on technological advances—easels, oil-based paints, lithography, or, in music, the highly technical pipe organ. His point is that the computer is not going to replace other tools in the artist's kit, but will simply be a new tool with which to explore and develop ideas.

There has always been a distinction between "machines" and "art"; machines are designed to do, and art is designed to be. As he says, "... art's purposes are distant, often obscure, often psychological or spiritual. Whereas a machine's purposes are immediate, obvious, direct, and physical."

With this starting point, Peterson traces the development of the use of the computer in the fine arts from its beginnings to the present time. In computer graphics, for example, he starts with the Whirlwind computer at MIT in the 1950s, and traces the work of Whitney and others who have explored the computer as a medium of visual expression.

He identifies some characteristics of the computer that make it sufficiently different from other media to warrant its use by artists. Specifically, he observes that precision, iteration, transformation, and serendipity are four characteristics of computer assisted artistic expression that are unique to this medium. The computer's ability to drive a pen plotter with extraordinary precision is well-known, and the use of programming loops for repeating picture elements is also of great utility.

Also, the fact that a computer can calculate "in between" images that allow one to see a transformation, for example, of a butterfly into an ice cream cone, is of obvious value to an artist. But the most exciting aspect of computer assisted art is that it offers many chances for serendipitous events to occur. Because computers allow more

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experimentation than most media, the artist can remain open to some exchange between mastery of technique and accident. Often this leads to unexpected results that the artist finds quite fascinating.

Sound And Symbol

In his section on creation with sound, Peterson quotes the brilliant composer Edgar Varese, who in 1917 wrote: "I dream of instruments obedient to thought—and which, supported by a flowering of undreamed-of timbres—will lend themselves to any combination I choose to impose and will submit to the exigencies of my inner rhythm."

Varese anticipated the type of freedom and power that modern day musicians have when a computer is used to help in the creation and/or performance of a musical score. By presenting a good background on the nature of computer-synthesized music, Dale Peterson gives the reader a basis for a deeper appreciation of the new musical ideas that are being developed with the aid of the computer.

Creation with symbol implies (more or less) creation with the written word. While not spending much time on topics as obvious as the use of word processors, Peterson instead focuses on the use of computers to create "computer generated"

poetry and prose. It is fascinating to see and read some of the results in this area, and it is important to understand that when a computer generates poetry, it does so because the human poet programmed it to do so. Nonetheless, the results of these programs are somewhat unpredictable and some of them are even very interesting.

The work of Scott Kim, author of the beautiful book *Inversions* (Byte/McGraw-Hill), is also presented in this chapter. Scott is a calligrapher who delights in writing words in such a stylized manner that they read the same way when turned upside down, or when viewed in a mirror. His creation of word-specific alphabets that allow words to be written this way is aided by computer technology. Peterson acknowledges that Kim's work might also fit well in his section on graphics, and herein lies an important message.

The computer artist is not that easy to categorize. Rather than being limited to visual expression, for example, the artist has all the expressive capabilities of the computer at his or her disposal. The use of graphics (and animation) and sound, and text, can all appear in a new synthesis of art that defies categorization.

It is this combination that I think really shows the power of the computer as a creative tool. This is certainly true in some modern computer-based games, and is touched on in the section on "creation in recreation."

Creative Possibilities

The computer as a game tool dates back to the early days of computing. I was delighted to read, for example, that Charles Babbage (who proposed the development of the Analytical Engine, a mechanical computer designed in the 1800s) suggested that the machine be programmed to play "tit tat to" and be set up to operate by having the player insert coins for each game. The concept of the coin-operated computer game predates the actual appearance of such games by over 100 years.

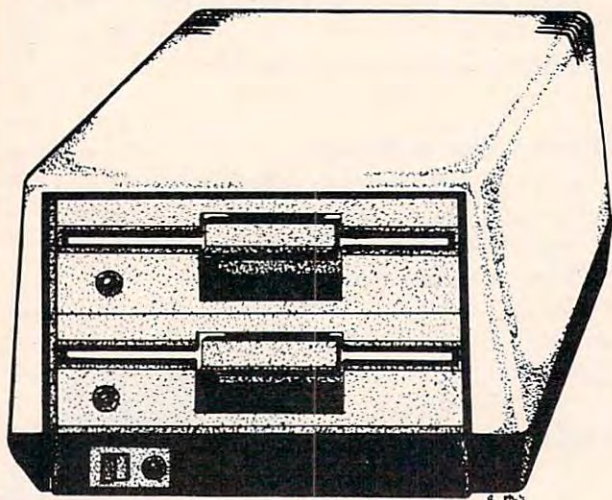
As a beautifully written book on a fascinating topic, *Genesis II* deserves a wide audience. By providing a brief history of the use of computers in the fine arts, it can serve as a springboard to future work in this area.

While *Genesis II* focuses on the pioneers who used large computer systems to do their work, I continue to be excited by the prospect that significant contributions to the use of computers in the arts will come from those of us who use personal computers. The fact that these machines are so widely accessible guarantees that they can be used by artists who would otherwise not have access to computer technology.

Next month we will explore two ways that the personal computer can be your tool for creative exploration.

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Questions Beginners Ask

Tom R. Halfhill, Features Editor

Are you thinking about buying a computer for the first time, but don't know much about computers? Or maybe you just purchased a computer and are still a bit baffled. Each month in this column, COMPUTE! will answer some questions commonly asked by beginners.

Note to readers: In the September 1983 "Questions Beginners Ask," I answered a question about why some computers have numeric keypads while others don't. I also noted that computer and calculator keypads are arranged exactly the opposite of Touch-Tone telephone keypads: Computers and calculators arrange the keys in descending numerical order, starting at the upper right and ending at the lower left, while telephone keys are just the reverse. I invited any readers who knew why to share the information.

Over the last couple of months I've received several answers—some of them contradictory. Interestingly, people seem to be divided into two camps on the subject. Therefore, in this month's column, I'll let the readers provide the answers. Here are samples:

Keypads on telephones and calculators, computers, etc., differ because an experienced bookkeeper and/or keypad operator would drive the telephone company "straight up the wall"—the new equipment of today might handle the speed, but equipment prior to (?) 1981 just wouldn't work—so we slowed them down by reversing the numbers.

*Harry Allston
Old Telephoneman (27 yrs.)*

When push-button phones were first available, the difference between calculator keyboards and telephone push buttons was commented on in several places. The explanation then was that a skilled calculator operator could enter numbers faster than the telephone equipment could respond. I can't quote a source.

Bob Strickland

When push-button telephones came out, the keypad was arranged differently because the letters which share keys with the numbers would be arranged in a confusing pattern if the adding machine standard had been followed (try imagining the telephone letters on a calculator

keypad sometime to see this effect). Calculator and computer manufacturers followed the adding machine standard, their products being closely related in use to adding machines. Thus we have two keypad standards.

Rod Smith

Here in Illinois, our phone company includes a monthly newsletter with each bill, entitled "Telebriefs." It just so happens that the August issue has a feature on the difference, entitled "It Adds Up: Touch-Tone Buttons Are 'Letter-Perfect'." The article goes on to explain that people still question the difference 19 years after the introduction of Touch-Tone service. They explain that despite the ideas of many people, having identical keypads would not reduce wrong numbers.

The arrangement of Touch-Tone pads allows for the alphabet to be in proper order from top to bottom. Also, the arrangement was decided upon by the engineers at Bell Labs only after careful consideration and experimentation. Sixteen different arrangements were tested. The results showed that even bookkeepers who constantly use calculators could "dial" calls faster with the present Touch-Tone keypads.

Interestingly, ITT [International Telephone & Telegraph] is introducing a new style of phone which has a linear keypad—a single row from left to right!

Robert M. Bara

I think the enclosed article from a monthly publication of Illinois Bell Telephone Company will at least explain the telephone company's logic in using their current configuration on Touch-Tone phones.

William R. Kunkel

Since two readers cited the article in Illinois Bell's "Telebriefs," I'll quote from it briefly: "If Touch-Tone dials followed the same pattern as the face of a calculator, the telephone alphabet would begin with 'PRS' and end with 'DEF'—not an ideal arrangement for most people. There's another reason...engineers at Bell Laboratories tested 16 different button arrangements. The result? Even bookkeepers, for whom calculators are everyday tools of the trade, found they could dial calls faster and more accurately with the buttons arranged as they are now."

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explanations as to why computer and telephone keypads are exactly opposite. One camp contends the phone company tried to slow down keypad typists, while the other side (including a phone company itself) claims that alphabetic order was the deciding factor, and that keypad typists aren't slowed down at all.

Who to believe? It's conceivable that both sides are right. Maybe the original push-button equipment really couldn't handle fast entry by bookkeepers, but today the phone company doesn't want to admit that it based its decision on obsolete equipment. Or, maybe Bell really did object to a backward alphabet—although the letters are rarely used when dialing phone calls.

In any case, is it really true, as Illinois Bell says, that even bookkeepers can dial calls "faster and more accurately" with telephone-style pads? Personally, I have trouble switching back and forth between the subtle differences of Atari and Commodore computer keyboards. On the other hand, I've heard that many experienced touch-typists have no problems adapting to the radical changes of Dvorak typewriter keyboards.

Anyway, pretty soon the whole question will become moot when machines are no longer mute. If voice-synthesis and voice-recognition technology keeps advancing, someday we might do away with keyboards and keypads altogether. ©

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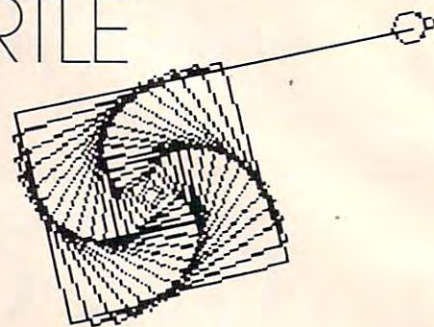


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David D. Thornburg, Associate Editor

The Demons Of Atari Logo

It is amazing, when one thinks about it, that within a very short time Logo has gone from a university-based research language to one of the most affordable and powerful programming languages ever to appear on personal computers.

What is even more exciting are the evidences of dynamic growth and development in Logo as new versions appear in the marketplace. Among the most powerful implementations of Logo ever to appear on an eight-bit computer is Atari Logo, developed by Atari and LCSi. In addition to having all the list-processing capability and turtle graphics that Logo is known for, Atari Logo also supports multiple turtles (four) and animation. From a graphics perspective, the excellence of this version derives from the fact that (using graphics mode 7) Atari computers can display any of 128 combinations of hue and luminance. Even with only four colors on the screen at a time, this ability to choose and change colors, even after they have been painted on the screen, gives the computer artist a flexibility and freedom lacking in other systems.

The WHEN Demon

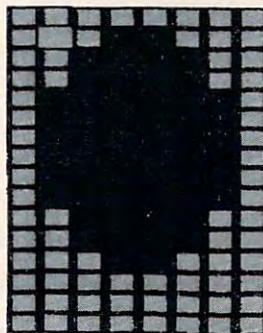
But, when I was writing my book on Atari Logo (*Computer Art and Animation—A User's Guide to Atari Logo*, Addison-Wesley, Spring, 1984), the feature that struck me as being most powerful was the WHEN demon.

A WHEN demon is a special Logo object that continuously monitors the computer, waiting for any of 21 special events to occur. Whenever one of these events takes place, the "demon" associated with that event executes its own set of Logo instructions no matter what other instruc-

tions or procedures are being used at the time. When these demon instructions or procedures are finished (and the WHEN condition is no longer satisfied), Logo goes back to whatever it was doing before the demon procedures were used. The best way to understand the power and utility of the WHEN demon is to see it in use.

A common starting point for experimenting with animation is to create a sequence that shows a bouncing ball. By using a WHEN demon, you can easily write a procedure that has a ball bounce from walls near the bottom and top of the screen and have the ball look "squashed" as it hits the walls.

First, we need two ball shapes—one for a round ball and one for a squashed ball. These shapes can be defined in Atari Logo as two of the 15 user-definable shapes available at any one time. We will assign shape 1 to the round ball and shape 2 to the squashed one. The easiest way to create shapes in Atari Logo is with the EDSH command that gives you access to the graphic shape editor. By moving the cursor to the appropriate places on the screen and pressing the space bar, you can build any shape you want in the available grid.



Turtle Collisions

Next, enter the following procedure:

```
TO BOUNCE
CS
WHEN 0 [SETSH 2 WAIT 5 SETSP - SPEED WAIT
  10 SETSH 1]
PU HT SETPOS [- 100 100] PD
SETH 90 FD 200
PU SETPOS [- 100 - 60] PD
FD 200
PU SETH 0 SETPOS [0 0]
SETSH 1 ST
SETSP - 30
END
```

Before using this procedure we will explain how it works. The first line that might appear cryptic is:

```
WHEN 0 [SETSH 2 WAIT 5 SETSP - SPEED WAIT
  10 SETSH 1]
```

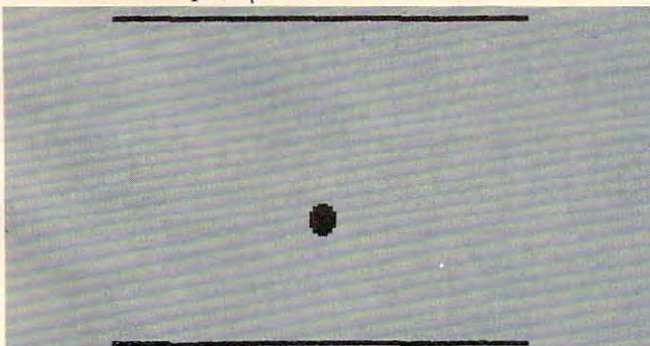
The WHEN command is followed by a number and a list of instructions. The number refers to a condition (shown in the table). Whenever this condition is satisfied, the list of instructions is executed. As you can see from the table, condition 0 will occur whenever turtle 0 collides with a line drawn by pen 0. So, whenever our default turtle touches a line drawn with the default pen, the WHEN demon will execute the list of commands shown, no matter what other commands or procedures Logo may be executing at the time. The commands we have chosen replace the round ball with the squashed one for a short time, and then reverse the direction of the turtle motion by changing its speed (given by the Logo function SPEED) to its negative value.

WHEN demons must be created while the computer is in either the split screen or full screen mode. Once a demon is created it remains active until you return it to its inactive state or clear the screen with the CS command. To return a demon to an inactive state you just enter, for example,

```
WHEN 0 []
```

Automatic Bounce

The next six lines of the BOUNCE procedure draw horizontal border lines at the top and bottom of the screen with pen 0 and place turtle 0 (with the round ball shape) in the center of the screen.



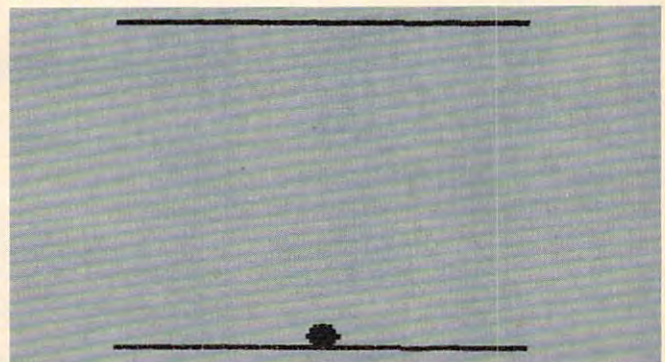
WHEN Demon Condition Table

| Condition Number | Detects When |
|------------------|--|
| 0 | turtle 0 touches a line drawn with pen 0 |
| 1 | turtle 0 touches a line drawn with pen 1 |
| 2 | turtle 0 touches a line drawn with pen 2 |
| 3 | button on joystick is pressed |
| 4 | turtle 1 touches a line drawn with pen 0 |
| 5 | turtle 1 touches a line drawn with pen 1 |
| 6 | turtle 1 touches a line drawn with pen 2 |
| 7 | each second has elapsed |
| 8 | turtle 2 touches a line drawn with pen 0 |
| 9 | turtle 2 touches a line drawn with pen 1 |
| 10 | turtle 2 touches a line drawn with pen 2 |
| 11 | not used |
| 12 | turtle 3 touches a line drawn with pen 0 |
| 13 | turtle 3 touches a line drawn with pen 1 |
| 14 | turtle 3 touches a line drawn with pen 2 |
| 15 | joystick position is changed |
| 16 | turtle 3 touches turtle 0 |
| 17 | turtle 3 touches turtle 1 |
| 18 | turtle 3 touches turtle 2 |
| 19 | turtle 0 touches turtle 1 |
| 20 | turtle 0 touches turtle 2 |
| 21 | turtle 1 touches turtle 2 |

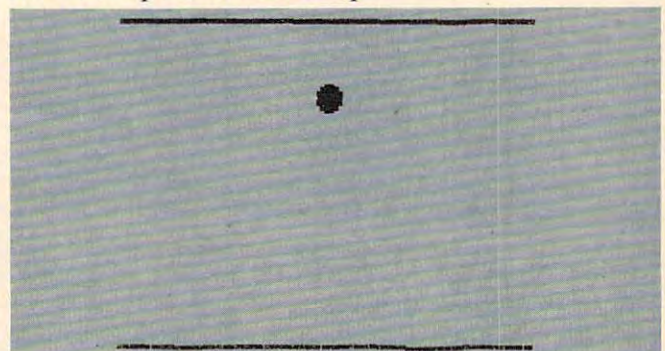
The command

```
SETSP - 30
```

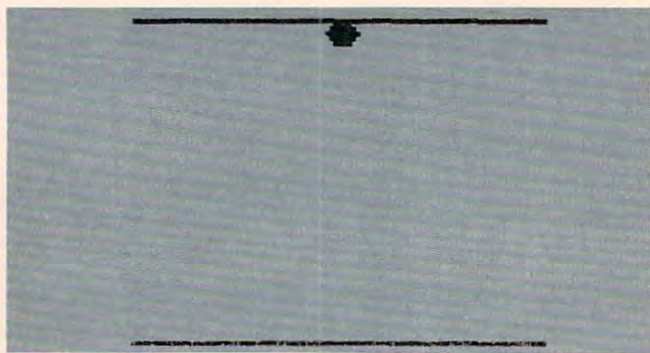
starts the ball moving down towards the bottom line. When the ball reaches the bottom, it takes on the squashed appearance and starts back up the screen.



The squashed ball quickly restores itself to its round shape as it moves up:



When the ball hits the top line, it gets squashed again and starts back down to repeat the process forever.



To see how automatic the process is, press the BREAK key to stop the procedure. It will keep on going by itself until you type something like CS.

WHEN demons allow you to do all sorts of interesting things as your turtles collide with lines or with each other, and can form the heart of many spectacular animation projects.

The experience of writing procedures that use this powerful feature is one of the more rewarding benefits of using Atari Logo. ©

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Commodore EXBASIC LEVEL II

Louis F. Sander

EXBASIC LEVEL II is a plug-in cartridge that adds to the built-in capabilities of PET, CBM, VIC-20, and Commodore 64 computers. The version tested is for the PET, and consists of two plug-in ROMs rather than a cartridge. In all, EXBASIC LEVEL II adds over 80 new commands, statements, and functions to the computer's built-in BASIC. The extended BASIC it provides is similar to Radio Shack's TRS-80 LEVEL II BASIC, and many TRS-80 programs should run on an EXBASIC II-equipped computer with little or no translation.

The table lists the new commands which EXBASIC II provides, along with a brief explanation of each. They are of three distinct types—programmer's aids, improvements to existing BASIC statements, and completely new statements and commands.

The programmer's aids are numerous and powerful and are more than satisfactory for the serious programmer.

Nevertheless, the additions and improvements to BASIC are what make this accessory so interesting—there are lots of them, and most of them you probably wish you had already. PRINT USING and PRINT@ are good examples of these, as are

EXBASIC LEVEL II Commands—Alphabetical List

| | |
|-------------|---|
| AUTO | Automatically rennumbers program lines |
| BASIC | Disables EXBASIC |
| BEEP | Does a timed CB2 beep |
| BEEP OFF | Disables BEEP |
| CALL | Like USR, but with named calls, multiple parameter passing |
| DEC | Converts hex to decimal |
| DEEK | Double-byte PEEK |
| DEF CALL | Sets CALL vector |
| DEF USR | Sets USR vector |
| DEL | Deletes a range of line numbers |
| DISPOSE | Allows graceful exit from GOSUB or FOR-NEXT loop |
| DOKE | Double-byte POKE |
| DOS Support | DOS support, or "wedge," commands are included |
| DUMP | Lists values of all variables (for arrays, see MATRIX) |
| ELSE | See IF...THEN |
| EVAL | Evaluates expressions in string format |
| EXEC | Executes BASIC statements in string format |
| FAST | Speeds up PRINTing |
| FAST OFF | Disables FAST |
| FIND | Finds desired statements in a program |
| FRAC | Returns fractional part of a number |
| GO | Calls the ML monitor (Extended monitor on 80-column machines) |
| GOTO | Improved: '.' shorthand |
| HARDCOPY | Dumps the screen to the printer |
| HELP | Lists all EXBASIC keywords |
| HELP* | Lists all Commodore BASIC keywords |
| HEX\$ | Converts decimal to hex |
| HIMEM | Sets top of memory |
| HPlot | Plots horizontal bar graphs |
| IF...THEN | Improved: ELSE allowed, THEN optional, '' shorthand |
| INPUTFORM | Improved INPUT statement #1 |
| INPUTLINE | Improved INPUT statement #2 |
| INSTR | Locates substrings |
| LETTER | Selects lowercase mode |
| LETTER OFF | Selects graphics mode |
| LIST | Improved: @ key causes pause, any key resumes; '.' shorthand |
| LOAD | Loads tapes made at fast speed (see SAVE and MOD) |
| LOAD* | Loads tapes made at standard Commodore speed (see SAVE*) |
| MATRIX | Lists values of array variables (for other variables, see DUMP) |
| MAX | Finds the largest of a group of values |
| MEM | Greatly expanded FRE(0) |
| MERGE | Merges or appends from fast tapes (see SAVE) |

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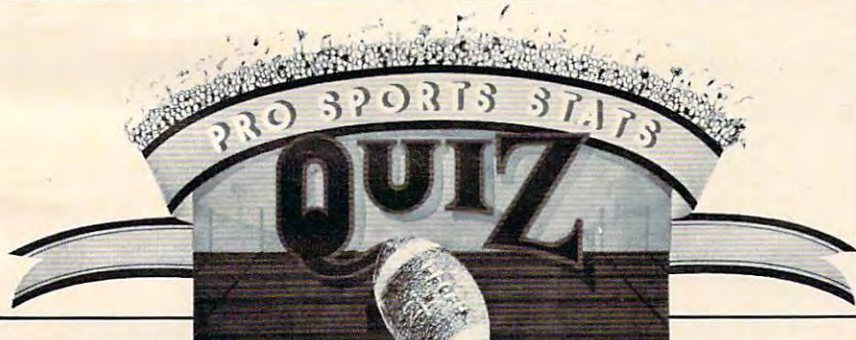
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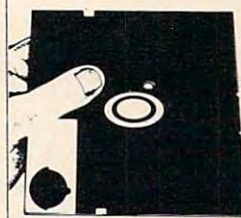
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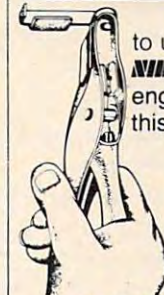
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PAT. PEND.

INPUTFORM and INPUTLINE. The first two are familiar to users of non-Commodore BASICS, while the latter allow easy formatting of INPUT statements, also allowing commas and semicolons to be input. The new IF...THEN...ELSE construction is another improvement, one that can eliminate a lot of confusing loops in your programs.

Graphics commands SET, RESET, and POINT allow you to do high-resolution plotting with 1/4 square pixels, while VPLOT and HPLOT make it easy to draw bar graphs. DOKE (Double-byte pOKE) simplifies things if you need to put a decimal number into low-byte/high-byte form and POKE it into two consecutive memory cells. DOKE828,1000 will automatically put the proper values for 1000 into cells 828 and 829, all numbers being expressed directly in decimal. DEEK is the corresponding double-byte equivalent of PEEK.

Particularly noteworthy are the improved SAVE, LOAD, and VERIFY commands, which speed up tape operations by a factor of about five. An 8K program takes 162 seconds to LOAD the old way, but only 35 seconds from an EXBASIC tape.

EXBASIC adds many new commands; programs written with it will not run on computers which lack it. You'll have to weigh that disadvantage against the many benefits of having the extra commands at your disposal.

All in all, EXBASIC LEVEL II is a useful and powerful addition to the Commodore programmer's bag of tricks. Its capabilities are meaningful, and I now wonder how I ever got along without many of them. The 60-page manual is a good one, and includes many examples of using the new commands and statements.

EXBASIC LEVEL II is available from:

Data Dynamics Technology
P.O. Box 1217 Cerritos, CA 90701
Price: \$98

| | |
|-----------------------|---|
| MERGE* | Merges or appends from disk |
| MIN | Finds the smallest of a group of values |
| MOD | Makes auto-RUNning fast speed tapes (see SAVE) |
| ODD | Tells whether a number is odd or even |
| ON | Enables repeat key and special error mode |
| OFF | Disables repeat key and special error mode |
| ON ERROR GOTO | Allows error recovery |
| ON...RESTORE | See RESTORE |
| POINT | Tells if a given hi-res point is SET or RESET |
| PRINT@ | Simplifies screen placement of PRINT statements |
| PRINT USING | Allows formatting of PRINT statements |
| REK | Expands the stack |
| REK OFF | Disables REK |
| REM | Improved: Allows use of ' as shorthand for REM |
| RENUM | Renumbers a program |
| RESET | Extinguishes a hi-res point (see SET) |
| RESTORE | Improved: DATA can be RESTORED selectively; ON...RESTORE allowed |
| RESUME | Terminates an error recovery routine |
| RND | Improved: Easier to set desired range |
| ROUND | Rounds off numbers to selected number of places |
| RUN | Improved: '.' shorthand |
| SAVE | Saves at high speed; longer program names; ML saves from BASIC |
| SAVE* | Saves at standard Commodore speed |
| SEC | Pauses for a given number of seconds |
| SET | Illuminates a hi-res point (80 x 50 resolution) |
| SPACE | Inserts spaces in listings |
| SPACE OFF | Disables SPACE |
| SPACE(a,b,c,d) | Clears or fills a rectangle on screen |
| STOP ON | Enables STOP key for machine language programs |
| STOP OFF | Disables STOP ON |
| STRING\$ | Sets up strings of identical characters |
| SWAP | Swaps the values of two variables |
| TRACE | Traces execution of BASIC programs |
| TRACE OFF | Disables TRACE |
| VARPTR | Returns memory location of any variable |
| VERIFY | Verifies tapes made at fast speed (see SAVE) |
| VERIFY* | Verifies tapes made at standard Commodore speed (see SAVE*) |
| VPLOT | Plots vertical bar graphs. |
| WAIT | Improved: STOP key now interrupts a WAIT |
| '.' | Shorthand for "last line used" in IF...THEN...ELSE, GOTO, LIST, RUN |

80-Column Screen Commands

| | |
|--------------------|---|
| BEGINLINE | Erases current line up to the cursor |
| DELLINE | Deletes current line, moves text upward to fill |
| ENDLINE | Erases current line rightward from the cursor |
| INSTLINE | Inserts a line at the cursor's position |
| SCREEN* | Lets 40-column programs run on 80-column machines |
| SCREEN | Disables SCREEN* |
| SCREEN DOWN | Scrolls screen downward |
| SCREEN UP | Scrolls screen upward |

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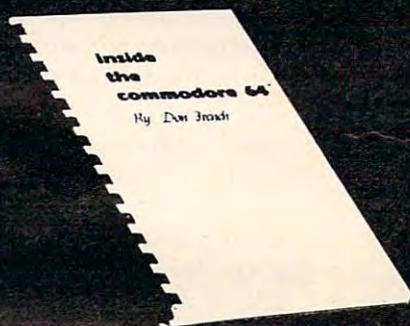
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Atari Starbowl Football

Orson Scott Card

If you like computer football, but don't have a regular playing partner, Gamestar's *Starbowl Football* for the Atari 400/800 is the answer. The computer opponent in the one-player option is *very* good. It will take all your skill on defense to keep the blue team out of the end zone, and on offense you have to be a superb quarterback or your passes will be picked off every time you aren't sacked!

And even if you have a human opponent, *Starbowl* lets the two of you struggle to outwit or outrun each other in a very convincing simulation of football action.

The football field scrolls horizontally across the screen as the players move. There are lots of little niceties. The game begins with the last few measures of "The Star-Spangled Banner." There is a musical interlude during half time. The crowd roars at the right moments. The players run back and forth across the field to get in place for the next play—eating up time on the clock.

The game itself offers good touches of realism. Take penalties, for instance. Let your safety touch the receiver while the ball is in the air, and pass interference is called. Blitz before the ball is snapped, and you are called offside. Take too long choosing your offensive play and snapping the ball, and you lose five yards on a delay-of-game penalty.

You can also be clumsy. The computer sees to it that your receiver is always in position to catch a perfectly thrown ball, but you have to push the joystick button at exactly the moment the ball arrives, or the pass is incomplete. It takes a lot of dropped balls before you get the timing down. If you try to run too soon after catching the ball,

your player fumbles—and the other team recovers. And if you throw a pass when your receiver is covered, you get to know how quarterbacks feel when their passes are picked off by a man in a jersey of the wrong color.

Each team has six players—a quarterback, two receivers, and a three-man line on offense; a safety, two defensive backs, and a three-man line on defense. On offense, you control the quarterback until a pass is released and the receiver after the pass is caught. On defense, you control the safety.

There are some things to watch out for. During play selection, you get no feedback when you push a button to choose the eligible receiver—after all, you don't want your opponent to know which receiver is going to get the ball. But if you pushed the button too soon, and it wasn't registered, you won't find out until you try to pass the ball and nothing happens. Also, if you aren't careful while you hurry to make play assignments before the 30-second clock expires, you can find yourself accidentally punting on first down or trying for a field goal from 80 yards back.

But these are minor issues. With practice, you can quickly memorize the play-selection procedure without ever looking at the book, and you soon develop good enough reflexes to catch the ball every time your eligible receiver is open. In fact, I got so good in a couple of games that I decided to switch from college level to the pro game setting. Then I discovered that the *Starbowl* is going to provide a challenge for a long time to come.

Starbowl Football
Gamestar, Inc.
1302 State Street
Santa Barbara, CA 93101
(805) 963-3487
\$31.95

Interpod Interface For VIC/64

Larry Bihlmeyer

If you own a VIC or Commodore 64, you are probably aware of limitations when trying to use the User Port with an RS-232 device. Most VIC/64 software fully supports the serial port (device #4), but does not address the User Port (device #2).

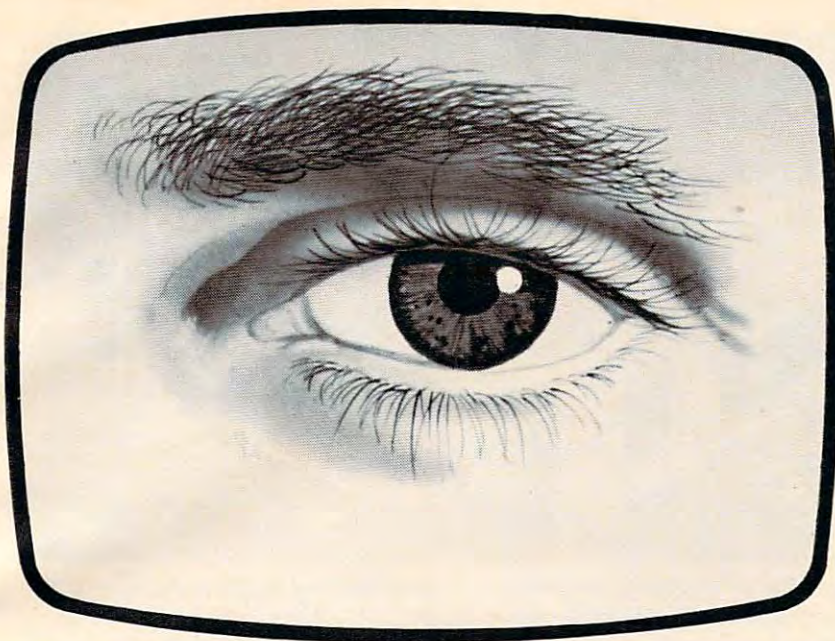
For example, if you try using a serial RS-232 printer with an interface connected to the User Port, software that doesn't support printing to a device #2 will not let you print.

One way to resolve this is to add an Interpod to your system, a dual interface which allows you to hook up a single RS-232 device and up to 30 parallel or serial IEEE devices to your VIC or 64.

Interpod has its own power supply and attaches at the serial port with a six-pin connector. This serial port is used by most software programs since it is the "normal" device #4. You can connect a single serial RS-232 device to the Interpod—a printer or modem, and up to 30 serial or parallel devices, like 1541, 2030, 4040, 8050, D9090 disk drives or 4022 and 4023 printers.

Its 6502 microprocessor allows data to be transferred to either the IEEE-488 or RS-232 port contained within the unit, or to both. Interpod contains both an IEEE bus and a true 25-pin DB-RS-232 port.

With this arrangement, the expansion port and eight-bit User Port are not tied up. Also, no software is required to load the Interpod. It's a stand-alone module, "hardwired" into your system. When it powers up, a red light indicates a self-test procedure by flashing 1.5 seconds and then stays on during operation unless there's a fault.



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Addressing

Device addressing through Interpod is entirely transparent to the user. However, because it is possible to connect both IEEE serial and parallel devices at the same time, situations may arise in which two peripherals with the same device address need to be connected simultaneously. In these cases, Interpod will recognize only the serial device. In order to access, say, a 1541 single disk drive and an 8050 dual disk drive, both of which are device #8, it is necessary to change their device numbers under software control. Programs to do this are included with the Interpod's instructions.

The RS-232 standard allows for a wide variety of baud rates and other options such as parity, stop bits, and carriage return delays. Interpod is easily configured to cope with all these, but for many cases, no reconfiguration is needed. Interpod powers up with the RS-232 interface configured as shown in the table.

Since RS-232 devices do not have device numbers associated with them, Interpod can be connected only to a single RS-232 component. Interpod will treat any RS-232 device by default as device #4. It is possible to communicate with the Interpod, much like communicating with a Commodore disk drive. The Interpod has a command channel similar to channel 15 on disk drives. So you can change baud rates, parity, and other settings as required.

One other feature incorporated in the Interpod is a CBM to ASCII conversion program. This interface will convert CBM ASCII to standard ASCII (uppercase letters substituted for lowercase and vice versa). This allows you to eliminate conversion routines in your programs for many applications.

Setting Up

The Interpod that I evaluated



Interpod module contains both an IEEE port and RS-232 port to support output. It also has a power supply connection and two serial attachments for the VIC/64 mating cable and a spare outlet for a serial unit such as a 1541 disk drive.

performed accurately and resolved a problem which had plagued me ever since I'd added a serial RS-232 printer to my 64. Many word processing, spreadsheet, and other software programs do not print out to device #2. When I connected the Interpod, this problem disappeared as the software output to device #4 (the serial port).

Interpod comes with good operating instructions which should allow you to handle most situations. However, you may

need dealer help in configuring a cable from the Interpod's RS-232 port to your printer or other device. This is not a fault—there is a wide range of printer cable configurations. Some printers have a male connector while others have female. And the pin designations can vary. So the best bet is to order a cable with the Interpod and be sure to specify the printer connector details when ordering.

The Interpod includes the Interpod module with 6502

Summary Of Interpod Commands

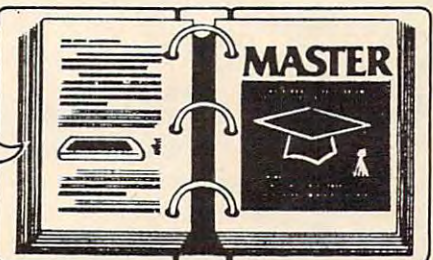
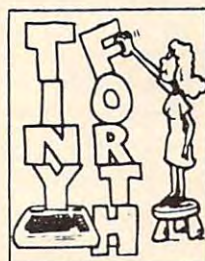
| Command | Meaning | Default Value |
|--|--|---------------|
| baud = (50, 75, 110, 134.5, 150, 300, 600, 1200, 1800, 2400, 3600) | set baud rates | 1200 |
| parity = (odd, even, none) | set parity | none |
| chrsize = (7, 8) | 7 or 8 bits | 8 |
| crdelay = (on, off) | carriage return delay (1/4 sec.) | off |
| stopbits = (1, 2) | select number stop bits | 1 |
| break | send break | N/A |
| unbreak | release break | N/A |
| change | readdress Interpod's command channel and RS-232 port | Device #4 |
| clear | clear buffer | N/A |
| convert | convert CBM ASCII to standard ASCII* | no conversion |
| unconvert | cancel convert | no conversion |

*This substitutes uppercase for lowercase letters and vice versa.

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The Interpod can solve several problems. First, it removes

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cal to the standard for the 65xx chips. Hence, Commodore assembler files can move to the PAL environment with little conversion. MAE assembler files are a bit harder to convert since they use nonstandard syntax, but Jim Strasma has written a conversion to PAL program which is included in the package.

PAL’s expression evaluator is second to none; it far exceeds the MOS standard. PAL has no macro assembly feature. This is not a problem as needed routines can be merged via BASIC.

PAL: An Extraordinary Assembler For The PET And 64

Elizabeth Deal

PAL (Personal Assembly System) is a symbolic assembler for the PET/CBM and the Commodore 64. It was written by Brad Templeton, the author of POWER for the PET and POWER64. The system is memory and disk-oriented, but most of the commands work with tape too.

A Multitude Of Features

PAL is a unique assembler. It is very fast, convenient, and easy to learn and use. It taps the best features of the PET and the 64 and cleverly uses them to create a powerful assembler in a rather small area of memory. Working with PAL is pure pleasure. In fact, working with PAL is sometimes easier than working with BASIC, especially considering some tricky features of the 64 (sound, sprites, bitmapped graphics), since you can freely program in binary or hexadecimal and can use long, eight-character labels.

Unlike several other assemblers of comparable versatility, PAL is very simple to use. Traditional fragmentation of tasks has been eliminated: Editing, assembling, and testing can be done without repeated loading and reloading. PAL coexists at all times with the BASIC environment, including BASIC

aids, such as POWER or POWER64, Toolkit, or BASIC Aid. PAL does not need special loaders or editors—they are already built into the computer.

A Powerhouse

PET’s PAL fits into exactly 4K of memory and can be put on a ROM chip. The 64 PAL is a bit over 4K. It can also be put on a chip, perhaps on a cartridge or some sort of adapter, since the 64 lacks the free sockets the PET has. RAM versions of PAL are relocatable, either to the top of memory or to a place of your choice. PAL can, in turn, create relocatable code attached to one BASIC line, such as 10 SYS 1234. As if this weren’t enough, the 64 PAL can create combined BASIC and machine language programs with machine language trailing right after BASIC. It’s a powerhouse.

PAL also permits customizing. You may add opcodes if you wish, but everything I need is already built-in.

PAL works with the IEEE and 1541 serial disk drives, but the 64 IEEE support depends on the link software in the 64 (RTC-Link is OK). Many printers and other output devices, such as printers on the User Port or modems, can be used.

PAL syntax is almost identi-

PAL Commands

The commands supported by PAL are all MOS assembler commands with provision for complex arithmetic expressions within the operands. All common numeric modes are supported, and their syntax follows the MOS standard. (Octal is not included, but who needs it?) Three assignment-type pseudo-ops are: equal (assignment), asterisk (program counter, label, and table definitions), and assignment of value to a variable for IF-GOTO commands. The pseudo-ops include: ASC (strings in quotes), BYTE, WORD, FILE (for assembling multisection programs), IF and GOTO (conditional assembly), GTB (go to BASIC), SYS (functions as a BASIC SYS command), STM (sets symbol table address for unusual configurations), SST (saves symbol table files), LST (loads symbol table), END, BAS (only on the 64). The OPT pseudo-op has numerous forms. It deals with the disposition of object code (memory, file) and assembler output in formatted form (screen, printer). It is a very flexible command.

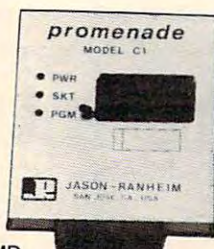
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Using PAL is convenient because PAL source files (the code you write) are BASIC files. You write as if you were writing BASIC, only better. For instance, you may use long variable names,

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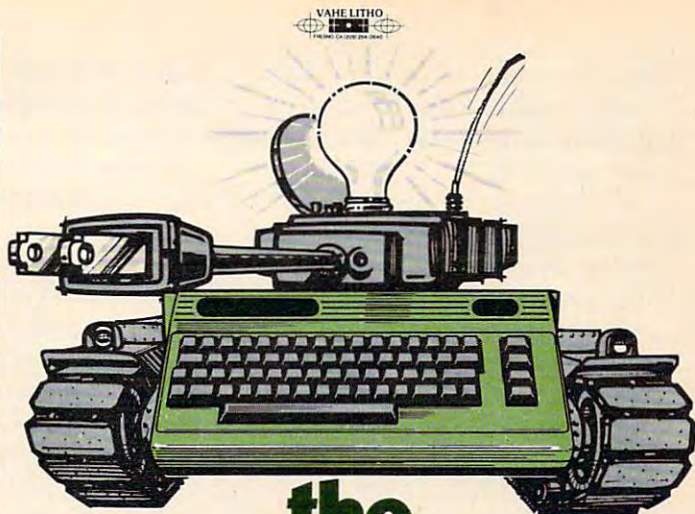
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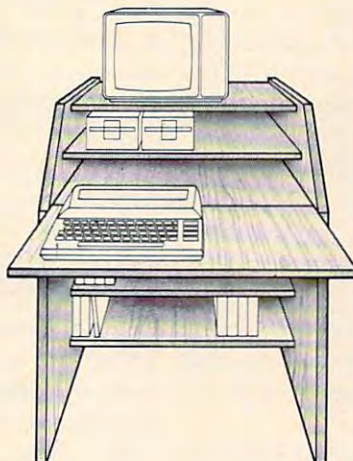
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multiple statements per line, comments within a line, and so on. It prints out, neatly, one instruction per line.

You use the computer's resident screen editor to fix the program and edit. You may also use Toolkit, POWER, or BASIC Aid to find things, replace them, renumber the program, delete, append—your familiar and useful commands are still valid.

The program is saved, loaded, and listed as if it were a BASIC program. This is convenient not only in editing, but also in the transportability of your programs.

You can assemble into memory. Consequently, the program is immediately available for use or for testing with BASIC without the gymnastics usually required in other assemblers.

Jim Butterfield once described (COMPUTE!, August 1982) the difficulties in fixing conventional assembly language: "The test program must be thrown out and the assembler loaded; a new 'object' program must be created. The clincher is...paperwork...the new program should be version-numbered... a program listing should be generated." Not so with PAL. PAL elegantly solves such house-keeping headaches once and for all.

PAL also permits assembly to tape, disk, screen, or printer. The output options can be switched on and off during the assembly. The flexibility is pretty amazing. Object files can be loaded via BASIC or Supermon as normal program files.

Assembly to memory is fast. Blink an eye and it's done. Assembly to disk is also fast (I think I got about 2000 bytes done in close to 15 seconds).

The nominal size of PET in-memory assembly is 1000 bytes. I've done a bit over 2000 with no problems at all. It depends on how tight the source code is.

PAL can be used to assemble huge programs—POWER, for

instance. Chaining is used in the process, and the number of chained files is unlimited. There are some limitations on moving the program counter, and there might be limits on the size of the symbol table. It's all described in the book. If you wish, the symbol table, variables, and addresses you used in writing the program can be in a library on disk and then it can be brought into the assembly process, precooked. This is one feature not available to tape users.

PAL also provides a nice expression evaluator. Expressions are not limited to the usual plus or minus one. They permit shifts, multiplication, and the PET's normal logical functions. Expressions can include modifications to, and use of, the program counter (*). This is tricky, but the explanation in the book is meticulous.

Error trapping works well. Each error message (9 syntax-type and 12 housekeeping-type) is clearly explained in the book. Errors are shown on the screen, full text, PET fashion, as in, for example, BRANCH OUT OF RANGE. Phase errors are handled by one clever line of code, very handy for people like me who always mess up .byte statements.

In the event of an error, PAL, for a bit of additional protection, stuffs zeros (BRK) into the code. Should you carelessly try to use the bad code, you stand a chance of surviving, since you may land on a Break command. Errors are not counted, a minor nuisance.

Other Features

Several exotic commands are included, such as adding your own opcodes or going to BASIC during the assembly process. This is limited to some BASIC statements, but has its place. Conditional assembly is permitted by use of IF and GOTO (renumberable). It is useful in getting the PET to assemble a bunch of repetitive instructions,

in skipping assembly of some code, or in chaining a particular file, depending on the result of IF, for instance, a computer type.

Commodore 64 users get a nice command that permits including BASIC programs in the assembled object code. A corresponding POWER64 command permits immediate testing of such code in a partition. If you don't use POWER64 you can do the same thing, but it is tricky to set up. In any case, the source code is never erased; you can go back and edit anytime.

Other nice touches appear throughout the system: Line indentation is permitted, the beginning and end (plus 1) address of the object program is displayed, so you can save it via the machine language monitor if you wish.

On start-up, PAL changes the top of memory pointer to itself, conveniently, if (and only if) the current top is higher than PAL. Otherwise the system setup is left alone. A nice touch.

I found no glitches after using PAL for two years. Everything seems to work well. I dislike only one thing: If I forget to specify where to place the code, it defaults to the tape buffer (PET) or \$C000 (64)—defaults I could do without. I'd rather get an error message.

Documentation

The PAL system is excellently documented. Each command is clearly described, and several thoroughly annotated coding examples will get you started. The book itself is not a tutorial text, but recommends sources for learning machine language.

For adventurous people who like to design and redesign things, the key subroutines have been documented. Their addresses, functions, and use of memory locations are described. The method of assembly is also briefly described; it is important to understand this process if you wish to do strange things.

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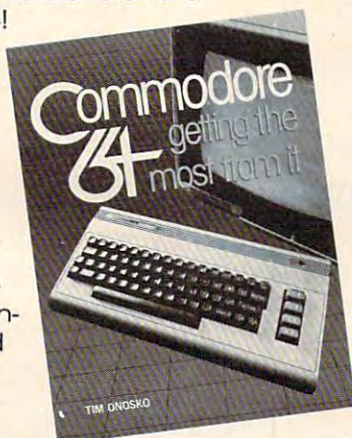
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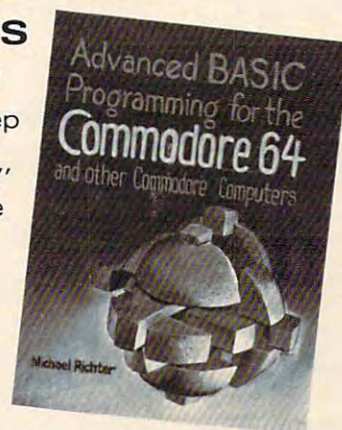
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A Note To Beginners

PAL is, in my opinion, ideally suited for both the expert and the beginner. It is friendly; it needs no special editors or loaders; it is superfast, and it coexists with BASIC programs in memory. It truly eliminates editing and testing headaches. And the multiple statements per line option is efficient in more than one way.

Anyone familiar with the tiny assemblers in monitor extensions such as Supermon; anyone who has gone through the nasty experience of hand assembly; or anyone experienced with machine language will find PAL a pleasure to use and will be unlikely to commit serious errors.

Once you have PAL, there is little reason to use tiny assemblers, except for small patches or corrections. You will never get away from Supermon, though, as its disassembler features will always be needed, unless, of course, you have the rare capacity to write supercode the first time around.

PET's PAL has been around for a while. It has proven to be a very nice assembler. PAL64 is new and has extra features. PAL is a very good buy, worth your serious consideration.

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across the top of the screen over an acid pit. Before the cage crashes into the far wall, the robot must jump onto a small ledge. Then he must jump again onto a pod floating on the surface of the acid. Timing the jumps is important, but there's no time to spare—an onrushing security robot makes sure of that.

Should your jumps be successful, the next obstacle is a long hallway guarded by six groups of security robots. Scurry through gaps in the robots' formation, take cover behind the pillars, and strive for the energizer at the other end.

The Second Acid Test

Once through the hallway, you'll face another acid pit test. As a guard robot rolls toward you, you must jump onto a floating pod which will carry you to a waiting elevator. And once on the elevator, you must jump again to an island in the center of the acid pit.

Upon reaching the island, you find yourself in a series of crisscross corridors with three groups of robots on patrol. Again your goal is to reach an energizer, but this time, once you put your android in motion—there's no place to hide. You'll have to fall in between a couple of guard robots, taking care to maintain your distance. The problem is that your android and the security robots travel at different speeds.

The next challenge is the final one before the dreaded Inner Chamber. In a two-tiered room filled with racing red automobiles, the robot must leap car after car, reach and climb a ladder, then jump more cars before clambering aboard the platform that leads to ORTSAC's officials.

The Inner Chamber is where the battle is fought. It's where you do what you've come to do. You've used your skills of locomotion to get this far, now you must fight—and quickly. In rapid succession, ORTSAC's

Robot Runner For The TI

Tony Roberts, Assistant Managing Editor

Games written in BASIC or Extended BASIC for the Texas Instruments 99/4A computer sometimes suffer from painfully slow action. The microprocessor just can't interpret BASIC fast enough to maintain a proper pace in an action game.

Moonbeam Software, however, has found a way to solve the problem in *Robot Runner*, one of the company's recent Extended BASIC releases. The game has seven screens, each requiring a slightly different approach. The game progresses quickly from one scenario to the next, eliminating the boredom that might set in if any one screen had to be played for long periods.

This multiple-screen approach accomplishes several things. For one thing, the programmer can limit the possibilities available at any given moment, allowing tighter, and thus faster, program loops. In addition, this method also permits the programmer to put the player

through some very difficult, but very short, game situations.

Taking Out Robot Terrorists

It's the year 2600. The Organized Robot Terrorist Society Against Civilization (ORTSAC) plans to send out its robots to conquer the world. Your mission is to guide your own android into the heavily guarded ORTSAC headquarters, find your way to the Inner Chamber, and there confront the five ORTSAC leaders.

At game's start, you find yourself at the bottom of a six-story building. Your goal, a transporter cage, is at the top. Your android must move from floor to floor while avoiding the Irata 004 Security Force Robots. A yellow chute provides a shortcut to the transporter cage, but to reach it, you'll have to run directly toward one of the security robots. Any mistake will be fatal.

When you reach the cage, the scene shifts to screen two. Your robot, in the cage, moves

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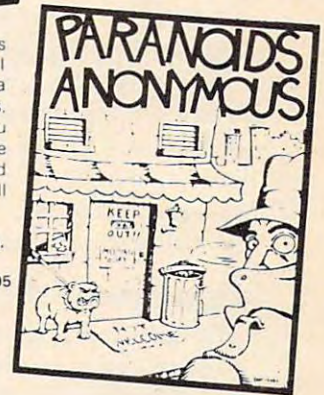


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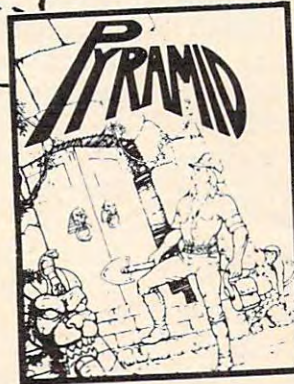
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leaders descend upon you. Take aim and shoot. You have only a couple of shots at each, and as soon as any one of them reaches you, your mission is over—unsuccessfully over.

Running The Gamut Again

Should you fail at any time during this whole process, you return to the beginning to try again. Each time through, however, things are slightly different. The difference is speed. The security robots are a bit faster, so your robot must be more alert. Sometimes he'll be forced to jump even before his target has come into sight.

The opening scene includes the score, the high score, the number of robots you have left, and a counter for the number of times you've started from the beginning. Note the last statistic, for each time through the game, you must adjust your timing.

The first time through the first screen, for example, it's almost impossible to fail. The third time through, however, there can be neither error nor indecision. One false step and you're caught. The fourth time, your progress is complicated by invisible guard robots.

Documentation Oddities

The documentation for *Robot Runner* is sketchy in places. It's difficult to understand the description of the seven scenes until you've played them, and the four-page instruction pamphlet is embarrassed by a number of misspelled words. This is most startling in the discussion of a "yellow shoot." Eventually, you'll realize that the writer is attempting to describe a yellow chute.

There are some minor inconsistencies between the scorekeeping as described and the scorekeeping as programmed. Basically, you earn a set number of points each time you complete a screen. After you've played a

few times, you'll find your scores remarkably similar game after game. Additional robots are awarded at 3,000 points and 10,000 points, and every 10,000 points thereafter.

The graphics in *Robot Runner* are bright and colorful. The screens are crisp and uncluttered. The sound effects are pleasant, and are a welcome change from what I've come to call "default TI sound effects"—the silly sounds that come from clumsy use of the noise generator.

Joystick Or Keyboard

The game is available on both tape and disk in versions for joystick or keyboard. I preferred using the keyboard, which is more responsive than the stiff TI joysticks.

However, I did have some difficulty with the cassette keyboard version. The program was inconsistent in detecting a

collision between the jumping android and one of the pods floating over the acid pit. It was aggravating to see the robot float right through the pod and end up sizzling to a metal fragment in the acid.

Precision collision-detection is another problem area for TI Extended BASIC. The collision must occur at the time the program is executing the line containing the collision-detection command. Tolerances can be specified so that a near miss is as good as a collision, and in most cases in *Robot Runner*, collision detection is fair, if a bit imprecise.

Though none of its seven screens could stand alone as a successful game, *Robot Runner's* combination of challenges provides a truly amusing game.

Robot Runner
Moonbeam Software
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Blue Max For Atari And Commodore 64

Dan Gutman

Just when you thought shoot-em-ups were passé, just when you thought you'd played every variation, along comes a game that may make standard two-dimensional eye/hand games obsolete. Bob Polin's *Blue Max* may well be the best action game there is.

The comparisons to *Zaxxon* are obvious. Both games feature a diagonally scrolling three-dimensional screen within which the player controls an aircraft that can shoot at air and ground targets. Unlike *Zaxxon*, here you pilot a 1915 biplane over a landscape of roads, bridges, tanks, and buildings.

It is World War I, and the Germans will award the Blue Max medal to any of their flyers who can gun you down. The

plane banks and rolls, as in *Zaxxon*, but even smoother—you may be tempted to sway your body into the turns. The biggest problem with *Zaxxon*—determining your ship's altitude—has been solved in this game. The background and shadow of the plane make it very clear how high you're flying. And, just for good measure, you've got an altimeter gauge. What *Zaxxon* pioneered, *Blue Max* perfected.

The Complexity Of An Adventure Game

If *Blue Max* merely improved on *Zaxxon*, it would not be such an outstanding game. What makes *Max* so special is that it does what no other shooting game has done before. You don't just fire away until your thumb gets

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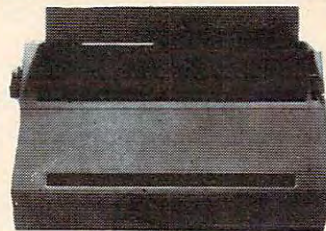
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sore. There's a lot of work to be done—bridges, tanks, and enemy planes are all destroyed in different ways. Your instrument panel tells you how much fuel you've got, how many bombs remain, the speed, altitude, wind, approaching enemy planes, and any damage to your aircraft. This control panel is not just for show: You have to use it to succeed. In fact, you have to use it to take off. This kind of complexity is usually found only in adventure games. So adventure game fans as well as arcade game buffs will appreciate it.

At the same time, *Blue Max* is not so complicated that it overwhelms. *Defender* is a great defensive game, but so much happens onscreen that a lot of people experience stimulus overload. Since *Blue Max* is mainly an offensive game, you don't have to be constantly on edge for that next assault. There is actually very little shooting at you. So you can look over the side and enjoy the scenery a bit—bomb a few bridges here, strafe a few tanks there. And if you miss, don't worry about it. There will be more bridges and tanks down the road.

Bombing is accomplished by hitting the fire button and pulling down on the stick at the same time. This takes some getting used to, especially when you consider that pulling down also causes your plane to dive. Realistically, pilots in World War I did not have sophisticated bomb site techniques.

In *Blue Max*, you have to drop bombs before you reach your target, depending on your location and altitude. It's similar to the way a quarterback has to "lead" his receiver with the ball. The initial frustration is offset by satisfaction as you gain control later in the game.

Perhaps the toughest part of the game involves periodically landing your plane to refuel and make repairs. First a tone

sounds, indicating you are approaching a friendly runway, and you'd better go for it or you'll run out of fuel before you see another one. Then you've got to quickly descend to 25 feet and press the fire button to lower your landing gear. A blue L on the control panel indicates it's safe to land. You position yourself over the runway and touch down. You want the first half of the runway; otherwise, you won't be able to build up enough speed to take off again. If this all sounds easy, wait until you crash and burn the first ten times.

Graphics And Sound

As for technical qualities, *Blue Max* is good to very good. The graphics are crisp and colorful. The screen lights up with explosives as you strafe a row of tanks. Little cars and trucks drive over the bridges, and when you bomb the bridges, chunks of it blow up, not the whole bridge. The sound is mostly explosions, but even here attention has been paid to the detail. Bombs dropped on the ground blow up, but the ones that hit the water make a splashing noise. There is also a jaunty rendition of *Hail Britannia* between games.

My complaints with *Blue Max* are nitpicking. I wish there was a little more variety to the scenery instead of the endless military suburbia of bridges, tanks, factories, and more bridges. There should be some sort of ultimate goal. Though you *can* enter an enemy city if you survive and hit four specific targets, only top-of-the-line players will ever see it. And the "city" is not that different from the rest of the countryside.

But again, these are small quibbles about a great game. *Blue Max* is head and shoulders above other shooting games.

Blue Max
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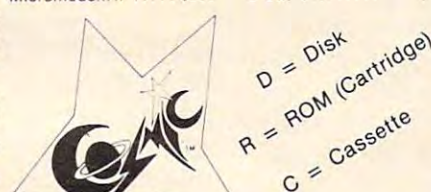
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Programming Tips And Hints

This month I will cover a variety of hints that I hope will be helpful in your programming, and answer some questions I have received that I think will be of general interest.

I appreciate your letters concerning my book, *Programmer's Reference Guide to the TI-99/4A*. Several people have written to me with problems concerning certain programs. All those programs have been checked, and I am happy to report the listings are correct. The most likely cause for errors is mistyping DATA statements. Be sure the numbers are typed correctly, and be sure all commas are placed correctly. See my November 1983 column for debugging hints.

MEMORY FULL Error

None of the programs I have published requires the 32K Memory Expansion. In fact, you cannot access the memory expansion with regular, built-in TI BASIC. You need the Extended BASIC command module or another module that can use the memory expansion. If you get a MEMORY FULL error, my first guess would be that you have a disk drive and disk controller connected. The disk system automatically uses up some memory with open files. The default number of files is three. To make memory available, specify only one opened file by typing

```
CALL FILES(1) (enter)
NEW           (enter)
```

then proceed normally. You may type in a program or load a program from cassette or disk. CALL FILES(1) uses up a little over 1000 bytes of RAM.

As a matter of general procedure, I do a CALL FILES(1) whenever I turn on my computer (if I have the disk system attached). There are still cases when you may be able to save a program on cassette, but not use it with the disk system—because of the 1000 bytes less when the disk system is connected. If you are loading a cassette and it stops with a DATA ERROR right after the header sound, full memory could be the cause.

Another cause of a MEMORY FULL error could be typing errors involving line numbers

(especially if GOSUB and RETURN statements are involved) or user-defined functions.

TI BASIC And Extended BASIC

Some TI Extended BASIC owners have tried to run *all* TI BASIC programs with Extended BASIC. If the program is designed for TI BASIC, it may not work with Extended BASIC. First, Extended BASIC uses up some of the available memory, so the TI BASIC program may not even fit in Extended BASIC. Second, TI BASIC may use graphic characters numbered from 144 to 159 in color sets 15 and 16; they are unavailable in Extended BASIC. Third, any PRINT statements using colons (for blank lines) in TI BASIC will confuse the computer in Extended BASIC because the double colon is used for separating commands.

For you new TI owners, TI Extended BASIC is a programming language on a command module that can give you even more powerful programming capability, including smoothly moving sprites. Any program written in TI Extended BASIC requires the TI Extended BASIC command module to run. The programming language that is built into the computer is called console BASIC or just TI BASIC.

Programming Speech And Games

How do you use speech? The TI Speech Synthesizer is a little box that attaches to the side of the computer and provides speech capabilities. To make it work, you also need a command module that has speech capabilities.

To program your own speech, you may use Speech Editor, TI Extended BASIC, or Terminal Emulator II. The first two command modules have a limited vocabulary; Terminal Emulator II is more versatile and allows unlimited speech. A manual comes with the module that illustrates how you can make the computer talk either by using allophones or by spelling words phonetically.

Several readers have requested help on writing a program for Spanish—using the tilde and accents. I hope to have such a program ready for next month's column. It will have optional speech.

If your joysticks don't seem to work right on the TI-99/4A, remember to release the ALPHA LOCK key. The ALPHA LOCK key should be in the "up" position for joysticks and down for most other programming.

Yes, there is a book of games specifically for the TI-99/4A. By the time you read this column, *COMPUTE!'s First Book of TI Games* will be available. There are games by several authors, including a few favorite games from past issues of *COMPUTE!*. Most of the games have not been published previously, and there is a variety to choose from. The book includes suggestions on how to adapt the games for your own use or how to write your own games using the illustrated techniques. One section of the book includes games written in TI Extended BASIC.

Numeric Functions

The price of the TI-99/4A may lead some people to think that this computer is "just a toy." Actually, the TI has such a powerful built-in BASIC that it can do many tasks that a few years ago only the very large (and expensive) computers could handle. For an example, I'd like to describe some of the built-in numeric functions that are available. In my college days we would spend hours (or days) working on calculations for problems. (That was in the slide rule days.) If you wanted more than three-digit accuracy, you could use math tables and interpolation. Of course, calculators became readily available and reduced the drudgery considerably. Now, however, you can write a program and practically instantly solve several problems.

Let N stand for a numeric expression—a number or combination of numbers or a variable name for a number. $SQR(N)$ will return the square root of a number. Try `PRINT SQR(64)` and press ENTER. Next try `PRINT SQR(60)`. The square root of the number in parentheses is printed, and it may contain a decimal portion. The number N must be zero or positive.

$ABS(N)$ returns the absolute value of a numeric expression N . I usually think of the absolute value of a number as the number without the positive or negative sign.

$INT(N)$ returns the integer value of a numeric expression N . The integer is the whole number part of a number, or the number without the fractional part. If you picture a number line, the integer function always returns the closest whole number to the left of the number specified. Thus $INT(6.4)$ is 6, but for negative numbers $INT(-3.45)$ is -4.

$EXP(N)$ is the exponential function and returns the value of e^N where e is the number 2.718281828.... The inverse is the natural logarithm function $LOG(N)$. Remember that this

function is using the base e , $\log_e(N)$. If you want a logarithm to a different base, use this formula:

$$\log_B(N) = \log_e(N) / \log_e(B)$$

For example, if you want the logarithm of N to the base 10:

```
PRINT LOG(N)/LOG(10)
```

$SGN(N)$ is the signum function which gives the algebraic sign of a number and is useful in evaluations where you need to know if a number is positive, zero, or negative. The values returned are 1 if the number is positive, 0 if the number is zero, and -1 if the number is negative.

$SIN(N)$, $COS(N)$, and $TAN(N)$ are the trigonometric functions sine, cosine, and tangent. The angle N is expressed in radians. If you prefer to think of the angle in degrees, you can multiply the number of degrees by $\pi/180$ or .01745329251994 to get the equivalent radians. Also remember that for some angles some of the functions may not be defined. If you need the other trigonometric functions, the secant is the reciprocal of the cosine, the cosecant is the reciprocal of the sine, and the cotangent is the reciprocal of the tangent. $ATN(N)$ is the arc tangent of the number N and returns the angle whose tangent is N . Again, the angle is expressed in radians.

The above numeric functions can be used in combinations or as numeric expressions in other statements. For example, the following are valid statements:

```
200 PRINT COS(A)
300 PRINT SIN(X/Y)+COS(N-.5)
400 ON SGN(A-B)+2 GOTO 300,520,600
500 L=LOG(X)/LOG(10)
600 S=INT(SQR(M))
```

User-Defined Functions

DEF allows you to define your own function if you want to use a formula that is not built-in or if you want to use a combination of functions and save some typing effort. The DEF statement number must be lower than the line number where the function is used, so it is wise to simply put DEF statements near the beginning of the program. An example using DEF is to have the definition statement near the beginning:

```
110 DEF F(X)=X^3+2*X*X-X/2
```

and later you may use such statements as:

```
500 PRINT F(4)
650 IF F(N)=0 THEN 780
680 A=F(L)+F(M)
```

Each time the function is used, the function is evaluated with the numeric value within the parentheses.

You do not have to specify a parameter in the DEFinition statement. For example, you may wish to define a random number R from 1 to 16:


```
120 DEF R=INT(16*RND+1)
```

Later, every time R is used in a statement, a random number from 1 to 16 will be used:

```
350 PRINT A$(R)
```

```
400 CALL COLOR(R,R,R)
```

(three possibly different values
of R will be used)

Controlling Screen Scrolls

If you have long lists of information, as you print the data the printing scrolls upward and off the screen. There are several techniques to control the scrolling. One method is to keep track of how many lines are printed. After a certain number are printed, create a pause or wait until the user presses ENTER or another key. "Control Scrolling" prints a list of 50 names, each with a random number. I'm using names and numbers for illustration purposes only; you would have your own information generated previously. L is a line counter, and line 200 increments the number of lines. Line 210 checks to see if 20 lines have been printed. If so, the counter L is reset to zero and a message to press ENTER is printed. CALL key waits for the ENTER key to be pressed before the program continues. Lines 200-260 could be put into a subroutine if you prefer. Remember that if you double-space your output, line 200 would be changed to L=L+2. L keeps track of how many lines on the screen have been used.

Another method to stop the printing from disappearing off the top of the screen is to have the user press any key to pause. When she or he lets go of the key, the printing resumes. The CALL KEY statement is used to detect if a key has been pressed. The general form is CALL KEY(0,KEY,STATUS) where 0 indicates for the computer to scan the whole keyboard. KEY returns a number corresponding to the key pressed (the ASCII code). STATUS returns 1 if a new key is pressed, 0 if no key is pressed, and -1 if the same key is pressed. You may use any variable names for KEY and STATUS.

The following sample program chooses a random number C then prints a letter corresponding to C along with C. One hundred letters and numbers are printed. If you want to stop the printing, hold a key down. When you want the printing to resume, release the key.

```
100 REM PRESS A KEY
```

```
110 CALL CLEAR
```

```
120 FOR N=1 TO 100
```

```
130 RANDOMIZE
```

```
140 C=INT(26*RND+1)
```

```
150 PRINT CHR$(C+64),C
```

```
160 CALL KEY(0,K,S)
```

```
170 IF S<>0 THEN 160
```

```
180 NEXT N
```

```
190 END
```

You may not want to keep holding a key down

to stop the printing. The following program illustrates how you can stop the printing by pressing any key, wait as long as you wish, then start the printing again by pressing another key. Line 170 checks the status of the CALL KEY statement in line 160. If no key is being pressed, control goes to line 200, which indicates to go to the next number. If a key is pressed, S will not equal zero and the program goes to line 180, another CALL KEY statement. This time line 190 checks to see if a new key is pressed. When a new key is pressed, S will be 1 and the program goes to line 200.

```
100 REM PRESS TWO KEYS
```

```
110 CALL CLEAR
```

```
120 FOR N=1 TO 100
```

```
130 RANDOMIZE
```

```
140 C=INT(26*RND+1)
```

```
150 PRINT CHR$(C+64),C
```

```
160 CALL KEY(0,K,S)
```

```
170 IF S=0 THEN 200
```

```
180 CALL KEY(0,K,S)
```

```
190 IF S<1 THEN 180
```

```
200 NEXT N
```

```
210 END
```

Neat Numbers Columns

You have probably noticed that the computer prints items starting at the left column. You can use commas and semicolons to separate items and to make nice columns, but the numbers line up starting at the left column rather than right-justifying lines as is standard. There are several techniques to get your columns to look prettier.

I often use a subroutine to convert a number to a dollars and cents amount, then the dollars and cents can be lined up. One of the easiest ways is to keep the money expressed as a whole number of cents; for example, 525 would correspond to 5 dollars and 25 cents. If you know the range of the money ahead of time, the coding can be simplified. In this example, let's assume a dollar amount of less than \$9.99. The cost is expressed in the number of cents, C. Let C\$ be the string value of C. Next check the length of C\$. If the length is 1, that means there is a single digit and we'll need a leading zero in our standard form of dollars and cents. If the length is 2, there are only cents and I will want a space between the dollar sign and the decimal point, so I want a leading space added to the string. The next step is to put two characters to the right of the decimal point. The subroutine is:

```
900 C$=STR$(C)
```

```
910 IF LEN(C$)>1 THEN 930
```

```
920 C$="0"&C$
```

```
930 IF LEN(C$)>2 THEN 950
```

```
940 C$=" "&C$
```

```
950 R$=SEG$(C$,LEN(C$)-1,2)
```

```
960 L$=SEG$(C$,1,LEN(C$)-2)
```

```
970 C$="$"&L$&". "&R$
```

```
980 RETURN
```

SEG\$ refers to the segment of C\$ starting at the middle number of the three within parentheses

and going to the last number.

You can use the same general idea to line up a column of any numbers. In the following example problem, lines 110–140 READ in nine numbers from the DATA statement in line 150 and print the numbers in a column. Notice that line 130 tells the computer to start printing the numbers in column 9 with the TAB(9) function. The TAB function is just like the tabulator on a typewriter—the computer goes to that column then starts printing, rather than starting at the left margin.

Lines 170 to 210 print out the numbers again, but this time right-justified (ones column, tens column, hundreds column). First, the number N(I) is converted to a string N\$ so that I can get the length L by using the LEN function. This length tells how many digits are in the number. Line 200 uses the TAB function again, but the starting column depends on the length of the number. If the number is one digit, L=1 and the computer TABs 12; if the number is two digits, the starting column is 11; and if the number is three digits, the starting column is 10.

```
100 CALL CLEAR
110 FOR I=1 TO 9
120 READ N(I)
130 PRINT TAB(9);N(I)
140 NEXT I
150 DATA 3,15,5,200,79,8,179,2,11
160 PRINT
170 FOR I=1 TO 9
180 N$=STR$(N(I))
190 L=LEN(N$)
200 PRINT TAB(13-L);N$
210 NEXT I
220 END
```

Keep in mind that there are usually many ways to write a given program. There are several techniques to get a column of numbers lined up right. If you can get the computer to do what you want it to do, your method is fine.

More Techniques

A note on calculations: Keep in mind that if you type a formula, the computer will evaluate the expression using the standard algebraic order of operations—powers, multiplication and division, addition and subtraction. You may use parentheses to group numbers to keep within the standard order.

Tip of the month: Use the left-hand SHIFT key to type the plus sign, +. (That's standard typing position anyway.) If you use the right SHIFT with the +, it is possible to hit the FCTN key instead, which results in QUIT, and you're back to the title screen and your program is gone.

The function keys can be used within a program by detecting their code numbers after a CALL KEY statement. For example, if you check to see if the ENTER key was pressed, you check IF KEY=13. If you wish to use REDO, which

corresponds to FCTN 8, then check for the key code of 6. In the "Southern States" program in the August 1983 issue of COMPUTE!, the user types in an answer. The typing is printed on the screen. The method used is CALL KEY rather than INPUT to prevent scrolling. If you want to be able to erase your answer as you are typing, add the following lines:

```
782 IF K=6 THEN 720
1062 IF K=6 THEN 1000
```

Now after the CALL KEY statement, the computer checks to see if a letter was pressed, the ENTER key, or FCTN 8.

I do appreciate your letters and can answer general questions in this column, or your questions can be answered in "Readers' Feedback" or "Questions Beginners Ask." If you have problems running any of my programs, I can also try to help. Please be specific about which program it is (and which computer, since I own several brands) and what the error is. The exact error message and line number helps to pinpoint the error. Please do not ask me to debug your own programs or programs from other authors.

A special welcome to all our new readers who may have just received a computer for Christmas. I will try to continue to write programs and columns that will meet your needs. May 1984 be a productive year for all of you TI owners.

Control Scrolling

```
100 REM CONTROL SCROLLING
110 DIM N$(50),P(50)
120 FOR I=1 TO 50
130 READ N$(I)
140 P(I)=INT(80*RND+10)
150 NEXT I
160 L=0
170 CALL CLEAR
180 FOR I=1 TO 50
190 PRINT N$(I),P(I)
200 L=L+1
210 IF L<20 THEN 270
220 L=0
230 PRINT : "PRESS <ENTER>"
240 CALL KEY(0,K,S)
250 IF K<>13 THEN 240
260 CALL CLEAR
270 NEXT I
280 GOTO 330
290 DATA ANDY,AURA,LENA,BILL,ED,GRANT,JIM,JOHN,RANDY,RICHARD,CHERY,CINDY,SHEILA,JOANN,GEORGE,SUSAN
300 DATA KELLY,JENNIE,ANGELA,BRYAN,DEAN,RELLE,LEWIS,MELISSA,DOUG,SHERYL,EUGENE,MITCH,KATHY,JEREMY
310 DATA JUSTIN,STEVE,JASON,PAM,TRACY,KIM,JOELLE,JUDY,BRENDA,BOB,JERRY,GARY,MARILYN
320 DATA JODI,DEBBIE,BRENDA,RON,MAE,RAY,LINDA
330 END
```


All About Commodore Chaining

Melvyn D. Magree

If you've tried chaining programs, but found that variables were lost in the process, you'll find the solution here. The article tells you how to chain programs so that variables are safe, and how to handle the variables you don't want to pass from one program to another.

You are writing a program which is rapidly becoming larger and larger. Then the dreaded message is displayed:

OUT OF MEMORY

What to do? You "crunch" the program again and again; you search for hours for one more thing to eliminate. Everything that you have left is important. (*Crunching* means saving memory by eliminating REM statements, combining commands onto multiple-statement lines, and using abbreviations such as ? for PRINT.)

At wit's end, you discover at least one part of the program that you use at the very beginning and never use again. You may even find that you have more sections you use only once and then move on to another section. Now, if you could load that section in only when it is needed and then load the next section when it is needed.

Many microcomputers do allow you to do this. You can use the LOAD command as a statement in your first program, and your computer will execute the first program and then LOAD in the requested program and go to the first statement of the second program. This is called *chaining*.

Changes In Variables

If you have a VIC-20 or a Commodore 64, you can chain. The *Commodore 64 Programmer's Reference Guide* states on page 59: "None of the variables are cleared during a chain operation." The *VIC-20 Programmer's Reference Guide* is a bit more thorough about this and states on page 8: "Variables used in the first program will not be cleared as long as the new program is *shorter* in length than the older one." You might find that this restriction causes you problems, especially if you have a small initialization section that you want to use as the first program.

But, beware! There is another "gotcha." It may be true that "none of the variables are cleared," but not all variables remain the same "during a chain operation." Programs 1 and 2 demonstrate this.

Program 1 is 89 bytes long, Program 2 is 25 bytes; so we have no problem with the size restriction. However, Program 2 does not print the variable S\$ as "TEST" as set in Program 1, but as "S\$".

All good designs, whether of space shuttles or of can openers, are compromises. Microcomputers are no exception. In order to conserve space in programs, the designers of Commodore BASIC chose to leave string text directly in the program rather than copy it to a separate area. Thus, when Program 2 overlays Program 1, the descriptor for S\$ points to the same location, but to different



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text. In the case of Program 2, this happens to be a part of line 2 and line 3 (I inserted the REM at line 1 to force S\$ to become something at least partly recognizable). To see what has happened, let's examine the contents of S\$ character by character. We do this by the direct statement:

```
FOR I=1 TO 4:PRINT ASC(MID$(S$,I));:NEXT
```

and get

```
83      36      0      23
```

that is, "S", "\$", and two nonprinting characters.

The structure of a BASIC statement is:

| next statement | statement number | tokenized statement | statement terminator (0) |
|----------------------------|----------------------------|------------------------|--------------------------------|
| low byte / high byte | low byte / high byte | | |

So we realize that the first two characters are the "S\$" of line 2, the zero is the terminator for line 2, and 23 is the low byte of the location of the line following line 3 (the program termination characters).

Passing Variables

If you are willing to make your programs look a bit clumsy, you can get around this problem rather simply (see Program 3). I modified line 1 of Program 1 so that S\$ is set to a null string plus "test". This causes space to be created in variable storage which is not overwritten when Program 2 is loaded. And so, when Program 3 calls Program 2, Program 2 prints S\$ correctly.

Another solution would be to set all strings with READ and DATA statements, which would put them beyond the area to be overlaid by any subsequent programs. But this can cause difficulties if you need to call bigger programs.

Here's a solution. As you write your various programs, monitor the size of each. You can do this by

```
PRINT PEEK(45),PEEK(46)
```

remembering the low-byte, high-byte format used. If any program is larger than the first in the chain, then do the following. In your first program set the start of numeric variables (memory addresses 45,46), the start of arrays (47,48), and the end of arrays (49,50) to the value for the size of the largest program in the chain or greater. You should do this as the first thing in your program so that you do not lose any variables. See Program

4 and Program 5. (I put line 2 in Program 5 for no other reason than to help make it bigger than Program 4.) These examples are for the Commodore 64. If you have a VIC-20, the 8 POKEd into locations 46, 48, and 50 would be replaced by 16 for an unexpanded version; by 4 for a 3K expansion; and by 18 for 8K or more expansion.

Of course, you may have variables that you do not wish to pass from the first program to others. To prevent these variables from being passed, you must use them in the first part of the first program. (Also, you can't use any variables in the first part that you wish to pass to other programs.) After you have used the variables which are not to be passed, do a CLR to clear variable storage; then POKE locations 45 to 50 with the size of the largest program. Now you can define and set the variables you wish to pass to other programs.

One final remark. As you update your programs, do not do so after one has been loaded by another program. When you SAVE, it will be the size of the largest program in the chain or even larger. This could have some side effects later that you would have difficulty figuring out. Reload any program you update before you SAVE. If you have done this consistently, its size as given in locations 45 and 46 will be accurate.

Program 1

```
1 N=99:S$="TEST"
2 PRINT"TEST1, A BIGGER PROGRAM THAN TEST
  2"
3 PRINTN,S$
4 LOAD"TEST2",8
```

Program 2

```
1 REM
2 PRINTN,S$
3 END
4 LOAD"TEST2",8
```

Program 3

```
1 N=99:S$=" "+ "TEST"
2 PRINT"TEST3, A BIGGER PROGRAM THAN TEST
  2"
3 PRINTN,S$
4 LOAD"TEST2",8
```

Program 4

```
1 POKE45,104:POKE46,8:POKE47,104:POKE48,8
  :POKE49,104:POKE50,8
2 N=99:S$=" "+ "TEST"
3 PRINTN,S$
4 LOAD"TEST5",8
```

Program 5

```
1 PRINT"TEST5, A PROGRAM WHICH WE WANT TO
  BE SOMEWHAT BIGGER THAN TEST4"
2 S$=" "+ S$
3 PRINTN,S$
4 END
```

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If you've ever gone through the steps to make your computer play a particular piece of music, you realize that it can be a significant programming task. To have your computer actually *write* music is a real feat.

To accomplish this, we've first got to find a way to work with POKE values in DATA statements in order to make the measures of music. Also, we need to be able to READ the values in any order so that the songs will be different with each run of the program. The commonly used string manipulation methods won't work very well here. We need variety, and the traditional way of working with strings quickly results in a tangled mess.

Alternatively, you could write each measure as a series of POKE Note/Duration/Next Note repeats. But by the time you had about a dozen measures entered this way, you'd see the ?OUT OF MEMORY error message on a VIC. The results of this method are fine, but you'll probably find it too long and repetitive.

Array Referencing

The shortest, best way to solve this problem is to use a technique called array referencing. First, to get the measures of music, you set up an array of all variables, then reference them by subscript into a POKE loop. Specifically, 14 variations on nine variables are required to make the music for this program. The random number generator is used to make the music different every time the program is run.

A Mozartian flavor results from a deliberate shortening of the low notes and making the high notes of varying lengths. And to keep the music from becoming totally random, DATA statements select the measures by their underlying tonality—tonic, subdominant, dominant, or supertonic. You also need to provide for cadence measures every four measures and for a final ending chord

for each tune.

This line-by-line explanation (of the VIC version) will help illustrate the programming steps involved.

Following The Composer

| Lines | |
|-----------|---|
| 10 | DIMension an array for notes—9 notes per measure, 14 variations. |
| 25 | Green screen with a red border. |
| 30-50 | Educational information printed on the screen. |
| 75 | Wait for two seconds before continuing. |
| 80 | Orange screen with a green border. |
| 90 | READ into the array all notes in the following DATA statements until 14 variations of the 9 measures are all read in. Add 212 to each note to make it a pitch value before the note is POKed. |
| 91-95 | The DATA statements that line 90 READs to fill the array. |
| 100-130 | Speed value and voice numbers—line 130 is the volume. |
| 160-178 | The DATA statements which keep the music like Mozart's by controlling the next tonality used and where the cadences will fall. |
| 180 | READ the next item in the DATA statements (170-178). |
| 190-270 | Determine the value of Y, then GOTO 1010 IF RR is 2, 5, or 7. If RR is 8, then 500; if RR is 9, then 1500. |
| 300-332 | These lines guarantee that the value of Y will be different each time the program is run. This section is a random number generator. Note: Y is used to select the variation READ from the array DIMed in line 10. At line 1010, these values of Y will be used to create a measure of music. |
| 500-510 | The ending module that is printed on the screen when the program is finished. |
| 900 | REM line telling the programmer that this is where the music is actually produced and POKed into the correct voices. |
| 1010-1035 | This is where the music is created—by taking the value of Y determined in lines 190-331 and reading the array at position Y (1-14) for 9 notes (subscripts) then POKeing these values into the correct voices to get the notes. Line 1035 ends with a GOTO 160 to make the program create another measure of music. |
| 1500-1510 | This section ends each tune with a long chord, then waits two seconds between tunes. Then the program plays another tune. |

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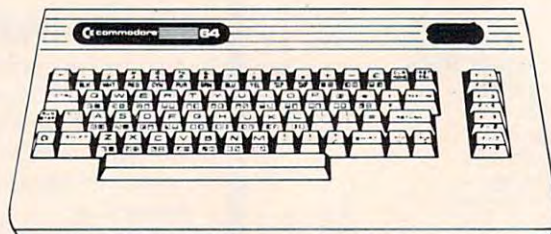
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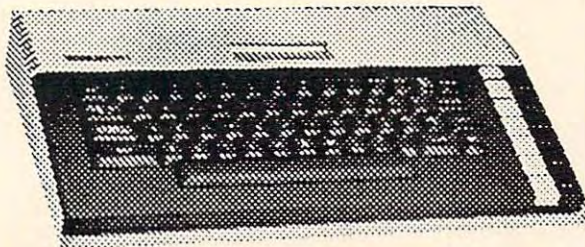
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| | |
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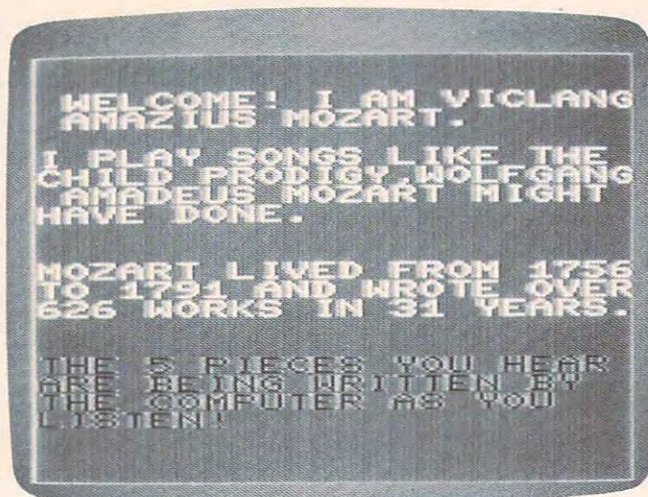
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Entertainment And Education

Significantly, this program does not copy any of Mozart's music; rather it imitates Mozart's style. You might want to introduce some alternative composition rules and stylistic ideas and come up with a mechanical composer of your own. How about a Pink Floyd machine or a Bartok machine?

If you don't want to type this program in yourself, cassette copies of the VIC version are available upon request. Send \$3, a blank cassette, and a stamped, self-addressed mailer to:

VIC Mozart Machine
1810 South 4th St.
Springfield, IL 62703



This screen introduces "The Mozart Machine" to VIC users. (Other versions similar.)

Program 1: VIC Mozart

```
10 DIMX(14,9)
25 POKE36879,90
30 PRINT"{CLR}{2 DOWN}{RIGHT}{WHT}WELCOME
  1 I AM VICLANG AMAZIUS MOZART."
35 PRINT"{DOWN}I PLAY SONGS LIKE THE CHIL
  D PRODIGY,WOLFGANG AMADEUS MOZART MIGH
  T HAVE DONE."
40 PRINT"{2 DOWN}MOZART LIVED FROM 1756TO
  1791 AND WROTE OVER626 WORKS IN 31 YE
  ARS."
50 PRINT"{DOWN}{RED}THE 5 PIECES YOU HEAR
  ARE BEING WRITTEN BY{2 SPACES}THE COM
  PUTER AS YOU{3 SPACES}LISTEN!"
75 FORT=1TO2000:NEXT
80 POKE36879,141
90 FORT=1TO14:FORTT=1TO9:READX:X(T,TT)=X+
  212:NEXTTT:NEXTT
91 DATA3,11,11,11,11,16,16,11,7,3,11,16,1
  1,16,13,16,11,16,3,11,13,11,16,13,16,1
  1,16
92 DATA3,13,16,13,19,22,19,23,13,3,13,19,
  13,19,16,19,13,13,3,19,13,13,3,19,19,1
```

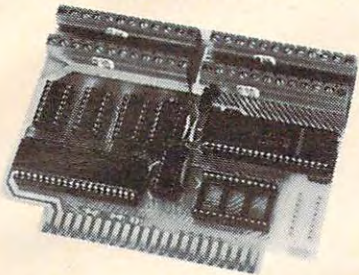
```
3,3
93 DATA7,13,16,13,22,16,16,13,7,0,7,16,7,
  13,11,16,7,13,7,19,22,13,16,13,16,11,7
94 DATA7,13,11,13,7,11,19,13,7,7,13,11,13
  ,7,11,19,13,13,3,11,13,11,16,16,16,16,
  16
95 DATA0,16,13,7,7,7,16,7,7,3,19,16,13,13
  ,13,19,13,13
100 REM SET VOICE NUMBERS,AND{2 SPACES}SP
  EED VALUE
120 K=36875:L=36876:P=175
130 POKE36878,12
160 REM SET SELECTED{2 SPACES}MEASURE BY
  {SPACE}DATA NUMBER
170 DATA1,3,6,2,1,4,6,2,3,4,1,5,1,4,6,7,1
  ,4,6,2,1,3,6,9
172 DATA 1,1,4,5,1,4,6,2,3,4,1,5,1,4,1,5,
  1,4,6,9
174 DATA 1,4,6,2,3,6,1,5,1,4,6,7,3,4,6,2,
  1,4,3,7,1,4,6,9
176 DATA 1,4,3,7,1,6,4,5,6,3,6,2,4,6,1,5,
  1,4,6,9
178 DATA 1,4,3,7,6,3,6,2,4,6,1,5,1,3,6,7,
  3,6,1,5,1,4,6,9,8
180 READRR
190 IFRR=1THEN300
200 IFRR=2THENY=12:GOTO1010
210 IFRR=3THEN310
220 IFRR=4THEN320
230 IFRR=5THENY=14:GOTO1010
240 IFRR=6THEN330
250 IFRR=7THENY=13:GOTO1010
260 IFRR=8THEN500
270 IFRR=9THEN1500
300 Y=1:X=RND(1):IFX<.35THENY=3
301 IFX>.75THENY=2
302 GOTO1010
310 Y=10:IFRND(1)<.4THENY=11:GOTO1010
320 Y=4:X=RND(1):IFX<.35THENY=5
321 IFX>.75THENY=6
322 GOTO1010
330 Y=7:X=RND(1):IFX<.35THENY=8
331 IFX>.75THENY=9
332 GOTO1010
500 PRINT"{CLR}{DOWN}{YEL}WELL, THAT'S ALL
  --HOPE{4 SPACES}YOU LIKED IT!!"
510 PRINT"{DOWN}RUN IT AGAIN--AND HEAR FI
  VE MORE SONGS!!":END
900 REM FOLLOWING ARE THE MUSIC MEASURES
  {SPACE}THAT VICLANG USES TO MAKETHE W
  HOLE TUNE
1010 POKEK,X(Y,1):POKEL,X(Y,2):FORT=1TOP:
  NEXT:POKEK,0:POKEL,X(Y,3):FORT=1TOP:
  NEXT
1020 POKEK,X(Y,4):POKEL,X(Y,5):FORT=1TOP:
  NEXT:POKEK,0:POKEL,X(Y,6):FORT=1TOP:
  NEXT
1030 POKEK,X(Y,7):POKEL,X(Y,8):FORT=1TOP:
  NEXT:POKEK,0
1035 POKEK,X(Y,9):FORT=1TOP:NEXT:GOTO160
1500 POKE36876,235:POKE36875,239:POKE3687
  4,235:FORT=1TO1200:NEXT
1510 POKE36874,0:POKE36875,0:POKE36876,0:
  FORT=1TO2000:NEXT:GOTO160
```

Program 2: Mozart For The 64

Translation by Gregg Peele, Assistant Programming Supervisor

```
100 DIMH(14,9),L(14,9)
101 FORT=54272TO54272+24:POKET,0:NEXT
102 POKE54296,15
```


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```

103 FORT=54272+5TO54272+24STEP7:POKET,17:
    POKET+1,244:NEXT
110 POKE53281,7:POKE53280,5
120 PRINT"{CLR}{2 DOWN}{RIGHT}{WHT}WELCOM
    E! I AM 64CLANG AMAZIUS MOZART."
130 PRINT"{DOWN}{2 SPACES}I PLAY SONGS LI
    KE THE CHILD PRODIGY,"
135 PRINT"WOLFGANG AMADEUS MOZART MIGHT H
    AVE DONE"
140 PRINT"{2 DOWN}MOZART LIVED FROM 1756
    {SPACE}TO 1791 AND WROTE";
145 PRINT"{6 SPACES}OVER 626 WORKS IN 31
    {SPACE}YEARS"
150 PRINT"{DOWN}{BLK}{4 SPACES}THE 5 PIEC
    ES YOU HEAR ARE BEING"
155 PRINT"COMPOSED BY THE COMPUTER AS YO
    U LISTEN"
160 FORT=1TO2000:NEXT
170 POKE53281,5:POKE53280,7
180 FORT=1TO14:FOR TT=1TO9:READH,L:H(T,TT)
    =H:L(T,TT)=L:NEXT TT:NEXT T
190 DATA12,143,31,165,31,165,15,210,31,16
    5,37,162,18,209,31,165,14,24
200 DATA12,143,31,165,37,162,15,210,37,16
    2,33,135,18,209,31,165,18,209
210 DATA12,143,31,165,33,135,15,210,37,16
    2,33,135,18,209,31,165,18,209
220 DATA12,143,33,135,37,162,16,195,42,62
    ,50,60,21,31,50,60,16,195
230 DATA12,143,33,135,42,62,16,195,42,62,
    37,162,21,31,33,135,16,195
240 DATA12,143,42,62,33,135,16,195,25,30,
    84,125,21,31,33,135,12,143
250 DATA14,24,33,135,37,162,16,195,50,60,
    37,162,18,209,33,135,12,143
260 DATA14,24,28,49,37,162,14,24,33,135,3
    1,165,18,209,28,49,16,195
270 DATA14,24,42,62,50,60,16,195,37,162,3
    3,135,18,209,31,165,14,24
280 DATA14,24,33,135,31,165,16,195,28,49,
    31,165,21,31,33,135,14,24
290 DATA14,24,33,135,31,165,16,195,28,49,
    31,165,21,31,33,135,16,195
300 DATA12,143,31,165,33,135,15,210,37,16
    2,37,162,18,209,37,162,18,209
310 DATA 12,143,37,162,33,135,14,24,28,49
    ,28,49,18,209,28,49,14,24
320 DATA12,143,42,62,37,162,16,195,33,135
    ,33,135,21,31,33,135,16,195
330 REM SET VOICE NUMBERS,AND{2 SPACES}SP
    EED VALUE
340 K=54272:P=175:W=K+4
350 POKE54296,15
360 REM SET SELECTED{2 SPACES}MEASURE BY
    {SPACE}DATA NUMBER
370 DATA1,3,6,2,1,4,6,2,3,4,1,5,1,4,6,7,1
    ,4,6,2,1,3,6,9
380 DATA 1,1,4,5,1,4,6,2,3,4,1,5,1,4,1,5,
    1,4,6,9
390 DATA 1,4,6,2,3,6,1,5,1,4,6,7,3,4,6,2,
    1,4,3,7,1,4,6,9
400 DATA 1,4,3,7,1,6,4,5,6,3,6,2,4,6,1,5,
    1,4,6,9
410 DATA 1,4,3,7,6,3,6,2,4,6,1,5,1,3,6,7,
    3,6,1,5,1,4,6,9,8
420 READRR
425 ON RR GOTO520,426,550,560,427,590,428
    ,620,1000
426 Y=12:GOTO650
427 Y=14:GOTO650
428 Y=13:GOTO650
520 Y=1:X=RND(1):IFX<.35THENY=3
530 IFX>.75THENY=2
540 GOTO650
550 Y=10:IFRND(0)<.4THENY=11:GOTO650
560 Y=4:X=RND(1):IFX<.35THENY=5
570 IFX>.75THENY=6
580 GOTO650
590 Y=7:X=RND(1):IFX<.35THENY=8
600 IFX>.75THENY=9
610 GOTO650
620 PRINT"{CLR}{DOWN}{BLU}{2 SPACES}WELL,
    THAT'S ALL--HOPE YOU LIKED IT!!"
625 POKE53281,1
630 PRINT"{DOWN}RUN IT AGAIN--AND HEAR FI
    VE MORE SONGS!!":END
640 REM FOLLOWING ARE THE MUSIC MEASURES
    {SPACE}THAT VICLANG USES TO MAKETHE W
    HOLE TUNE
650 POKEW,17:POKEK,L(Y,1):POKEK+1,H(Y,1):
    POKEK+7,L(Y,2):POKEK+8,H(Y,2)
655 POKEW+7,17:FORQ=1TOP:NEXT:POKEW,16
660 POKEK,L(Y,3):POKEK+1,H(Y,3):FORT=1TOP
    :NEXT
670 POKEW,17:POKEK,L(Y,4):POKEK+1,H(Y,4):
    POKEK+7,L(Y,5):POKEK+8,H(Y,5)
675 POKEW+7,17:FORQ=1TOP:NEXT:POKEW,16
680 POKEK,L(Y,6):POKEK+1,H(Y,6):FORT=1TOP
    :NEXT
690 POKEW,17:POKEK,L(Y,7):POKEK+1,H(Y,7):
    POKEK+7,L(Y,8):POKEK+8,H(Y,8)
695 POKEW+7,17:FORQ=1TOP:NEXT:POKEW,16
700 POKEK,L(Y,9):POKEK+1,H(Y,9):FORT=1TOP
    :NEXT:GOTO370
1000 POKEK,143:POKEK+1,12:POKEK+7,165:POK
    EK+8,31:POKEK+14,30:POKEK+15,25
1010 POKEW,17:POKEW+7,17:POKEW+14,17:FOR
    T=1TO2000:NEXT:POKEW,16:POKEW+7,16
1020 POKEW+14,16:GOTO370

```

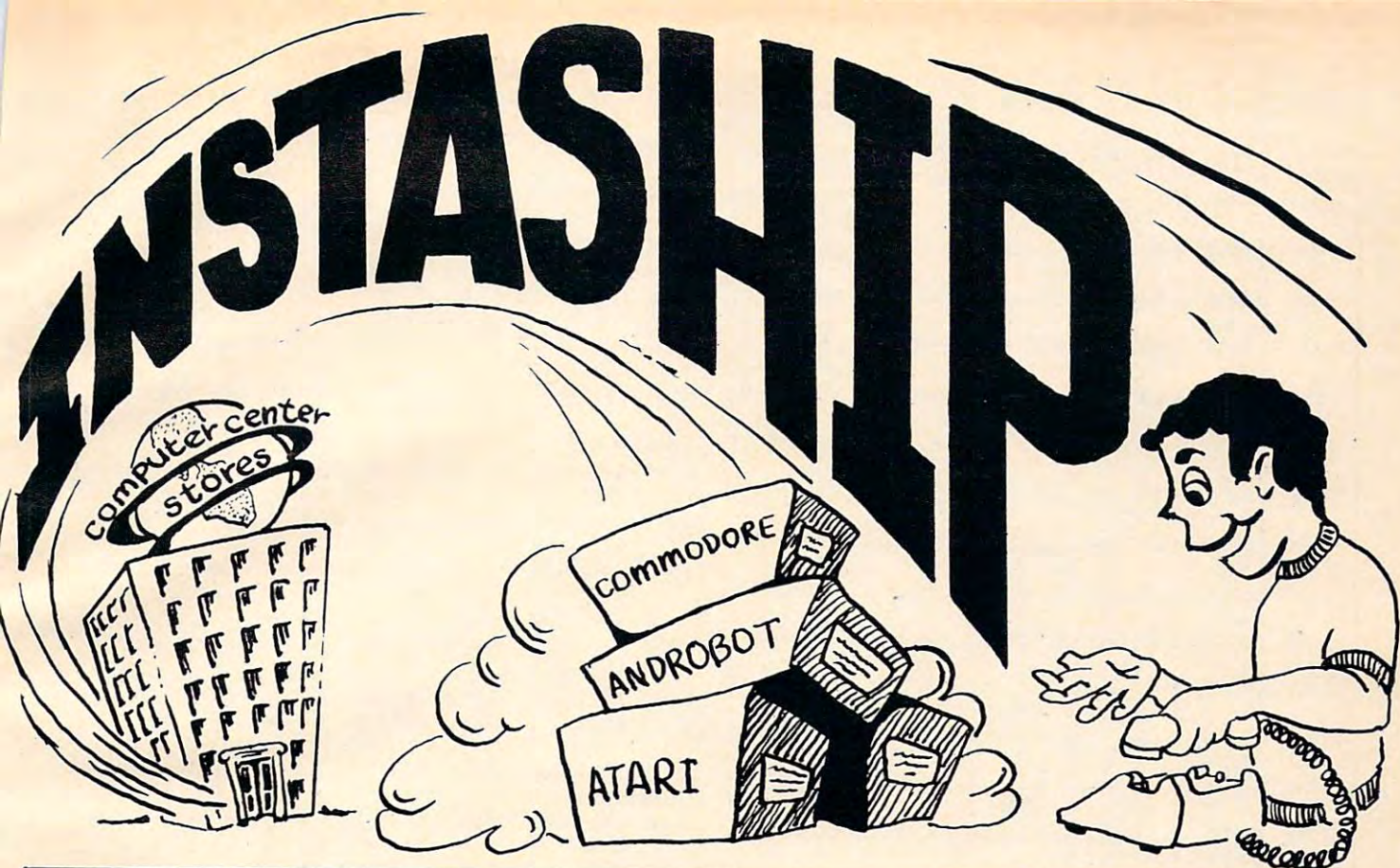
Program 3: Atari Mozart

Translation by Gregg Peele, Assistant Programming Supervisor

```

3 GRAPHICS 18:POSITION 3,5: ? #6;"COM
    PUTER MOZART"
5 RESTORE :FOR T=1 TO 1000:NEXT T:GR
    APHICS 0:POKE 752,1:SETCOLOR 4,8,1
    0:SETCOLOR 1,12,2:SETCOLOR 2,13,14
10 DIM X(14,9)
20 REM SCREEN COLOR
25 POSITION 2,5
30 ? "Welcome! I am Wolfgang Atari M
    ozart.{DOWN}"
40 ? "I play songs like the child pr
    odigy,{DOWN}"
50 ? "Wolfgang A. Mozart might have
    done.{2 DOWN}"
60 ? "Mozart lived from 1756 to 1791
    and{DOWN}"
70 ? "wrote over 626 works in 31 yea
    rs.{DOWN}"
80 ? "the five pieces you are listen
    ing to{DOWN}"
90 ? "are being composed by the comp
    uter.{DOWN}"
120 REM CHANGE COLOR
130 FOR T=1 TO 14:FOR TT=1 TO 9:READ
    A:X(T,TT)=A:NEXT TT:NEXT T
140 DATA 40,64,64,128,64,53,108,64,1
    44
150 DATA 40,64,53,128,53,60,108,64,1
    08

```

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```

160 DATA 40,64,60,128,53,60,108,64,1
    08
170 DATA 40,60,53,121,47,40,96,40,12
    1
180 DATA 40,60,47,121,47,53,96,60,12
    1
190 DATA 40,47,60,121,81,47,96,60,16
    2
200 DATA 144,60,53,121,40,53,108,60,
    144
210 DATA 144,72,53,144,60,64,108,72,
    121
220 DATA 144,47,40,121,64,53,108,64,
    144
230 DATA 144,60,64,121,72,64,96,60,1
    44
240 DATA 144,60,64,121,72,64,96,60,1
    14
250 DATA 162,64,60,128,53,53,108,53,
    108
260 DATA 162,53,60,144,72,72,108,72,
    144
270 DATA 162,47,53,121,60,60,96,60,1
    21
300 DATA 1,3,6,2,1,4,6,2,3,4,1,5,1,4
    ,6,7,1,4,6,2,1,3,6,9
310 DATA 1,1,4,5,1,4,6,2,3,4,1,5,1,4
    ,1,5,1,4,6,9
320 DATA 1,4,6,2,3,6,1,5,1,4,6,7,3,4
    ,6,2,1,4,3,7,1,4,6,9
330 DATA 1,4,3,7,1,6,4,5,6,3,6,2,4,6
    ,1,5,1,4,6,9
340 DATA 1,4,3,7,6,3,6,2,4,6,1,5,1,3
    ,6,7,3,6,1,5,1,4,6,9,8
350 P=75
400 READ RR
401 ON RR GOTO 500,420,521,525,430,5
    29,440,535,1500
420 Y=12:GOTO 1010
430 Y=14:GOTO 1010
440 Y=13:GOTO 1010
500 Y=1:X=RND(0):IF X<0.35 THEN Y=3
510 IF X>0.75 THEN Y=2
520 GOTO 1010
521 Y=10:IF RND(0)<0.4 THEN Y=11:GOT
    O 1010
525 Y=4:X=RND(0):IF X<0.35 THEN Y=5
527 IF X>0.75 THEN Y=6
528 GOTO 1010
529 Y=7:X=RND(0):IF X<0.35 THEN Y=8
533 IF X>0.75 THEN Y=9
534 GOTO 1010
535 GRAPHICS 0:?"(CLEAR)(DOWN)Well,
    that's all--hope you liked it!!
    "
540 ? "Run it again--to hear 5 more
    songs!!":POKE 752,0:END
1010 SOUND 0,X(Y,1),10,8:SOUND 1,X(Y
    ,2),10,8:FOR T=1 TO P:NEXT T
1020 SOUND 0,0,0,0:SOUND 1,X(Y,3),10
    ,8:FOR T=1 TO P:NEXT T
1030 SOUND 0,X(Y,4),10,8:SOUND 1,X(Y
    ,5),10,8:FOR T=1 TO P:NEXT T
1040 SOUND 0,0,0,0:SOUND 1,X(Y,6),10
    ,8:FOR T=1 TO P:NEXT T
1050 SOUND 0,X(Y,7),10,8:SOUND 1,X(Y
    ,8),10,8:FOR T=1 TO P:NEXT T
1060 SOUND 0,0,0,0:SOUND 1,X(Y,9),10
    ,8:FOR T=1 TO P:NEXT T:GOTO 350
1500 SOUND 0,40,10,8:SOUND 1,64,10,8
    :SOUND 2,81,10,8:FOR T=1 TO 600
    :NEXT T
1510 SOUND 0,0,0,0:SOUND 1,0,0,0:SOU

```

```

ND 2,0,0,0:FOR T=1 TO 1000:NEXT
    T
1520 GOTO 350

```

Program 4: TI Mozart

Translation by Gregg Peele, Assistant Programming Supervisor

```

100 DIM X(14,9)
110 REM THE TICLANG AMAZIUS MOZART
120 CALL CLEAR
130 CALL SCREEN(14)
140 PRINT "{3 SPACES}WELCOME! I AM
    TICLANG"
150 PRINT "{6 SPACES}AMAZIUS MOZART
    ."
160 PRINT
170 PRINT "I PLAY SONGS LIKE THE CH
    ILD"
180 PRINT "PRODIGY, WOLFGANG AMADE
    US "
190 PRINT " MOZART MIGHT HAVE DONE
    ."
200 PRINT
210 PRINT "{5 SPACES}MOZART LIVED F
    ROM"
220 PRINT "{8 SPACES}1756 TO 1791"
230 PRINT "AND WROTE OVER 626 WORKS
    IN"
240 PRINT "{8 SPACES}31 YEARS."
250 PRINT
260 PRINT "THE 5 PIECES YOU HEAR AR
    E"
270 PRINT "{3 SPACES}BEING WRITTEN
    BY THE "
280 PRINT " COMPUTER AS YOU LISTEN!"
290 PRINT
300 PRINT
310 PRINT
320 FOR T=1 TO 14
330 FOR TT=1 TO 9
340 READ X(T,TT)
350 NEXT TT
360 NEXT T
370 DATA 196,494,494,247,494,587,29
    4,494,220
380 DATA 196,494,587,247,587,523,29
    4,494,294
390 DATA 196,494,523,247,587,523,29
    4,494,294
400 DATA 196,523,587,262,659,784,33
    0,784,262
410 DATA 196,523,659,262,659,587,33
    0,523,262
420 DATA 196,659,523,262,392,659,33
    0,523,196
430 DATA 220,523,587,262,784,587,29
    4,523,220
440 DATA 220,440,587,220,523,494,29
    4,440,262
450 DATA 220,659,784,262,587,523,29
    4,494,220
460 DATA 220,523,494,262,440,494,33
    0,523,220
470 DATA 220,523,494,262,440,494,33
    0,523,262
480 DATA 196,494,523,247,587,587,29
    4,287,294
490 DATA 196,587,523,220,440,440,29
    4,440,220
500 DATA 196,659,587,262,523,523,33
    0,523,262
510 P=250

```


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520 DATA 1,3,6,2,1,4,6,2,3,4,1,5,1,
4,6,7,1,4,6,2,1,3,6,9
530 DATA 1,1,4,5,1,4,6,2,3,4,1,5,1,
4,1,5,1,4,6,9
540 DATA 1,4,6,2,3,6,1,5,1,4,6,7,3,
4,6,2,1,4,3,7,1,4,6,9
550 DATA 1,4,3,7,1,6,4,5,6,3,6,2,4,
6,1,5,1,4,6,9
560 DATA 1,4,3,7,6,3,6,2,4,6,1,5,1,
3,6,7,3,6,1,5,1,4,6,9,8
570 READ RR
580 ON RR GOTO 650,590,730,780,610,
860,640,940,1040
590 Y=12
600 GOTO 990
610 Y=14
620 GOTO 990
630 Y=13
640 GOTO 990
650 Y=1
660 RANDOMIZE
670 IF RND>.35 THEN 700
680 Y=3
690 RANDOMIZE
700 IF RND<.75 THEN 720
710 Y=2
720 GOTO 990
730 Y=10
740 RANDOMIZE
750 IF RND>.4 THEN 780
760 Y=11
770 GOTO 990
780 Y=4
790 RANDOMIZE
800 IF RND>.35 THEN 820

```

```

810 Y=5
820 RANDOMIZE
830 IF RND<.75 THEN 850
840 Y=6
850 GOTO 990
860 Y=7
870 RANDOMIZE
880 IF RND>.35 THEN 900
890 Y=8
900 RANDOMIZE
910 IF RND<.75 THEN 930
920 Y=9
930 GOTO 990
940 PRINT "{5 SPACES}WELL, THAT'S A
LL"
950 PRINT "{4 SPACES}HOPE YOU LIKED
IT!!"
960 PRINT "RUN IT AGAIN AND HEAR FI
VE"
970 PRINT "{8 SPACES}MORE SONGS."
980 END
990 FOR I=1 TO 9 STEP 3
1000 CALL SOUND(P,X(Y,I),2,X(Y,I+1)
,2)
1010 CALL SOUND(P,X(Y,I),30,X(Y,I+2)
,2)
1020 NEXT I
1030 GOTO 570
1040 CALL SOUND(1800,196,2,494,2,78
4,2)
1050 FOR T=1 TO 800
1060 NEXT T
1070 KOL=INT(RND*8)+8
1080 CALL SCREEN(KOL)
1090 GOTO 570

```

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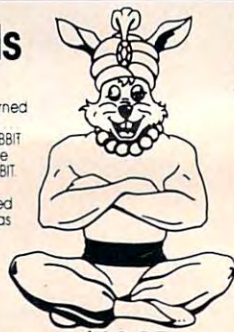


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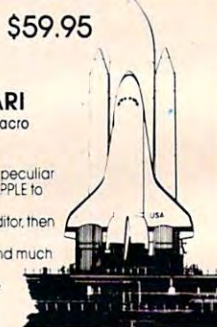
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Hidden 64 Memory

Alan R. and Julie R. Krauss

BASIC programmers can POKE data into the Commodore 64's hidden RAM, but retrieving that data requires switching between blocks of RAM and ROM. The machine language program given here makes it easy to do what BASIC can't do directly—giving you an extra 20K.

The Commodore 64 contains 24 kilobytes of Random Access Memory (RAM) which cannot immediately be used by BASIC. However, that memory is accessible to the VIC-II chip, so it seems an ideal place to store a high-resolution (bit-mapped) screen (as well as other large arrays of data). The catch is that although it is possible to move data into this area using POKE statements, you can't retrieve all of it directly using BASIC. In this article we describe a technique which makes most of this large block of memory available to the BASIC programmer.

How To Get Five Quarts To A Gallon

The microprocessor in most smaller computers, including the Timex 1000, IBM PC, and DEC PDP-11, has 16 or fewer memory address lines. So these computers can address no more than 2^{16} —64K—bytes of memory directly. The more expensive machines appear to have a larger addressable memory because their memory-management circuitry and operating systems allow them to switch blocks of memory into and out of their actual address space. The inexpensive Commodore 64 has no special Memory Management Unit, yet it is able to address 20K of Read Only Memory (ROM) and numerous I/O chips plus 64K of RAM. This is like filling a one-gallon pitcher with five quarts of water. It works because the microprocessor can switch between various blocks of ROM and RAM even when they have the same addresses.

In its normal configuration, the first 2K of the 64's memory is used as a work area for the Operating System, and for screen memory. Of the remaining RAM, locations 2048 through 40959 are the programmer's BASIC area. The space above 40959 contains 4K of RAM (addresses 49152–53247) which is not contiguous with BASIC's dedicated area and can be accessed by BASIC only via PEEKs and POKES; by the ROM BASIC interpreter (40960–49151); by the Kernal Operating System (57344–65535); and by the Input-Output (I/O) circuitry (53248–57343). However, there is another 20K of RAM which is similarly addressed; to be used, it must be switched in and out of the ROM-masked space. This chore is handled by registers at locations 0 and 1.

What The Pointers Mean

Although the extra RAM isn't directly available to BASIC, data may be stored there by using the POKE instruction. However, a PEEK of one of these locations will return the value stored at that address in ROM. In order to have access to the corresponding RAM, it is necessary to set a pointer so that the processor will ignore the ROM. Bits 0, 1, and 2 of location 1 are the pointers. Their functions are as follows:

| Bit | Value | Meaning |
|-----|-------|--|
| 0 | 1 | Indicates normal BASIC ROM |
| | 0 | Indicates noncontiguous RAM (addresses 40960–49151) |
| 1 | 1 | Indicates Kernal ROM |
| | 0 | Indicates underlying RAM (addresses 57344–65535) |
| 2 | 1 | Indicates I/O chips |
| | 0 | Indicates ROM character tables (addresses 53248–57343) |

If we wished to save a variable—call it A—at, say, address 45000, and later retrieve it, we might envision a routine like this:

CodePro-64

Main Menu

Overview

- 0 — Using CodePro-64
- 1 — CBM-64 Keyboard Review

BASIC Tutorial

- 2 — Introduction to BASIC
- 3 — BASIC Commands
- 4 — BASIC Statements
- 5 — BASIC Functions

Graphics & Music

- 6 — Keyboard GRAPHICS
- 7 — Introduction to SPRITES
- 8 — SPRITE Generator
- 9 — SPRITE Demonstrator
- A — Introduction to MUSIC
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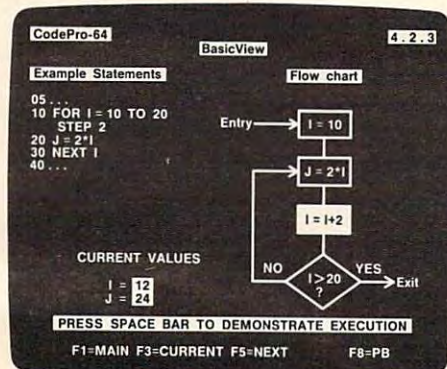
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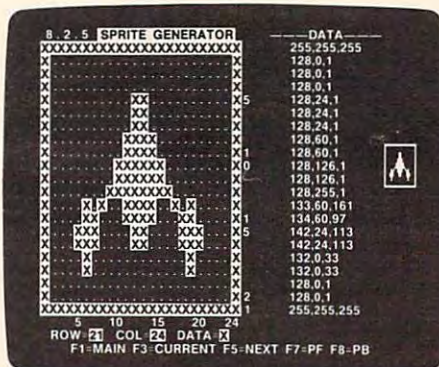
By seeing graphic displays of program segment execution you learn by visual example. You learn faster and grasp programming concepts easier with CodePro-64 because you immediately see the results of your input.

You control your learning. You can go through the tutorial sequentially, or return to the main menu and select different topics, or use keywords to select language elements to study. You can page back and forth between screens within a topic at the touch of a function key.

CodePro-64 lets you follow your interests and practice with interactive examples. But you can never get "lost". F1 will always return you to the main menu. Once you have practiced and mastered the BASIC language elements you move on to more advanced concepts. You learn about sprite and music programming.

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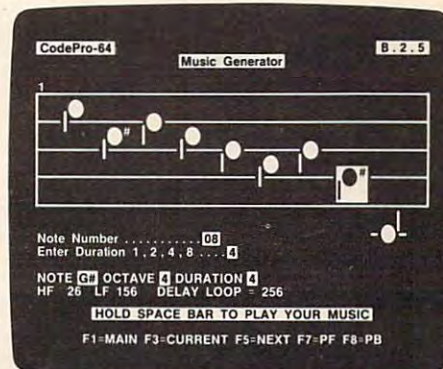
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```

10 POKE 45000,A :REM STORE THE VALUE
20 POKE 1,54 :REM SET POINTER TO RAM
30 A=PEEK(45000):REM GET THE VALUE
40 POKE 1,55 :REM RESTORE POINTER
50 END

```

This, though, amounts to sawing off the branch we're sitting on. The result is a lovely crash.

It's easy to see why. Line 20 tells the processor to look not at the BASIC interpreter in ROM, but somewhere else instead. So when line 30 calls for the BASIC PEEK instruction, it can't be found, and the system hangs. If we change the pointer for Kernal ROM or for I/O, we also crash.

Machine Language Makes It Easy

But the extra memory is too tantalizing to pass up. Since we can't get at it properly from BASIC, we'll try machine language (ML). We'll use a BASIC loader for the routine, as in Program 1.

It works! We can now store data in the formerly unavailable area of masked RAM. The ML routine, which is only 14 bytes long, sets the appropriate pointer (bit 0 in this example) to ignore the ROM (here, the BASIC interpreter). It then puts the byte of data into a location normally accessible to BASIC (since location 251 is in unused zero page space, we chose that) and resets the pointer. A disassembly of the machine language for this routine is shown in Program 2.

Let's take a look at Program 1. Lines 100–120, 340, and 350 are not really part of our routine—lines 100 and 110 give us some data to use in illustration, and line 340 prints the data that the ML routine saved for us, just to prove it really worked. The 4K of RAM beginning at location 49152 is unused, and since it is not contiguous with the BASIC area, it can't be overwritten by BASIC; so we've chosen to put our ML there. Line 130 sets location 49152 as the starting location for the machine language routine.

Lines 140, 160, 170, and 180 determine what value location 1 should contain, and put that value in BL. The numbers in the DATA statements (lines 190 and 200) are the bytes of ML (in decimal). Three of these are 0. The first (shown as 00 for prominence) will hold the block pointer, BL. The second and third, 000 and 0000, will hold the low-order and the high-order bytes, respectively, of the address of the target masked-RAM location.

Lines 210–240 POKE the ML into place. Line 250 inserts the value of the block pointer into byte 2 of the ML routine. Lines 260 and 270 calculate the high- and low-order bytes, respectively, of the target address; lines 280 and 290 POKE them into place. Line 300 disables interrupts so that the keyboard will not be scanned during execution of the machine language routine; this obviates the possibility of the system's hanging should the scan interrupt occur at the wrong moment.

The innocuous-looking line 310, the system call, signals the real action—here is where we branch out to perform our machine language routine. When the subroutine is finished, it returns control to BASIC. Now we can get our data whenever we need it: It has been left in location 251 for us.

Note that the ML could reside virtually anywhere—even in masked RAM. If it is placed within the normal BASIC area, of course, the appropriate BASIC pointers should be altered to protect it. From line 140 on, the routine is perfectly general and may be used to read the value stored at any RAM address within the range 0–65535, except for that lying beneath the I/O area (53248–57343). To see the underlying 4K of RAM in this area would require another technique, since there are three layers of memory here; our routine uncovers the second layer and lets us look at Character ROM directly. This could be useful in programs using custom-character routines, in order to restore portions of the ROM character table selectively.

Finally, we must note two things. First, this routine may be used to read memory locations in which either the BASIC program or the ML routine resides. However, we must not permit a POKE instruction (for example, line 120) to alter the program unless we specifically wish to do so. Also, if we POKE to a location in the I/O area, we may drastically alter our output.

Program 1: ML Access To Hidden RAM

```

100 A=3{15 SPACES}:REM{2 SPACES}PUT DESIR
    ED DATA BYTE IN VARIABLE "A"
110 AD=45000{10 SPACES}:REM{2 SPACES}WE'L
    L SAVE "A" AT LOC. 45000 (IN MASKED R
    AM)
120 POKE AD,A{9 SPACES}:REM{2 SPACES}SAVE
    "A"
130 MS=49152{10 SPACES}:REM{2 SPACES}MACH
    INE CODE WILL BE LOADED STARTING AT L
    OC. 49152
140 IF 40959<AD AND AD<49152 THEN BL=54:
    {SPACE}GO TO 190
145 REM{21 SPACES}LOCATION 1 WILL CONTAIN
    BLOCK POINTER, BL
150 REM{21 SPACES}BL = 54 -- BASIC INTERP
    RETER ROM OUT
160 IF 53247<AD AND AD<57344 THEN BL=51:
    {SPACE}GO TO 190
165 REM{21 SPACES}BL = 51 -- I/O ROUTINES
    OUT
170 IF 57343<AD AND AD<=65535 THEN BL=53:
    GO TO 190
175 REM{21 SPACES}BL = 53 -- KERNAL ROM O
    UT
180 BL = 55{11 SPACES}:REM{2 SPACES}WITHI
    N NORMAL BASIC AREA
190 DATA 162,00,134,1 :REM{2 SPACES}MACHI
    NE LANGUAGE ROUTINE
200 DATA 174,000,0000,134,251,162,55,134,
    1,96
210 FOR I=0 TO 13{5 SPACES}:REM{2 SPACES}
    LOOP FOR BASIC LOADER

```


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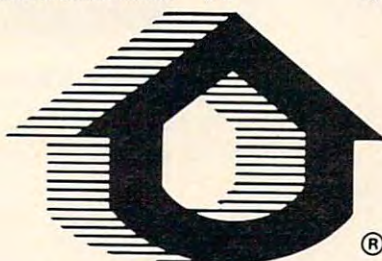
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```

220 READ ML{11 SPACES}:REM{2 SPACES}GET N
EXT BYTE OF M. L. ROUTINE
230 POKE (MS+1),ML{4 SPACES}:REM
{2 SPACES}PUT M. L. BYTE INTO PLACE
240 NEXT
250 POKE(MS+1),BL{5 SPACES}:REM{2 SPACES}
STORE BLOCK POINTER IN 2ND BYTE OF M.
L. ROUTINE
260 HA=INT(AD/256){4 SPACES}:REM
{2 SPACES}HIGH-ORDER BYTE OF MASKED-R
AM ADDRESS
270 LA=AD-256*HA{6 SPACES}:REM{2 SPACES}L
OW-ORDER{3 SPACES}"{3 SPACES}"
{4 SPACES}"{5 SPACES}"{4 SPACES}"
280 POKE MS+5,LA{6 SPACES}:REM{2 SPACES}P
UT ADDRESSES INTO M. L. ROUTINE
290 POKE MS+6,HA
300 POKE 56333,127{4 SPACES}:REM
{2 SPACES}DISABLE INTERRUPTS
310 SYS(MS){11 SPACES}:REM{2 SPACES}EXECU
TE M. L. ROUTINE
320 POKE 56333,129{4 SPACES}:REM
{2 SPACES}RE-ENABLE INTERRUPTS
330 A=PEEK(251){7 SPACES}:REM{2 SPACES}RE
AD THE DATA BYTE
340 PRINT A
350 END

```

Program 2: Disassembly Of ML Routine

```

LDX #000 ;BLOCK POINTER TO X REGISTER
STX $01 ;STORE IN LOCATION 1
LDX $0000;CONTENTS OF MASKED RAM TO X-REGISTER
STX $FB ;STORE IN LOCATION 251 (DECIMAL)
LDX #37 ;NORMAL VALUE OF POINTER (55 DECIMAL)
STX $01 ;RESTORE NORMAL VALUE TO LOCATION 1
RTS ;RETURN TO BASIC

```

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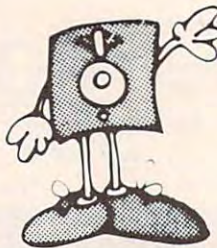
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FACTORS: A Machine Language Factoring Program

Part 1

Machine language is known for its speed. Sometimes we overlook another advantage of machine language: the ability to do things that BASIC can't.

This program—for PET/CBM, VIC, and Commodore 64—runs quickly because of its machine language structure. More importantly, it breaks through a boundary of conventional BASIC: It allows numbers up to 19 digits long to be entered and used for computation.

In fact, the program can deal with slightly over 19 digits. The highest number it will take is:

18,445,055,223,849,287,685

The program finds the prime factors of any number entered. If the number is prime, the program will simply repeat it. Users should know that numbers over 12 digits or so can take a very long time to factor, especially if they are prime. The RUN/STOP key will take you out of the program if you get bored (very large numbers could take up to 24 hours!).

Students of machine language will find several useful modules in the program: a numeric input, a numeric output, and a division subroutine. But you don't need to be a machine language buff to use it, of course.

You'll need a monitor to enter this program. Once it's safely saved on tape or disk, the monitor is no longer needed; it's there only to help you get the program in place. Any convenient monitor will do: the built-in monitor in PET/CBM models, Tinymon, Supermon, VICmon, HESmon, etc. VIC users may need to adjust slightly; many VIC monitors present memory locations five at a time,

and the memory printout here gives them in groups of eight.

The method is generally a simple one of trial division. We divide by two, by three, by five, searching for an "exact" result (no remainder). After that, we use a cyclical method of generating divisors. For example, if we have established that a number will not divide by 3, there's no point in trying divisors of 9 or 15.

When numbers get big, there are more efficient methods of looking for factors, but they are not used in this simple program. Even if more advanced methods were used, very large numbers are hard to crack. There's no guaranteed way to factor a huge number within a reasonable amount of time.

Machine language nuts will easily be able to extend this program to allow more digits: 50, 100, or whatever. But for really large numbers, time catches up with you.

How To Enter "Factors"

For the PET/CBM, enter Program 1 using a machine language monitor. After it has been entered, set the BASIC pointers with:

.: 0028 01 04 6D 07 6D 07 6D 07

Then return to BASIC and save Factors to tape or disk like a normal BASIC program.

For the VIC-20 and Commodore 64, type in the following commands before entering Program 2.

POKE 4608,0:POKE 43,18:NEW

Now switch to any machine language monitor, and enter the program.

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Now enter the following memory changes:

∴ 002B 01 12 6D 15 6D 15 6D 15

You may now return to BASIC and save the program to tape or disk. When you load this program at a later time, you won't need any special POKE commands; the program will adapt to any configuration.

To use either the VIC/64 or PET/CBM version of Factors, simply LOAD the program from tape or disk and give the usual BASIC RUN command.

Next month we'll disassemble the machine language for Factors to see how it works in more detail.

Program 1: Factors—PET/CBM Version

```
0400 00 24 04 64 00 99 22 50
0408 52 49 4D 45 20 46 41 43
0410 54 4F 52 53 20 4F 46 20
0418 41 4E 20 49 4E 54 45 47
0420 45 52 22 00 46 04 6E 00
0428 99 22 20 20 20 20 20 20
0430 20 20 20 20 20 4A 49 4D
0438 20 42 55 54 54 45 52 46
0440 49 45 4C 44 22 00 65 04
0448 78 00 99 22 55 50 20 54
0450 4F 20 31 39 20 44 49 47
0458 49 54 53 20 4E 55 4D 42
0460 45 52 53 22 00 79 04 82
0468 00 99 22 4D 41 59 20 42
0470 45 20 55 53 45 44 20 2D
0478 00 97 04 8C 00 99 22 42
0480 55 54 20 56 45 52 59 20
0488 4C 41 52 47 45 20 4E 55
0490 4D 42 45 52 53 22 00 B7
0498 04 96 00 99 22 4D 41 59
04A0 20 54 41 4B 45 20 41 20
04A8 56 45 52 59 20 4C 4F 4E
04B0 47 20 54 49 4D 45 00 CA
04B8 04 A0 00 99 22 54 4F 20
04C0 46 41 43 54 4F 52 2E 2E
04C8 2E 00 D5 04 AA 00 9E 20
04D0 31 32 38 30 00 00 00 81
04D8 00 00 00 00 83 40 00 00
04E0 00 81 00 00 00 00 83 20
04E8 00 00 00 83 20 00 00 00
04F0 84 10 00 00 00 00 00 00
04F8 00 00 83 60 00 00 00 82
0500 A9 0D 20 D2 FF 20 BA 05
0508 A9 3D 8D 4A 03 A2 0F A9
0510 00 9D 50 03 9D 58 03 9D
0518 60 03 CA 10 F4 20 E1 FF
0520 F0 17 20 E4 FF C9 0D F0
0528 11 20 C4 05 B0 03 4C 1D
0530 05 A9 3F 20 D2 FF 4C 00
0538 05 60 A9 20 20 D2 FF A9
0540 14 20 D2 FF A2 07 BD 50
0548 03 D0 05 CA D0 F8 F0 E1
0550 A9 02 20 7A 06 90 4B A9
0558 03 20 7A 06 90 44 A9 05
0560 20 7A 06 90 3D A2 00 8E
0568 4C 03 20 E1 FF F0 CA AC
0570 4C 03 C8 C0 08 90 12 A0
0578 00 18 A9 1E A2 03 7D 60
0580 03 9D 60 03 A9 00 CA 10
0588 F5 8C 4C 03 B9 65 07 18
0590 A2 03 7D 60 03 9D 68 03
```

```
0598 A9 00 CA 10 F5 20 7D 06
05A0 B0 C8 AE 57 03 CA D0 0C
05A8 A2 06 BD 50 03 D0 05 CA
05B0 10 F8 30 03 20 B9 06 4C
05B8 00 05 A9 23 20 D2 FF A9
05C0 9D 4C D2 FF C9 30 90 42
05C8 C9 3A B0 3D 20 D2 FF 29
05D0 0F A8 20 BA 05 20 0B 06
05D8 B0 30 20 0B 06 B0 2B A2
05E0 07 18 BD 50 03 7D 58 03
05E8 9D 50 03 CA 10 F4 B0 1A
05F0 20 0B 06 B0 15 A2 07 98
05F8 18 7D 50 03 9D 50 03 9D
0600 58 03 A9 00 CA 10 F2 B0
0608 01 18 60 A2 07 18 3E 50
0610 03 CA 10 FA 60 A9 00 A2
0618 0B 9D 6C 03 CA 10 FA A2
0620 00 A0 00 8E 48 03 BD 50
0628 03 D0 06 E8 D0 F8 BD 50
0630 03 99 70 03 E8 C8 EE 48
0638 03 E0 08 90 F1 0E 48 03
0640 0E 48 03 0E 48 03 18 A2
0648 0B 3E 6C 03 CA 10 FA A2
0650 03 38 BD 6C 03 FD 68 03
0658 CA 10 F7 90 0F A2 03 38
0660 BD 6C 03 FD 68 03 9D 6C
0668 03 CA 10 F4 CE 48 03 D0
0670 D6 A2 07 3E 70 03 CA 10
0678 FA 60 8D 6B 03 A9 00 8D
0680 49 03 20 15 06 A9 00 A2
0688 03 1D 6C 03 CA 10 FA AA
0690 D0 10 EE 49 03 A2 07 BD
0698 70 03 9D 50 03 CA 10 F7
06A0 30 E0 A2 07 38 BD 70 03
06A8 FD 64 03 CA 10 F7 08 AE
06B0 49 03 F0 03 20 D0 06 28
06B8 60 AD 4A 03 20 D2 FF 20
06C0 04 07 A2 07 BD 50 03 9D
06C8 70 03 CA 10 F7 4C 0F 07
06D0 AD 4A 03 20 D2 FF A9 2A
06D8 8D 4A 03 20 04 07 A2 03
06E0 BD 68 03 9D 74 03 CA 10
06E8 F7 20 0F 07 AE 49 03 CA
06F0 F0 11 20 04 07 AE 49 03
06F8 8E 77 03 A9 5E 20 D2 FF
0700 20 0F 07 60 A2 07 A9 00
0708 9D 70 03 CA 10 FA 60 A2
0710 09 A9 00 9D 78 03 CA 10
0718 FA A0 3F A2 07 18 3E 70
0720 03 CA 10 FA A2 09 78 F8
0728 BD 78 03 7D 78 03 9D 78
0730 03 CA 10 F4 D8 58 88 10
0738 E2 A2 00 8E 4B 03 BD 78
0740 03 48 4A 4A 4A 20 55
0748 07 68 29 0F 20 55 07 E8
0750 E0 0A 90 EA 60 D0 06 CD
0758 4B 03 D0 01 60 EE 4B 03
0760 09 30 4C D2 FF 01 07 0B
0768 0D 11 13 17 1D AA AA AA
```

Program 2: Factors—VIC/64 Version

```
1200 00 24 12 64 00 99 22 50
1208 52 49 4D 45 20 46 41 43
1210 54 4F 52 53 20 4F 46 20
1218 41 4E 20 49 4E 54 45 47
1220 45 52 22 00 44 12 6E 00
1228 99 22 20 20 20 20 20 20
1230 20 20 20 4A 49 4D 20 42
```


COMPUTE!'s Machine Language For Beginners

Author: Richard Mansfield

Price: \$12.95

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

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

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

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

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

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

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 1260 00 99 22 4C 41 52 47 45
 1268 20 4E 55 4D 42 45 52 53
 1270 20 54 41 4B 45 20 54 49
 1278 4D 45 21 22 00 8C 12 8C
 1280 00 97 39 30 30 2C C2 28
 1288 34 36 29 00 9A 12 96 00
 1290 97 20 34 36 2C 32 31 3A
 1298 9C 00 BC 12 A0 00 54 B2
 12A0 28 C2 28 39 30 30 29 AB
 12A8 32 31 29 AC 32 35 36 3A
 12B0 8B 20 54 B2 30 20 89 20
 12B8 32 30 30 00 D5 12 AA 00
 12C0 81 20 4A B2 35 34 38 34
 12C8 20 A4 20 34 38 36 34 20
 12D0 A9 20 AB 31 00 E8 12 B4
 12D8 00 97 20 4A 2C C2 28 4A
 12E0 AA 54 29 3A 82 20 4A 00
 12E8 F3 12 C8 00 9E 20 34 38
 12F0 36 34 00 00 00 AA AA AA
 12F8 AA AA AA AA AA AA AA
 1300 A9 0D 20 D2 FF 20 BA 13
 1308 A9 3D 8D 4A 03 A2 0F A9
 1310 00 9D 50 03 9D 58 03 9D
 1318 60 03 CA 10 F4 20 E1 FF
 1320 F0 17 20 E4 FF C9 0D F0
 1328 11 20 C4 13 B0 03 4C 1D
 1330 13 A9 3F 20 D2 FF 4C 00
 1338 13 60 A9 20 20 D2 FF A9
 1340 14 20 D2 FF A2 07 BD 50

1348 03 D0 05 CA D0 F8 F0 E1
 1350 A9 02 20 7A 14 90 4B A9
 1358 03 20 7A 14 90 44 A9 05
 1360 20 7A 14 90 3D A2 00 8E
 1368 4C 03 20 E1 FF F0 CA AC
 1370 4C 03 C8 C0 08 90 12 A0
 1378 00 18 A9 1E A2 03 7D 60
 1380 03 9D 60 03 A9 00 CA 10
 1388 F5 8C 4C 03 B9 65 15 18
 1390 A2 03 7D 60 03 9D 68 03
 1398 A9 00 CA 10 F5 20 7D 14
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 13A8 A2 06 BD 50 03 D0 05 CA
 13B0 10 F8 30 03 20 B9 14 4C
 13B8 00 13 A9 23 20 D2 FF A9
 13C0 9D 4C D2 FF C9 30 90 42
 13C8 C9 3A B0 3D 20 D2 FF 29
 13D0 0F A8 20 BA 13 20 0B 14
 13D8 B0 30 20 0B 14 B0 2B A2
 13E0 07 18 BD 50 03 7D 58 03
 13E8 9D 50 03 CA 10 F4 B0 1A
 13F0 20 0B 14 B0 15 A2 07 98
 13F8 18 7D 50 03 9D 50 03 9D
 1400 58 03 A9 00 CA 10 F2 B0
 1408 01 18 60 A2 07 18 3E 50
 1410 03 CA 10 FA 60 A9 00 A2
 1418 0B 9D 6C 03 CA 10 FA A2
 1420 00 A0 00 8E 48 03 BD 50
 1428 03 D0 06 E8 D0 F8 BD 50
 1430 03 99 70 03 E8 C8 EE 48
 1438 03 E0 08 90 F1 0E 48 03
 1440 0E 48 03 0E 48 03 18 A2
 1448 0B 3E 6C 03 CA 10 FA A2
 1450 03 38 BD 6C 03 FD 68 03
 1458 CA 10 F7 90 0F A2 03 38
 1460 BD 6C 03 FD 68 03 9D 6C
 1468 03 CA 10 F4 CE 48 03 D0
 1470 D6 A2 07 3E 70 03 CA 10
 1478 FA 60 8D 6B 03 A9 00 8D
 1480 49 03 20 15 14 A9 00 A2
 1488 03 1D 6C 03 CA 10 FA AA
 1490 D0 10 EE 49 03 A2 07 BD
 1498 70 03 9D 50 03 CA 10 F7
 14A0 30 E0 A2 07 38 BD 70 03
 14A8 FD 64 03 CA 10 F7 08 AE
 14B0 49 03 F0 03 20 D0 14 28
 14B8 60 AD 4A 03 20 D2 FF 20
 14C0 04 15 A2 07 BD 50 03 9D
 14C8 70 03 CA 10 F7 4C 0F 15
 14D0 AD 4A 03 20 D2 FF A9 2A
 14D8 8D 4A 03 20 04 15 A2 03
 14E0 BD 68 03 9D 74 03 CA 10
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 1500 20 0F 15 60 A2 07 A9 00
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 1518 FA A0 3F A2 07 18 3E 70
 1520 03 CA 10 FA A2 09 78 F8
 1528 BD 78 03 7D 78 03 9D 78
 1530 03 CA 10 F4 D8 58 88 10
 1538 E2 A2 00 8E 4B 03 BD 78
 1540 03 48 4A 4A 4A 20 55
 1548 15 68 29 0F 20 55 15 E8
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INSIGHT: Atari

Bill Wilkinson

Well, it's the new year and, even though I am writing this months before New Year's Eve, I'm going to make at least one resolution right now: I hereby resolve to write the articles which I have promised. (Except, of course, if I...naw, that's not fair. I'll even try to avoid those exceptions.)

So, in the spirit of that resolution, I'm going to deliver the fourth part of my series on writing self-relocatable machine language right now. This month. Immediately. After I feed you some tidbits first.

Keep Those Cards And Brickbats Coming

Recently, I have received several letters ("several" means more than four—I am seldom exactly deluged with mail) which all bear on one or two topics. Since there appears to be some interest in these two areas, I would like to touch on them this month. Normally, I acknowledge my readers by name when I answer letters. This time, however, several asked the same questions, and I am hesitant to single out any one letter. If you recognize, in this column, a response to a letter you wrote me, I offer my thanks for the ideas you have given me.

Machine Language

The questions about this topic ranged all the way from "How about a section for machine language beginners?" to "Are you planning any more about graphics from machine language?"

To begin, let me say that I do not intend to teach a tutorial machine language class through this column. A good tutorial would take about 200 magazine pages, minimum. That's about what *COMPUTE!* allots me for two years' writing. By the time the series were finished, I would hope that you would have been experienced programmers for over a year!

On the other hand, I will try to take the spirit of the questions to heart and include a little more material for those who are just beginning to learn machine language. (Unfortunately, that does not include this month's article, but I feel committed to finishing the series.)

Several of you have asked me if I will write

on how to do I/O and graphics from machine language. Unfortunately, I have already written a lot about these subjects (primarily from November 1981 to February 1982, but with many additions through the summer of 1982).

Alas, there is no beginner-level book which treats these subjects. Most of what I discussed in my articles is thoroughly explored in Atari's Technical Notes and Operating System documentation or *De Re Atari*, but you need to be well-versed in 6502 machine language before tackling either.

Probably the most popular books about the 6502 are those by Rodnay Zaks. My personal opinion is that they are good, but not great books. So, after you have digested Richard Mansfield's *Machine Language for Beginners* (*COMPUTE!* Books), you probably should be very careful about what book you pick up from your dealer's shelves. Pick one which appears appropriate to your level. But keep watching: More books are on their way.

The 1050 Disk Drive And DOS 3

I had promised that I would say no more on these topics, since there is obviously something of a conflict of interest for me here. (Atari hasn't bought our DOS XL, but some of the other disk drive manufacturers have.) But I have received several cogent questions and comments, and I will try to answer them as honestly as possible.

First, I heard from a couple of people that the 1050 drive does *not* support 32 sectors per track in its pseudo-double-density mode. The claim is that it only supports 26 sectors per track, a substantial reduction in capacity. Since I don't have a 1050 drive or the final version of DOS 3, I cannot directly verify or dispute this claim. (Is it possible that this claim is a result of an opinion which I myself expressed to a users group last spring?) I can only reiterate that it was an examination of a preliminary copy of DOS 3 which resulted in my comments.

The other letters I received either chided me for not giving more details on DOS 3 or simply asked whether it would work with...well, almost anything (Atari 810 drives, RAMDISKS, Mosaic boards, etc.). First, let me state that I have not

been able to exhaustively test DOS 3. The preliminary version works on an Atari 800 with an 810 drive. Beyond that, I cannot say.

DOS 3 achieves its random access file capability by segmenting the disk into 128 blocks of 1K each. Obviously, with so few blocks, one can keep a pointer to each block in memory at all times. In fact, the VTOC (which is a bitmap on DOS 2) is also the file block map (which doesn't exist on DOS 2, hence no random files), all nicely packed into only 128 bytes of your computer's memory per drive.

And that is beginning to get more technical than I meant to get in this section, but let me close by noting that expanding this scheme to a 5 megabyte drive would imply either 40,000 bytes per block on the disk (and remember, a block is the smallest possible file size) or 10,000 bytes of VTOC and file map per drive in your main memory (in order to maintain the 1K block size). And that is why I said in my previous articles that DOS 3 does not expand well.

Anyway, I found it surprising that Atari would introduce the double-sided drives of the 1450XLD with DOS 3. But maybe I'm going to be surprised again.

A Tidbit

Once again, I am indebted to Steve Lawrow, the author of our MAC/65 assembler for telling me of another discovery about Atari BASIC which I shall share with you.

I have been traveling around demonstrating our new BASIC XL to various user groups; and, quite naturally, I have found several quick and easy programs which show off the language. One of my favorites is the following little gem:

```
1 REM
2 REM
3 REM
...
99 REM
100 POKE 20,0
101 IF I<200 THEN I=I+1 : GOTO 101
102 PRINT PEEK(20)
```

The object of this little gem is to get a bunch of do-nothing lines (in fact, 99 REMarks) in a program and then see how much they slow down the loop in line 101. Location 20 is the $\frac{1}{60}$ second clock tick ($\frac{1}{50}$ second in countries using 50Hz power systems), so the result of lines 100 and 102 is to print out the elapsed time in clock ticks.

Well, I usually run this program in Atari BASIC first, Atari Microsoft BASIC second, BASIC XL in slow mode third, and BASIC XL in FAST mode last. (See the chart for timings.)

Steve mentioned to me, though, that the timings of Atari BASIC (and slow-mode BASIC XL) were dependent on the line numbers chosen.

Skeptically, I renumbered the program to look like this:

```
1 REM
2 REM
3 REM
...
99 REM
4000 POKE 20,0
5000 IF I<200 THEN I=I+1 : GOTO 5000
6000 PRINT PEEK(20)
```

Sure enough, all the BASICs (except, naturally, BASIC XL in FAST mode) speeded up a little (again, see the chart). Why?

I know the answer for Atari BASIC and BASIC XL, and I suspect it is the same answer for Microsoft BASIC. When these BASICs need to make a line number search, they place the line number being searched for in a particular memory location. Then they search through the program, a line at a time, looking for a match on the numbers. As they search, though, they always check the high bytes of the line numbers first. If the high bytes do not match, they don't bother to check the low bytes.

In our first example, since all the line numbers were less than 256, all the high bytes were the same, so the search took slightly longer. In the second example, though, the GOTO statement caused a search for line number 5000, whose high byte is *never* the same as those of any of the other lines. Bingo, fast search speed.

What does this mean? When writing in BASIC, it might be a good idea to modify the old traditional line-numbering-by-10. Purposely break your program up into sections so that the target lines of GOTOs and GOSUBs all differ by at least about 300, and you will help BASIC do its searching a bit faster. (And even though BASIC XL in FAST mode is not affected by these foibles when working with absolute line numbers, even it will be helped when in slow mode or when you use variable names or expressions as GOTO/GOSUB targets.)

And, incidentally, you might remember that the Microsoft version of this program must be typed exactly as shown to get these timings. Using longer variable names, more spaces in a line, more variable names, etc., will significantly slow down Microsoft BASIC. Often to the point where it is slower than Atari BASIC.

Anyway, here is the chart of timings. The Microsoft BASIC Integer version timings were obtained by appending a % to all variable and constant usage in lines 101 and 5000. Try some timings like this yourself. You'll be amazed.

Timings For The 99 REM Benchmark

| | Atari BASIC | Microsoft Fltg Pt. | Microsoft Integer | BASIC XL Slow | BASIC XL Fast |
|-----------|----------------|-----------------------|----------------------|------------------|------------------|
| GOTO 101 | 178 | 169 | 155 | 125 | 35 |
| GOTO 5000 | 162 | 160 | 145 | 110 | 35 |

Self-Relocatable Machine Language, Part 4 (At Last)

Since it has been three months since Part 3 of this sort-of series appeared (COMPUTE!, September 1983), let me briefly summarize why self-relocatable machine language (ML) is desirable:

1. If all your ML is self-relocatable, you can load as many (or as few) modules as desired without worrying about where to put them in memory.
2. If you are using ML within Atari BASIC strings, remember that the strings can be moved by BASIC, so the ML virtually *has* to be self-relocatable.
3. Various pieces of systems software (for example, Atari BASIC, Pascal, Microsoft BASIC, some compilers) insist on using certain portions of memory. Since the pieces they insist on are not consistently the same, it is an advantage to be able to load your ML (especially device drivers, utilities, etc.) wherever the systems software leaves you a hole.

Also, let me summarize some of the rules for "Safe Relocatable Techniques," as presented in September:

1. Change JMPs to branches.
2. Save register values in the stack, not in fixed memory.
3. From BASIC, pass the address of a string as a location (or series of locations) to load from or store to. Note that Part 3 discussed how the ML string itself could be used for this purpose.
4. Move ML from relocatable memory to fixed memory temporarily.
5. Avoid load, store, and transfer instructions which refer to locations within your own module.

Finally, let me remind you that I promised to tell you how to utilize more than 255 bytes of relocatable storage and how to generate pointers to such storage without the "benefit" of help from a calling BASIC program. I shall attempt to fulfill my promise.

The techniques I will discuss here require a very small segment of nonrelocatable ML as well as one or (better) several zero page pointers. If you are in really dire straits, you can make do with temporary locations for both those requirements, but if possible you should find a way to preserve the required memory exclusively for your routine. In fact, the rest of this discussion assumes that you *have* managed to preserve the locations.

First Requirement: Find Yourself

You must have a subroutine, located at a fixed location, which looks like this:

```
BASE    =    $CE
        *=    $680
FINDME
        PLA
        STA    BASE+1
        PLA
        STA    BASE
        PHA
        LDA    BASE+1
        PHA
        RTS
```

Note that I have placed this routine in the infamous Page 6 and have used a fixed zero page location. These choices are for convenience, for illustration. Feel free to make your own choice of locations.

And just what does this routine *do*? How does it work? Quite simply, it finds the address of the program which called it. More precisely, it finds the address of the last byte of the three-byte JSR instruction with which a relocatable program calls it. An illustration of the calling program will help:

```
        *=    ???
START
        JSR    FINDME
BASEPT1 =    *-1
        ...
        LDY    #DATABYTE-BASEPT1
        LDA    (BASE),Y
        ...
DATABYTE .BYTE 99
```

Do you follow this? When FINDME is called via the JSR, it places the address of BASEPT1 into the zero page location called BASE. Then the Y register is loaded with the offset from BASEPT1 to DATABYTE and used as an index for the LDA instruction. (This is similar to the technique discussed in Part 3, but it could only be used from BASIC USR calls.)

The limitation of this technique is that the data location (for example, DATABYTE above) must be located no more than 255 bytes away from the JSR (for example, BASEPT1). If you are writing a package of several small routines, this may not prove to be a limitation. After all, each routine could call FINDME if needed, and each routine could thus have its own storage areas, located no more than 255 bytes from the respective call to FINDME. If you are writing a subroutine library or a device driver, this might prove to be a very worthwhile option.

Note the side "benefit" to the scheme: If you call FINDME each time you enter a routine, then BASE may prove to be a really very temporary location and can be shared with other routines.

So far, so good. But suppose that you really

do need a large data area or program, all self-relocatable. Well, then, your program might have to do this:

```

* =      ???
DATABASE = $CC

START
      JSR  FINDME
BASEPT1 = * - 1
OFFSET1 = DATABYTES-BASEPT1
...
      CLC
      LDA  BASE
      ADC  #OFFSET1&255
      STA  DATABASE
      LDA  BASE + 1
      ADC  #OFFSET1/256
      STA  DATABASE + 1
...
      LDY  <some offset in DATABYTES>
      LDA  (DATABASE),Y
...
DATABYTES .BYTE 1,2,3,4,5,6,7,8,9,10

```

Even more confused? You have a right to be. Here, we actually develop the base address of a data area and place it in a new zero page location. Now we can access the data area from anywhere in our self-relocatable ML by simply placing an offset within that data area into the Y register. Again, this limits the size of access to 256 bytes (the range of values the Y register can take on), but now the program can be as large as desired.

Finally, what happens if you actually do have a data area larger than 256 bytes? There are several possible solutions, none of them easy. If no "array" within the data area is larger than 256 bytes, you could simply develop several zero page pointers—one for each group of 256 bytes or less—using the ADC #OFFSET technique presented above.

If you have a single array or table which is larger than 256 bytes, the chances are that you have already developed some method of addressing into it (since the 6502 limits you to index sizes of 0 through 255, unless you play with indirect-Y addressing and calculated zero page pointer values). You need only use the contents of DATABASE, as generated above, in place of an absolute address for the start of the array or table, and your address calculations will be similar or even identical.

If you are lost at this point, don't worry. Much of what I just said will suddenly be meaningful as you write more and more advanced machine language programs. Just keep this article for handy reference.

Second Requirement: Calling Yourself

Suppose you want to call subroutines within your self-relocatable ML. How do you do it?

Of course, if the subroutine is at a fixed location (in ROM somewhere), you need do nothing special. The JSR instruction insists on an absolute

address, and you simply supply one. But what happens if the routine you want to call is itself part of the self-relocatable ML?

Advice: Avoid doing what I am about to describe if you possibly can. However, if you need to write ML which *must* use these techniques, read on.

First, you could simply write some self-modifying ML. An example:

```

START
      JSR  FINDME
BASEPT = * - 1
ROUTINE1 = ROUTINE - BASEPT
CALL1 = CALL + 1 - BASEPT
...
      LDY  #CALL1
      CLC
      LDA  BASE
      ADC  #SUB1&255
      STA  (BASE),Y
      INY
      LDA  BASE + 1
      ADC  #SUB1/256
      STA  (BASE),Y
...
CALL   JSR  0; ADDRESS WILL BE GENERATED
...
ROUTINE
...
      RTS

```

Simply, did he say? Well, it's not as bad as it looks. After all, if we could generate the address of a table and place it in zero page, why can't we place a subroutine's address directly into our ML? Of course, we must do the placing indirectly, since even the address of the JSR instruction is self-relocatable. Did you note that CALL1 is an offset to the first address byte in the instruction? It wouldn't do to modify the instruction byte!

Another way of doing JSRs like this might be to place yet another small routine in nonrelocatable memory. You could (1) load the A and X registers with the offset to the desired subroutine, then (2) JSR to the nonrelocatable routine which would calculate the actual address you desired, and (3) JMP to that location. When the subroutine returned, execution would continue at the instruction after your JSR. ©

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Printing Graphics

I've been receiving a number of letters asking for more information about printers and printer interfaces. Possibly last month's article helped some. Several people asked about graphics.

Most printers implement their graphics capabilities differently. Fortunately, there are enough similarities so that they can be discussed as a class, somewhat generally. I have used the graphics on a number of different printers, so I will try to share what experience I have accumulated. You should be able to apply this information to your own printer.

Dot-Matrix Characters

Before getting into the graphics, let's take a quick look at how a printer forms its dot-matrix characters. The characters are placed on paper by the printhead, which travels horizontally back and forth across the paper. This printhead contains a number of print needles. These needles can be pushed out to strike the printer ribbon against the paper to form a dot. Most dot-matrix printers have eight to ten needles, though there are some with more. Usually the needles are arranged in a straight vertical line. Those with more needles will typically arrange the needles in two rows which are offset vertically:

0
0
0
0
0
0
0
0
0

Since the vertical spacing between the needles is very small, the dots resulting from the dual-row printhead will actually overlap. The advantage of the dual-row printhead is that better, more fully formed characters can be printed. However, this

advantage may not serve graphics. It depends on the printer.

Printing is accomplished as the printhead traverses the paper. At certain intervals, a set of print needles are "fired," printing a group of vertical dots on the paper. Characters are formed by printing these vertical dots in a pattern appropriate for the character. So, during normal printing, each byte or character sent to the printer will result in the printing of a number of vertical groups of dots. Typically, enabling the graphics feature of the printer means that each byte or character sent to the printer will print only one vertical group of dots. The dots in the group are specified, of course, by the character which was sent. In the remainder of this article, I will use the term "graphics character" to refer to characters sent to the printer while the printer's graphics mode is enabled. As you will see, while in graphics mode, you have control over each dot that is printed.

Since each byte sent to the printer contains eight bits, up to eight dots can be controlled by each graphics character. In all printers that I've seen, a bit which is a one will cause the corresponding dot to be printed. Bits which are zero indicate that no dot should be printed. Most printers print eight dots per graphics character, but there are some which print six or seven. A printer which prints eight dots per graphics character will work out best for use with the 64 since eight dots is also the height of a character cell on the display.

Now let's start looking at what it takes to print graphics. First, we'll restrict ourselves to printing graphics on a single line. Afterwards we can go over how to visualize printing a graphics image which is more than one line high.

Entering The Graphics Mode

The first step in trying to print graphics is to de-

termine how to enter and exit the graphics printing mode. In general, two methods are used to accomplish this. The first method sends the printer an "escape sequence" which includes the number of graphics characters that are intended to be sent. With this method, the only way to exit the graphics mode is to send the specified number of characters, at which point the printer automatically exits the graphics mode. The second method uses one escape sequence to enter the graphics mode, and another to exit graphics mode. This method implies that there will be some way to distinguish the escape sequences from the graphics characters. For printers which print eight dots per graphics character, all I've seen, including my NEC-8023, use the first method. (Escape is a "key," like the SHIFT key, which alerts a machine that the following number is special. ESC is the number 27. So, 27 24 could mean italics mode to a printer. Consult your printer's manual for the correct escape sequences to activate special modes.)

The escape sequence to put my NEC-8023 into graphics mode is

ESC,S,"nnnn"

and "nnnn" is a four-digit string giving the number of graphics characters that will be sent. To illustrate how this is output to the printer, here is a subroutine to output the proper escape sequence for N graphics characters to channel 4:

```
N$=STR$(N)
N$=RIGHT$(N$,LEN(N$)-1):REM DROP SPACE
N$=LEFT$("0000",4-LEN(N$))+N$
PRINT#4,CHR$(27);"S";N$;
RETURN
```

The second line of the routine is needed to remove the leading space from STR\$(N). The third line places the required number of leading zeros to N\$.

Preparing Graphics Characters

Once you know how to enter and exit the graphics mode, the next step is to determine how the graphics characters need to be prepared. The first consideration is which bit in the graphics character controls which dot. On some printers, the least significant bit controls the uppermost dot, and on others it controls the lowest dot. I've seen both used many times, so you will have to check your printer manual to determine which applies to you.

A second consideration for preparing the graphics characters is how the dots of the graphics image are activated. Usually a graphics image is accessed a byte at a time, just as it is printed a byte at a time.

You must first obtain some bytes from the graphics image which are displayed vertically. The number of bytes to fetch is the same as the number of dots printed per graphics character.

Since my NEC prints eight dots per graphics character, I will need to fetch eight bytes. Once these bytes have been obtained, the next step is to begin removing a single bit from each of these bytes and combining the bits to form a graphics character. Eight graphics characters may be formed from the bytes fetched from the graphics image.

An important consideration at this point is which bit of the graphics image byte represents the leftmost dot. In every computer I've encountered, the most "significant" bit is displayed on the left. This means the bits should be extracted from our graphics image bytes starting with the most significant bit (that is, bit 7) first. We can extract bit 7 of a byte by ANDing it with 128. This will leave us a byte with bit 7 the same as the original byte, but all other bits set to zero. By shifting the remaining bits in the graphics image byte toward bit 7, we can extract each bit of the byte in sequence. To shift the bits toward bit 7, we simply multiply by 2.

Since any bit we extract is bit 7, it would be easier if we put it into the graphics character at bit 7 also. This can be done by ORing the extracted bit with the graphics character. Successive bits can be put into the graphics character by shifting the bits in the graphics character toward the least significant bit (bit 0) then ORing in the next bit. Shifting the bits toward bit 0 is accomplished by dividing by 2.

By using this procedure, we establish that the first bits placed in the graphics character will end up at the least significant bit positions. Now we need to determine if these first bits should be the top dots or the bottom dots. On my NEC, the least significant bits should be the top dots. To illustrate the process, here is a short subroutine that would accomplish the rearrangement for the NEC. It assumes that the eight bytes from the graphics image are contained in the array SA(), with SA(0) containing the top dots. The resulting graphics characters will be output to channel 4.

```
FOR J=1 TO 8:GC=0:REM DO 8 GR. CHARS
FOR I=0 TO 7:REM 8 DOTS PER GR. CHAR
GC=GC/2 OR (SA(I) AND 128)
SA(I)=SA(I)*2
NEXT I:PRINT#4,CHR$(GC);:NEXT J
RETURN
```

If you need the least significant bits of the graphics characters to be the bottom dots, just place the bytes in the SA() array so that SA(0) contains the bottom dots. If you are using a printer interface, you must also make sure that the interface is in a mode where it will not do any character translations, such as most do for color control codes, etc. On my printer interface, secondary address 4 or 5 is specified for graphics printing, with 4 including auto linefeed. Thus I might use OPEN 4,4,4 or OPEN 4,4,5 to open a channel to the printer.

Printing Graphics

If you wanted to print a line of graphics, the following routine shows how it could be done. This routine would output a line 320 graphics characters long.

```
N=320:GOSUB <enable graphics mode>
FOR NC=1 TO N STEP 8
GOSUB <fill the SA() array>
GOSUB <print SA() array>
NEXT NC
```

I haven't covered any specifics about how to "fill the SA() array." This will depend somewhat on the graphics image you are trying to print. However, it turns out that the way the 64 stores its graphics images in memory is ideal for graphics printing (provided the printer prints eight dots per graphics character). The bytes needed to fill the SA() array are found right next to each other in memory. An example of a "fill SA()" routine may be found in the demo program at the end of this article.

If you need to print only one line of graphics, you can continue with text immediately after the last graphics character. You could also output a carriage return and continue with text on the next line. With normal line spacing there will be a gap between your graphics line and the previous and following lines of text. If you want to print multiple lines of graphics, and have them print next to each other, there's an additional step to take.

This involves getting the printer to feed a distance less than the normal line spacing. On some printers, there is a special code or escape sequence to do this. However, on most printers, this is done with an escape sequence which allows you to change the linefeed distance. Once it is changed appropriately for graphics, the usual carriage return and linefeed may be used to move to the next graphics line. This is how it is done on my NEC. The escape sequence to change the linefeed distance on the NEC-8023 is:

ESC,T,"nn"

where "nn" is a two-digit string which indicates how many 144ths of an inch the linefeed distance should be. Since the vertical distance between the centers of the needles is $\frac{1}{2}$ inch, eight dots would require $\frac{16}{144}$ inch. Therefore, the appropriate sequence would be:

ESC,T,"16"

Normal line spacing ($\frac{1}{6}$ inch) can be restored by selecting $\frac{24}{144}$ inch, or by the escape sequence: ESC,A.

To bring all this together, here is a demo program which will print a copy of the 64 Character Generator ROMs on a NEC. Try to determine what changes are necessary to make it work with your printer. Since the program is accessing the

character ROMs, keyboard interrupts and the I/O registers must be disabled in order to read the data. The required POKEs and PEEKs are found in the subroutine at lines 250 and 260. You can refer to the section on Character Memory which starts on page 106 of the *Commodore 64 Programmer's Reference Guide* for details. This program is intended strictly as a demonstration. Written entirely in BASIC, it is rather slow when printing an image of any size. In next month's column I will try to provide some machine language routines to accomplish the same thing much faster.

Example Of ROM Character Printout



Print Character ROM Image

```
10 REM PROGRAM TO PRINT CHAR ROM IMAGE
20 OPEN 4,4,5
30 GOTO 1000
100 REM ENABLE GR. MODE FOR N CHARS
110 N$=STR$(N):N$=RIGHT$(N$,LEN(N$)-1)
120 N$=LEFT$("0000",4-LEN(N$))+N$
130 PRINT#4,CHR$(27);"S";N$;
140 RETURN
200 REM FILL SA() FROM 8 BYTES AT CP
210 POKE 56334,PEEK(56334) AND 254
220 POKE 1,PEEK(1) AND 251
230 FOR I=0 TO 7
240 SA(I)=PEEK(CP+I):NEXT
250 POKE 1,PEEK(1) OR 4
260 POKE 56334,PEEK(56334) OR 1
270 RETURN
300 REM PRINT SA() ARRAY
310 FOR J=0 TO 7: GC=0
320 FOR I=0 TO 7
330 GC=GC/2 OR (SA(I) AND 128)
340 SA(I)=SA(I) * 2
350 NEXT I:PRINT#4,CHR$(GC);:NEXT J
360 RETURN
1000 REM THE MAIN ROUTINE
1010 PRINT#4,CHR$(27);"T16";
1020 N=16*8:CP=53248
1030 FOR L=1 TO 32:REM PRINT 32 LINES
1040 GOSUB 100
1050 FOR G=1 TO 16:REM 16 GROUPS/LINE
1060 GOSUB 200:GOSUB 300:CP=CP+8:NEXT G
1070 PRINT#4:NEXT L
1080 PRINT#4,CHR$(27);"A";
1090 CLOSE 4
```

©

Atari Autorun BASIC

Michael E. Hepner

The Atari DOS makes it possible to automatically run a machine language program. This program shows you how to automatically run a BASIC program—a technique especially helpful when you're writing programs for novice users.

The Atari Disk Operating System (DOS 2.0S) provides the capability to automatically run a user-written machine language program whenever the computer is turned on. This article will show you how to use this feature to automatically run a program which is written in BASIC.

The need to automatically run a BASIC program arose as I was writing a program for a friend's business. Most of the employees who would have to run the program were unfamiliar with computers. I wanted to make the program easy for them to use. I knew that once the program gained control, I could help the user make inputs through menus and prompts. But the user still had to remember the syntax of the RUN command to make the program run, and had to cope with looking up the meaning of an error code if he or she made a mistake.

To solve these problems, I wrote a machine language program which tells the BASIC cartridge to run a BASIC program named AUTORUN.BAS from disk. I stored the machine language program output from the assembler onto disk as AUTORUN.SYS.

When the computer is turned on, the operating system loads DOS from disk and then runs an AUTORUN.SYS program if it finds it on the disk. My AUTORUN.SYS program then causes the BASIC program to be run. In this way, the user only needs to turn the computer on, reply to questions from the BASIC program, and turn the computer off.

The machine language program uses a trick that was documented in *De Re Atari* to run the BASIC program. The program writes two BASIC instructions on one line on the screen, tells BASIC to accept its input from the screen editor, and gives control to the BASIC cartridge.

When the BASIC cartridge takes control, it

processes the two commands on the screen. The first command is POKE 842,12. This command tells BASIC to get its next input from the keyboard after it has finished processing all the commands in the current line. The second command is RUN "D1:AUTORUN.BAS". This command loads the BASIC program named AUTORUN.BAS from disk number one and runs it. You should SAVE the BASIC program you wish to have automatically RUN on the disk with the filename AUTORUN.BAS.

The BASIC program here will write the machine language program to your disk as AUTORUN.SYS. It reads data from DATA statements and creates the machine language program with the necessary load and run information with it.

Line 10 opens the disk for output. The output goes to a program on disk named AUTORUN.SYS.

Lines 20 and 50 set up a loop to read 94 bytes of data.

Line 30 reads the integer data from the DATA statement into the variable A.

Line 40 writes one byte to the disk. This byte is the ATASCII code that corresponds to the number in variable A.

Line 60 closes the disk.

Lines 80-100 contain the integer representation of the machine language program, including the load and run information.

Atari BASIC AUTORUN.SYS

```
10 OPEN #4,8,0,"D1:AUTORUN.SYS"
20 FOR I=1 TO 94
30 READ A
40 PUT #4,A
50 NEXT I
60 CLOSE #4
70 END
80 DATA 255,255,0,6,81,6,216,24,173,4
      8,2,105,4,133,204,173,49,2,105,0,1
      33,205,24,160,0,177,204,105,162,13
      3,212
90 DATA 160,1,177,204,105,0,133,213,1
      60,32,185,49,6,145,212,136,208,248
      ,169,13,141,74,3,96,0,48,47,43,37,
      0,24
100 DATA 20,18,12,17,18,26,50,53,46,0
      ,2,36,17,26,33,53,52,47,50,53,46,
      14,34,33,51,2,226,2,227,2,0,6 ©
```


Commodore Files For Beginners

Part 3

Jim Butterfield, Associate Editor

Part 3 continues the discussion of files appearing in the two previous issues of COMPUTE!. This month, Butterfield explains how to handle files that fit within or are larger than RAM, and how to change or delete files.

We've set up our file of data. So we know how to write it. We've written a reading program. So we know how to read it. In fact, we know how to do everything: additions, deletions, and corrections, since these are just reading and writing with a little computing in between.

Sizing

Can you handle a file of 100,000 characters when you have only a 5K machine? The answer is yes, but it's a qualified yes.

There are a few difficulties, but in principle you can handle a big file with a small computer. Ultimately, you may have to. Even if your computer were fitted with a million bytes of memory, somebody would dream up a two-million byte file—which could not be held entirely within the computer's RAM.

There are techniques for handling big files. The main idea is to handle an item and then get rid of it. If you had a list of a million customers on a disk (it would be a big disk), you could print out all the customers' names without trouble. Read a name, print it, and then loop back and read the next one. The names don't have to stay in the computer's memory: Once they have been printed, they are no longer needed.

Even when we are updating a big file, we won't have too much trouble provided we have a disk unit. Read a record from the input file; change or delete it if necessary; write it to the output file; and then go back and repeat. A little computer can handle big files.

Cassette tape is a special problem. To use this "big file" approach, we'd need to have two tape drives. That's not possible on VIC-20 or Commodore 64, and it's impractical on most PET/CBMs. So where cassette files are concerned, you'd better plan to have files that will fit entirely within memory.

And there are bonus things you can do when a file fits into RAM. For example, sorting records within memory is a snap. In contrast, special techniques are called for when files don't fit.

Let's confine this discussion to files that do fit entirely within the computer's memory space. But don't let your thinking freeze—you can do the bigger ones. It's just more work.

Bringing It In

First, we must make space for the number of records we expect. We set up the arrays with a DIM statement:

```
100 DIM A$(50),B$(50),M(50)
```

This leaves room for up to 50 students. To work out memory space, allow three bytes plus the average length for each string, plus seven bytes for each numeric. Here, we have a table of student names (A\$), of student numbers (B\$), and marks (M). Let's calculate, using previous data.

We estimate memory space with:

| | |
|-----------------|----------------------------|
| Surname: | 50 × (3 plus 8 characters) |
| Student number: | 50 × (3 plus 4 characters) |
| Mark: | 50 × 7 bytes |

This gives us a rough estimate of 1250 bytes for storage. It is not highly accurate—we haven't allowed for the zero elements, for example—but it will give us an idea whether things will fit. The program itself will need extra storage, of course.

Note that we're simply allocating space. We can provide for 50 students, but only need space for 30; that's quite OK.

Now we can read our file into memory:

```
110 INPUT "NAME OF INPUT FILE";N$
```

For disk, we use:

```
120 OPEN 1,8,2,N$
```

And for tape, we code:

```
120 OPEN 1,1,0,N$
```

or simply:

```
120 OPEN 1
```

Now we read the data into our memory tables. The coding is quite similar to our previous example, except that this time we need to give each record a code number:

```
130 J=0
140 J=J+1
150 INPUT#1,A$(J)
160 INPUT#1,B$(J)
170 INPUT#1,M(J)
```

We'll look for the last record in the usual (ST) way, and log the number of records as variable N:

```
190 IF ST=0 GOTO 140
200 N=J
210 CLOSE 1
220 PRINT "THERE WERE";N;"RECORDS"
```

At this moment, our whole file is parked neatly in memory. Record 1 contains a surname in A\$(1), a student number in B\$(1), and a mark in M(1).

Deciding What To Do

Let's give the user a series of options:

```
230 PRINT
240 PRINT "ADD - DELETE - CHANGE - WRITEFILE"
250 INPUT "ACTION";X$
260 X$=LEFT$(X$,1)
270 IF X$="A" GOTO 400
280 IF X$="D" GOTO 600
290 IF X$="C" GOTO 700
300 IF X$<>"W" GOTO 250
```

Writing It Out

If we get to line 310, the user has selected the "writefile" option. Let's write the code; it will be

similar to what we have done before:

```
310 INPUT "NAME OF OUTPUT FILE";N$
320 OPEN 1,8,2,"0:"+N$+",S,W
330 FOR J=1 TO N
340 PRINT#1,A$(J);CHR$(13)
350 PRINT#1,B$(J);CHR$(13)
360 PRINT#1,M(J);CHR$(13)
370 NEXT J
380 CLOSE 1
390 END
```

For tape, change line 320 to:

```
320 OPEN 1,1,2,N$
```

Adding A Record

Line 400 is reached if the user wishes to add a record. Since we haven't sorted our records, we can stick the new record on the end:

```
400 INPUT "NAME";A$
410 INPUT "NUMBER";B$
420 INPUT "MARK";M
430 INPUT "OK";X$
```

As before, we'll give the user a chance to back out:

```
440 IF X$<>"Y" AND X$<>"YES" GOTO 230
450 N=N+1
460 A$(N)=A$
470 B$(N)=B$
480 M(N)=M
490 GOTO 230
```

Finding A Record

To change or delete a record, we'll need to find that record. Let's save time by writing a subroutine to search for a student number:

```
500 INPUT "NUMBER";B$
510 E=0:FOR J=1 TO N
520 IF B$<>B$(J) GOTO 560
530 PRINT A$(J);" ";B$(J);" ";M(J)
540 INPUT "IS THIS THE RECORD";X$
550 IF X$="Y" OR X$="YES" GOTO 590
560 NEXT J
570 PRINT "RECORD NOT FOUND"
580 E=1
590 RETURN
```

Deleting A Record

Line 600 is for deletion of a record. First, we call the subroutine at 500, noting if the record was not found:

```
600 GOSUB 500:IF E GOTO 230
```

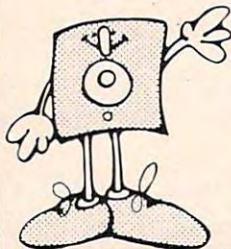
Now we have found the record; close up the space:

```
610 N=N-1
620 FOR K=J TO N
630 A$(K)=A$(K+1)
640 B$(K)=B$(K+1)
650 M(K)=M(K+1)
660 NEXT K
670 PRINT "RECORD DELETED"
680 GOTO 230
```


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Changing The Record

Finally, line 700 starts the sequence to change a record. Again, we locate the record with the sub-routine at 500:

```
700 GOSUB 500:IF E GOTO 230
710 INPUT "NEW NAME";A$
720 INPUT "NEW NUMBER";B$
730 INPUT "NEW MARK";M
740 INPUT "OK";X$
750 IF X$<>"Y" AND X$<>"YES" GOTO 230
760 A$(J)=A$
770 B$(J)=B$
780 M(J)=M
790 PRINT "DONE!":GOTO 230
```

Other Projects

That's all. We might add to this program:

- A LIST option to allow the current file to be listed to the screen;
- A PRINT option to output the file to the printer;
- An UPDATE option to allow new marks to be entered for all students;
- Where disk is used, disk error checking.

At this point, we're starting to achieve a small but effective sequential filing system.

Next month, we'll deal with "keys," sorted files, and merges.

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MLX

Machine Language Entry Program For Commodore 64

Charles Brannon, Program Editor

Remember the last time you typed in the BASIC loader (a group of DATA statements) for a long machine language program? You typed in hundreds of numbers and commas. Even then, you couldn't be sure if you typed it in right. So you went back, proofread, tried to run the program, crashed, went back and proofread again, corrected a few typing errors, ran again, crashed again, rechecked your typing. Frustrating, wasn't it?

Until now, though, that has been the best way to get machine language into your computer. Unless you happen to have an assembler and are willing to wrangle with machine language on the assembly level, it is much easier to just type in a BASIC program that reads DATA statements and then POKes the numbers into memory.

Some of these "BASIC loaders" will use a *checksum* to see if you've typed the numbers correctly. The simplest checksum is just the sum of all the numbers in the DATA statements. If you make an error, your checksum will not match up with the total. Some programmers make your task easier by including checksums every few lines, so you can locate your errors more easily.

Now, MLX comes to the rescue. MLX is a great way to enter all those long machine language programs with a minimum of fuss. MLX lets you enter the numbers from a special list that looks similar to DATA statements. It checks your typing on a line-by-line basis. It won't let you enter illegal characters when you should be typing numbers. It won't let you enter numbers greater than 255. It will prevent you from entering the numbers on the wrong line. In short, MLX will make proofreading obsolete.

Tape Or Disk Copies

In addition, MLX will generate a ready-to-use copy of your machine language program on tape or disk. You can then use the LOAD command to read the program into the computer, just like a BASIC program. Specifically, you enter:

LOAD "program name",1,1 (for tape)

or

LOAD "program name",8,1 (for disk)

To start the program, you need to enter a SYS command that transfers control from BASIC to your machine language program. The starting SYS will always be given in the article which presents the machine language program in MLX format.

Using MLX

Type in and SAVE MLX (you'll want to use it in the future). When you're ready to type in the machine language program, RUN MLX. MLX will ask you for two numbers: the starting address and the ending address.

You'll then get a prompt showing the specified starting address.

The prompt is the current line you are entering from the MLX-format listing. Each line is six numbers plus a checksum. If you enter any of the six numbers wrong, or enter the checksum wrong, the 64 will sound a buzzer and prompt you to reenter the entire line. If you enter the line correctly, a pleasant bell tone will sound and you may go on to enter the next line.

A Special Editor

You are not using the normal Commodore 64 BASIC editor with MLX. For example, it will only

accept numbers as input. If you need to make a correction, press the INST/DEL key; the entire number is deleted. You can press it as many times as necessary, back to the start of the line. If you enter three-digit numbers as listed, the computer will automatically print the comma and go on to accept the next number in the line. If you enter less than three digits, you can press either the comma, space bar, or RETURN key to advance to the next number. The checksum will automatically appear in inverse video.

MLX is an extremely easy way to enter long listings. With the audio cues provided, you don't even have to look at the screen if you're a touch-typist.

Done At Last!

When you get through typing, assuming you type your machine language program all in one session, you can then save the completed and bug-free program to tape or disk. Follow the instructions displayed on the screen. If you get any error messages while saving, you probably have a bad disk, or the disk was full, or you made a typo when entering the MLX program. (MLX can't check itself.)

Command Control

What if you don't want to enter the whole program in one sitting? MLX lets you enter as much as you want, save the completed portion, and then reload your work from tape or disk when you want to continue. MLX recognizes these few commands:

SHIFT-S: Save
SHIFT-L: Load
SHIFT-N: New Address
SHIFT-D: Display

Hold down SHIFT while you press the appropriate key. You will jump out of the line you've been typing, so I recommend you do it at a new prompt. Use the Save command to store what you've been working on. It will write the tape or disk file as if you've finished. Remember what address you stop on. The next time you RUN MLX, answer all the prompts as you did before, then insert the disk or tape containing the stored file. When you get to the entry prompt, press SHIFT-L to reload the file into memory. You'll then use the New Address command (SHIFT-N) to resume typing.

New Address And Display

After you press SHIFT-N, enter the address where you previously stopped. The prompt will change, and you can then continue typing. Always enter a New Address that matches up with one of the line numbers in the special listing, or else the checksums won't match up. You can use the Display command to display a section of your typing.

After you press SHIFT-D, enter two addresses within the line number range of the listing. You can stop the display by pressing any key.

Tricky Stuff

The special commands may seem a little confusing, but as you work with MLX, they will become valuable. For example, what if you forgot where you stopped typing? Use the Display command to scan memory from the beginning to the end of the program. When you reach the end of your typing, the lines will contain a random pattern of numbers. When you see the end of your typing, press any key to stop the listing. Use the New Address command to continue typing from the proper location.

You can use the Save and Load commands to make copies of the completed machine language program. Use the Load command to reload the program from tape or disk, then insert a new tape or disk and use the Save command to create a new copy.

One quirk about tapes made with the MLX Save command: When you load them, the message "FOUND program" may appear twice. The tape will load just fine, however.

Programmers will find MLX to be an interesting program which protects the user from most typing mistakes. Some screen formatting techniques are also used. Most interesting is the use of ROM Kernal routines for LOADING and SAVING blocks of memory. To use these routines, just POKE the starting address (low byte/high byte) into memory locations 251 and 252 and POKE the ending address into locations 254 and 255. Any error code for the SAVE or LOAD can be found in location 253 (an error would be a code less than ten).

Be sure to save MLX; it will be used for future applications in COMPUTE! Magazine, COMPUTE!'s GAZETTE, and COMPUTE! Books.

Machine Language Editor (MLX)

```
100 PRINT"{CLR}{CYN}";CHR$(142);CHR$(8);:
    POKE53281,1:POKE53280,1
101 POKE 788,52:REM DISABLE RUN/STOP
110 PRINT"{RVS}{40 SPACES}";
120 PRINT"{RVS}{15 SPACES}{RIGHT}{OFF}
    [*]{RVS}{RIGHT}{RIGHT}{2 SPACES}
    [*]{OFF}[*]{RVS}{[RVS]
    {13 SPACES}";
130 PRINT"{RVS}{15 SPACES}{RIGHT} [G]
    {RIGHT}{2 RIGHT}{OFF}[*]{RVS}[*]
    {OFF}[*]{RVS}{13 SPACES}";
140 PRINT"{RVS}{40 SPACES}"
200 PRINT"{2 DOWN}{PUR}{BLK}{3 SPACES}A F
    AILSAFE MACHINE LANGUAGE EDITOR
    {5 DOWN}"
210 PRINT"[*]{2 UP}STARTING ADDRESS?
    {8 SPACES}{9 LEFT}";:INPUTS
215 F=1-F:C$=CHR$(31+119*F)
220 IFS<256OR(S>40960ANDS<49152)ORS>53247
    THENGOSUB3000:GOTO210
```



```

225 PRINT:PRINT:PRINT
230 PRINT"[5]{2 UP} ENDING ADDRESS?
{8 SPACES}{9 LEFT}";:INPUTE:F=1-F:C$=
CHR$(31+119*F)
240 IFE<256OR(E>40960ANDE<49152)ORE>53247
THENGOSUB3000:GOTO230
250 IFE<STHENPRINTC$;"{RVS}ENDING < START
{2 SPACES}":GOSUB1000:GOTO 230
260 PRINT:PRINT:PRINT
300 PRINT"{CLR}";CHR$(14):AD=S:POKEV+21,0
310 PRINTRIGHT$( "0000"+MID$(STR$(AD),2),5
);":":FORJ=1TO6
320 GOSUB570:IFN=-1THENJ=J+N:GOTO320
390 IFN=-211THEN 710
400 IFN=-204THEN 790
410 IFN=-206THENPRINT:INPUT"{DOWN}ENTER N
EW ADDRESS";ZZ
415 IFN=-206THENIFZZ<SORZZ>ETHENPRINT"
{RVS}OUT OF RANGE":GOSUB1000:GOTO410
417 IFN=-206THENAD=ZZ:PRINT:GOTO310
420 IF N<-196 THEN 480
430 PRINT:INPUT"DISPLAY:FROM";F:PRINT,"TO
";:INPUTT
440 IFF<SORF>EORT<SORT>ETHENPRINT"AT LEAS
T";S;"{LEFT}, NOT MORE THAN";E:GOTO43
0
450 FORI=FTOTSTEP6:PRINT:PRINTRIGHT$( "000
0"+MID$(STR$(I),2),5);":":
451 FORK=0TO5:N=PEEK(I+K):PRINTRIGHT$( "00
"+MID$(STR$(N),2),3);":":
460 GETA$:IFA$<" THENPRINT:PRINT:GOTO310
470 NEXTK:PRINTCHR$(20);:NEXTI:PRINT:PRIN
T:GOTO310
480 IFN=0 THEN PRINT:GOTO310
490 A(J)=N:NEXTJ
500 CKSUM=AD-INT(AD/256)*256:FORI=1TO6:CK
SUM=(CKSUM+A(I))AND255:NEXT
510 PRINTCHR$(18);:GOSUB570:PRINTCHR$(20)
515 IFN=CKSUMTHEN530
520 PRINT:PRINT"LINE ENTERED WRONG : RE-E
NTER":PRINT:GOSUB1000:GOTO310
530 GOSUB2000
540 FORI=1TO6:POKEAD+I-1,A(I):NEXT:POKE54
272,0:POKE54273,0
550 AD=AD+6:IF AD<E THEN 310
560 GOTO 710
570 N=0:Z=0
580 PRINT"[+}";
581 GETA$:IFA$=" THEN581
585 PRINTCHR$(20);:A=ASC(A$):IFA=13ORA=44
ORA=32THEN670
590 IFA>128THENN=-A:RETURN
600 IFA<20 THEN 630
610 GOSUB690:IFI=1ANDT=44THENN=-1:PRINT"
{LEFT} {LEFT}";:GOTO690
620 GOTO570
630 IFA<48ORA>57THEN580
640 PRINTA$;:N=N*10+A-48
650 IFN>255 THEN A=20:GOSUB1000:GOTO600
660 Z=Z+1:IFZ<3THEN580
670 IFZ=0THENGOSUB1000:GOTO570
680 PRINT",";:RETURN
690 S%=PEEK(209)+256*PEEK(210)+PEEK(211)
691 FORI=1TO3:T=PEEK(S%-I)
695 IFT<>44ANDT<>58THENPOKES%-I,32:NEXT
700 PRINTLEFT$("{3 LEFT}",I-1);:RETURN
710 PRINT"{CLR}{RVS}*** SAVE ***{3 DOWN}"
720 INPUT"{DOWN} FILENAME";F$
730 PRINT:PRINT"{2 DOWN}{RVS}T{OFF}APE OR
{RVS}D{OFF}ISK: (T/D)"

```

```

740 GETA$:IFA$<"T"ANDAS<"D"THEN740
750 DV=1-7*(A$="D"):IFDV=8THENF$="0:"+F$
760 T$=F$:ZK=PEEK(53)+256*PEEK(54)-LEN(T$
):POKE782,ZK/256
762 POKE781,ZK-PEEK(782)*256:POKE780,LEN(
T$):SYS65469
763 POKE780,1:POKE781,DV:POKE782,1:SYS654
66
765 POKE254,S/256:POKE253,S-PEEK(254)*256
:POKE780,253
766 POKE782,E/256:POKE781,E-PEEK(782)*256
:SYS65496
770 IF(PEEK(783)AND1)OR(ST AND191)THEN780
775 PRINT"{DOWN}DONE." :END
780 PRINT"{DOWN}ERROR ON SAVE.{2 SPACES}T
RY AGAIN." :IFDV=1THEN720
781 OPEN15,8,15:INPUT#15,E1$,E2$:PRINTE1$
;E2$:CLOSE15:GOTO720
790 PRINT"{CLR}{RVS}*** LOAD ***{2 DOWN}"
800 INPUT"{2 DOWN} FILENAME";F$
810 PRINT:PRINT"{2 DOWN}{RVS}T{OFF}APE OR
{RVS}D{OFF}ISK: (T/D)"
820 GETA$:IFA$<"T"ANDAS<"D"THEN820
830 DV=1-7*(A$="D"):IFDV=8THENF$="0:"+F$
840 T$=F$:ZK=PEEK(53)+256*PEEK(54)-LEN(T$
):POKE782,ZK/256
841 POKE781,ZK-PEEK(782)*256:POKE780,LEN(
T$):SYS65469
845 POKE780,1:POKE781,DV:POKE782,1:SYS654
66
850 POKE780,0:SYS65493
860 IF(PEEK(783)AND1)OR(ST AND191)THEN870
865 PRINT"{DOWN}DONE." :GOTO310
870 PRINT"{DOWN}ERROR ON LOAD.{2 SPACES}T
RY AGAIN.{DOWN}":IFDV=1THEN800
880 OPEN15,8,15:INPUT#15,E1$,E2$:PRINTE1$
;E2$:CLOSE15:GOTO800
1000 REM BUZZER
1001 POKE54296,15:POKE54277,45:POKE54278,
165
1002 POKE54276,33:POKE 54273,6:POKE54272,
5
1003 FORT=1TO200:NEXT:POKE54276,32:POKE54
273,0:POKE54272,0:RETURN
2000 REM BELL SOUND
2001 POKE54296,15:POKE54277,0:POKE54278,2
47
2002 POKE 54276,17:POKE54273,40:POKE54272
,0
2003 FORT=1TO100:NEXT:POKE54276,16:RETURN
3000 PRINTC$;"{RVS}NOT ZERO PAGE OR ROM":
GOTO1000

```

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CAPUTE!

Modifications Or Corrections To Previous Articles

Modem Save And Download For The VIC-20

For Program 1 of this telecommunications utility from the November 1983 issue (p. 215) to run properly, the following line must be changed:

```
40 CK=0: FOR A=10496 TO 10751: READ D: CK
=CK+D: POKE A,D: NEXT A
```

In Program 2, line 190 should read THEN 220 instead of THEN 210.

The Filer For TI

The program in "The Beginner's Page" (October 1983, p. 32) will not run in standard TI console BASIC. In console BASIC there can be only one statement per line, and the THEN in IF-THEN statements can be followed only by a line number. Also, TI BASIC requires that spaces be left between BASIC commands and variables. The GETK\$ in line 30 must be replaced on the TI with an appropriate CALL KEY command.

Moving Maze For The 64

When "Shuttle Escape," the 64 version of this game from the October 1983 issue (Program 3, p. 82), is run for the first time, the program will stop with an ILLEGAL QUANTITY ERROR IN 500 message. If you then hit the RUN/STOP and RESTORE keys and run the program again, it will function properly. To prevent this error message, make the following changes:

```
10020 CK=CK+A:POKE I,A:I=I+1:GOTO 10005
10025 IF CK<>34430 THEN PRINT "DATA ERROR
IN LINES 10030-11120":STOP
50040 CS=CS+A:POKE I,A:I=I+1:GOTO 50010
50045 IF CS<>188431 THEN PRINT "DATA ERRO
R IN LINES 50050-52010":STOP
```

Spelling Quiz For VIC

To prevent a BAD SUBSCRIPT ERROR IN 165 message when this program from the October 1983 issue (p. 127) is run, change the DIMension of W\$(20) in line 10 to W\$(21).

Runway 180 For TI

As presented, this game from the October 1983 issue (p. 208) requires that the ALPHA LOCK key be down to read the instructions. Since this key must be up to use the joystick in the game, Gordon Millham suggests the following changes so that ALPHA LOCK can be left up throughout the program: Change the value for K to 103 in line 190 and to 105 in line 200, and change the word ON in line 210 to OFF. He also suggests the following

additional line, which creates a delay so that you can admire your skill when you land the plane successfully.

```
1895 FOR DELAY=1 TO 800 :: NEXT DELAY
```


Also in this program, note the stray zero at the end of line 1850. That line should end with GOTO 1870.

High Speed Mazer For The 64

In the "Munchmaze" game (Program 6) with this article (October 1983, p. 254), there is a spurious question mark in line 13752 which should be removed. Since this game is written entirely in machine language, any errors in the DATA lines will prevent it from functioning properly.

Protector For The 64

In the table for this VIC-20 article from the October 1983 issue (p. 272), several values for disabling certain functions on the 64 were given. In particular, the article stated that POKE 808,225 could be used to disable STOP, RESTORE, and LIST on the 64. This works for most programs, but could cause problems since it scrambles the value in the jiffy clock. A safer way is to POKE 808,234. If you wish to disable only the STOP key, you can use POKE 808,239. ©



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