If you have a problem that can be solved by a computer—we have a systems solution.

- Two central processors with maximum RAM capacities of 56K and 384 K bytes
- Three types of disk drives with capacities of 175K, 1.2M and 16M bytes
- Two dot matrix printers with 80 and 132 line capacity
- A Selectric typewriter interface and a daisy wheel printer

Match these to your exact need, add one or more of our intelligent terminals and put together a system from one source with guaranteed compatibility in both software and hardware.

Southwest Technical Products systems give you unmatched power, speed and versatility. They are packaged in custom designed woodgrain finished cabinets. Factory service and support on the entire system and local service is available in many cities.
You can do surprising things when you have 64 kilobytes of fast RAM on one card

4 MHz FAST—AND EXPANDABLE
Here's 64 kilobytes of memory on one RAM card. Yes, we mean 512K bits of read/write memory on this single card.

And, yes, we mean it's fast. With 150-nanosecond chip access times —so the card can operate in fast Z-80 systems with no wait states. Repeat, no wait states.

EXPANDABLE ON TWO LEVELS
Not only does the new Model 64KZ give you a large, fast RAM but it is expandable on two levels.

First, through our Cromemco Bank Select feature, you can expand to 512 kilobytes in eight 64K banks.

Or, with our Extended Bank Select feature, you can expand memory space to as much as 16 megabytes.

This expandability we call your obsolescence insurance.

The legend on the card's heat sink is an easy reference for address and bank selection.

BENCHMARK IT
Obviously, the speed and memory capacity of this new card give you a lot of power.

You can see that for yourself in our new 7-station Multi-User Computer System which uses these Model 64KZ cards. This 5100-bus system outperforms the speed of many if not most timesharing systems of up to 10 times the Cromemco price.

And yet where some of these much more expensive and cumbersome systems clearly slow to a snail's pace when timesharing, the Cromemco system using Bank Select switching runs surprisingly fast.

SEE IT NOW
See the new Model 64KZ at your computer dealer now. Study the literature on it. See how for only $1785 you can get around that ever-present barrier of memory that's too little and too slow.
Here's how you can be fully computerized
for so much less than you thought

BUSINESS — EDUCATION — ENGINEERING — MANUFACTURING

We are pleased to announce the first professional time-sharing system in the microcomputer field.
Naturally, it’s from Cromemco.
This new multi-user system will do all of the tasks you usually associate with much more expensive time-sharing computers. Yet it’s priced at an almost unbelievably low figure.

Look at these features:
• You can have up to 7 terminals plus a fast, 132-column line printer
• You can have a large system RAM memory that’s expandable to ½ megabyte using the Bank Select feature
• Each user has an independent bank of RAM
• You can have floppy disk storage of up to 1 megabyte
• And, make no mistake, the system is fast and powerful. You’ll want to try its fast execution time yourself.

PROGRAMMERS LOVE OUR BASIC
This new system is based on Cromemco’s well-known System Three Computer and our new Multi-User BASIC software package.
Programmers tell us that Cromemco Multi-User BASIC is the best in the field. Here are some of its attractions:
• You can use long variable names and labels up to 31 characters long — names like “material on order” or “calculate speed reduction.”
• You get many unusual and helpful commands that simplify programs and execution — commands such as PROTECT, LIST VARIABLES, NOLIST, and many more.
• No round-off error in financial work (because our BASIC uses binary-coded decimal rather than binary operation). And we’ve still been able to make it FAST.
• Terminals and printer are interrupt-driven — no additional overhead until key is pressed.
• The conveniences in this Multi-User BASIC make it much easier to write your own application software.
• A line editor simplifies changes.

BENCHMARK IT — NOW
In the final analysis, the thing to do is see this beautiful new system at your dealer. See its rugged professional quality. Evaluate it. Benchmark it for speed with your own routine (you’ll be agreeably surprised, we guarantee you).
Find out, too, about Cromemco’s reputation for quality and engineering.
Look into it now because you can have the capabilities of a fully computerized operation much quicker and for much less than you ever thought.
In The Queue

Foreground

10 A MODEL OF THE BRAIN FOR ROBOT CONTROL, Part 1: Defining Notation, by James Albus
Defining the mathematical notation for a model of the brain

49 MIND OVER MATTER: Add Biofeedback Input to Your Computer, by Steve Ciarcia
Use muscle signals to produce computer input

100 COMPUTER GENERATED MAPS, Part 2, by William D Johnston
A general purpose perspective projection program

How can behavior of an organism be described?

176 DESIGNING A COMMAND LANGUAGE, by G A Van den Bout
Using theory of finite state machines to design input command language

Background

36 SIMPLE MAZE TRAVERSAL ALGORITHMS, by Sandra and Stephen A Allen
A contestant of the IEEE Micromouse Contest discusses maze running strategies

60 MORE COLORS FOR YOUR APPLE, by Allen Watson III
Any pair of complementary colors can be displayed

70 A HOME FOR YOUR COMPUTER, by Joseph Dawes
Increase the utility and enjoyability of your equipment with a carefully planned cabinet

74 TALK TO A TURTLE: Build a Computer Controlled Robot, by James A Gupton Jr
Use your computer to control a mobile “robot”

86 MY COMPUTER RUNS MAZES, by David E Stanfield
Using simple tree searches to reach a goal

146 THE 1802 OP CODES, by Henry Melton
The instruction set of the RCA/Hughes 1802 microprocessor

148 THE HISTORY OF COMPUTING: THE IBM 7070, by Keith S Red-Green
The IBM 7070 might have been the start of a new decimal-based computer family

152 ARTIFICIAL INTELLIGENCE AND ENTROPY, BY R M Kahn
Chemistry, artificial intelligence, and the second law of thermodynamics

156 BASIC TEXT EDITOR, by Fred Ruckdeschel
The right tool for the job is often a text editor in BASIC

166 BUBBLE MEMORIES: A Short Tutorial, by A I Halsema
A nonvolatile, medium speed, data storage device

168 STACKS IN MICROPROCESSORS, by T Radhakrishnan and M V Bhat
Learn the ups and downs of stacks in your microprocessor

228 TIMESHARING: SQUEEZING THE MOST FROM YOUR MICRO, by Sheldon Linker
Microcomputers come of age with timesharing

234 THREE TYPES OF PSEUDORANDOM SEQUENCES, by C Brian Hones
Use of random numbers is more than just an everyday occurrence

Nucleus

6 Editorial: On Beginning a New Project

8 Letters

129 BYTE News

186 Technical Forum

194 Nybbies: The Great APL Contest

198 Book Reviews

206 Programming Quickies

213 Clubs and Newsletters

133, 214 BYTE’s Bugs

216 Languages Forum

223 Event Queue

133, 225 BYTE’s Bits

249 What’s New?

286 Unclassified Ads

288 BOMB

288 Reader Service

BYTE is published monthly by BYTE Publications Inc., 70 Main St, Peterborough NH 03458. Address all mail except subscriptions to above address: phone (603) 924-7217. Address subscriptions, change of address, USPS Form 3579, and fulfillment questions to BYTE Subscriptions, PO Box 590, Martinsville NJ 08836. Second class postage paid at Peterborough NH 03458 and at additional mailing offices—USPS Publication No. 102410 (ISSN 0360-5280). Subscriptions are $18 for one year, $32 for two years, and $46 for three years in the USA and its possessions. In Canada and Mexico, $20 for one year, $36 for two years, $52 for three years. $32 for one year air delivery to Europe, $32 surface delivery elsewhere. Air delivery to selected areas at additional rates upon request. Single copy price is $2 in the USA and its possessions, $2.40 in Canada and Mexico, $3.50 in Europe, and $4 elsewhere. Foreign subscriptions and sales should be remitted in United States funds drawn on a US bank. Printed in United States of America.

Address all editorial correspondence to the editor at the above address. Unacceptable manuscripts will be returned if accompanied by sufficient first class postage. Not responsible for lost manuscripts or photos. Opinions expressed by the authors are not necessarily those of BYTE. Entire contents copyright © 1979 by BYTE Publications Inc. All rights reserved.

BYTE is available in microform from University Microfilms International, 300 N Zeeb Rd, Dept PR, Ann Arbor MI 48106 USA or 18 Bedford Row, Dept PR, London WC1R 4EJ ENGLAND.

Subscription WATS Line: (600) 258-5485 Office hours: Mon-Thur 8:30 AM — 4:30 PM Friday 8:30 AM — Noon

June 1979 © BYTE Publications Inc 3
This month's cover by Ken Lodding is called "The Necker Cube, an optical illusion" after the famous test defined by Alan Turing. It was Turing's contention that a computer could be judged as intelligent if a human questioner could not differentiate between a computer in one room and a human being in another.

The basis for the cover painting is the Necker cube, an optical illusion where it is unclear which end of the cube is in front. The question here is: Is it the human or the computer circuit connected to the keyboard?

In This BYTE

Before discussing the design of A Model of the Brain for Robot Control, it is necessary to define the notation that will be used in the model. James Albus discusses the overall model objectives and the notation used to describe it, drawing on control systems theory. page 10

The IEEE Micromouse contest requires that a mechanical "mouse" find its way through a maze. The winner is the mouse that makes it through the maze in the least amount of time. Sandra and Stephen A Allen discuss some of the Simple Maze Traversal algorithms they and Tony Rosselli used for the Micromouse contest. page 36

The types of input available for your computer are limited only by the imagination. This month Steve Ciarcia uses Mind Over Matter to control his computer. Find out how to influence your computer using muscle power. page 48

Although the official documentation for the Apple II high resolution color graphics package states that the colors violet and green are the only colors besides black and white which may be obtained, adjustment of the television controls allows any pair of complementary colors to be displayed. It is also possible to obtain four colors and black and white with appropriate adjustments. Allen Watson III explains how in his article More Colors for Your Apple. page 60

If you enjoy taking your computer system to club meetings or other events, but don't look forward to the attendant wire fiddling and fuss, read A Home for Your Computer by Joseph Dawes. Now you can have a compact computer storage and travel case that doubles as a desk. page 70

One of the most interesting applications of your computer is the control of physical devices. Perhaps you've thought of having a robot-like device that your computer could control. James Capton Jr describes the fun that he and two of his students had when they set out to do just that in Talk to a Turtle. page 74

It's not hard to put a bit of artificial intelligence into your computer system. David Stanfield found a way to make his system search for "food" in a maze he set up. Find out how to do it in My Computer Runs Mazes. page 86

William D Johnston develops a general purpose program with the capability to generate a wide variety of more advanced perspective projections. He includes a functional program with great versatility, as well as a number of maps generated by that program. Mr Johnston shows how Computer Generated Maps can be used in satellite communications and many other practical applications. page 100

William T Powers has a control theory approach to the simulation of human behavior. However, before we can simulate human behavior in a robot, we must determine what behavior is. William Powers takes a look at behavioral actions as he explores The Nature of Robots. page 132

When hand-assembling a program it is useful to have a table summarizing the op codes for the processor. Henry Mellon supplies us with a table for The 1802 Op Codes. page 146

Keith S Reid-Green continues his History of Computing discussion with a look at The IBM 7070, a second generation computer announced in 1959. page 148

Some scientists over the years have argued that a thinking machine cannot be built because it would violate the second law of thermodynamics. In Artificial Intelligence and Entropy author R M Kiehn discusses some recently completed work in chemistry that refutes this claim and opens the door once more to the possibility of intelligence in machines. page 152

When performing a lot of manipulations with text it is necessary to have the ability to perform editing functions completed on the file that is being used. If you have a computer system that runs BASIC, you may find that Fred Ruckdeschel's BASIC Text Editor is a very handy tool. page 156

Bubble memories are a fairly new form of mass storage medium that is available to the general public. For a quick overview of Texas Instruments' bubble memory product, see A Halenska's article Bubble Memories. page 166

What is a stack? What does LIFO mean? Stacks can be important tools for the computer programmer. Knowing what they are and how to use them will aid you in improving your programming skills. Find out how stacks stack up in T Radhakrishnan and M V Bhat's article, Stacks in Microprocessors. page 168

An input command language is often regarded as the least important part of a system. Therefore, some excellent systems are ignored due to the inconvenience encountered when trying to use them. Finite state machine theory is one solution to this problem. For an excellent introduction to the world of finite state machines read G A Van den Boult's article on Designing a Command Language. page 176

Have you ever considered using your computer system in a timesharing mode? To discover what is involved in setting up such a system, read Timesharing: Squeezing the Most from Your Micro by Sheldon Linker page 228

Calculating randomness is a very deterministic proposition, especially when pseudorandom number sequences are used. C Brian Hones in his article on Three Types of Pseudorandom Sequences gives some necessary background information on random number calculations and statistical tests of randomness. page 234
Structured Systems business software can put a microcomputer to work for you.

SSG's general accounting, data inquiry, mailing, and communications software packages are bringing real computer power to hundreds of businesses right now. They are ready to go to work for your business.

The Honest-To-Business $12,000 Computer* Our software will power DYNABYTE, CROMEMCO, IMSAI, NORTHSTAR, ALTOS, MICROMATION, DIGITAL SYSTEMS, or other Z-80 or 8080 based computers through your General Ledger, Accounts Receivable, and Accounts Payable. And maintain a conversational data-base query system, store and print your mailing list and labels, produce and edit correspondence, address it from your mailing list, and more. The price for a total system—hardware and SSG software—ranges from $8,000 to $14,000.

Real Business Computing Our Business Software packages are designed to be up and running and working for you in a matter of hours. Without expensive reprogramming, technical staff additions, or costly trial-and-error. Our quality is high, our documentation practically self-instructive. The applications are flexible and extensive, designed to meet and exceed the requirements of most small to medium businesses. Real computer solutions at microcomputer prices.

Some Pleasant Surprises Your computer retailer can give you a demonstration and literature. You might find a solution just right for your business with "off the shelf" prices and delivery times. Or we will be happy to send you literature direct, including a list of our dealers and compatible hardware. Write us, or call.

The SSG product line includes these outstanding packages:

- General Ledger
- Accounts Receivable
- Accounts Payable
- CBASIC-2
- LETTERIGHT Letter Writer
- NAOS Mailing System
- QSORT Sorting System
- WHATSIT? Data/Query System

Structured Systems Group
520 Claremont Oakland, California 94618 (415) 547-1567

* Complete prices will vary with equipment and software selected. Required: 8080 or Z-80 based computer running a CP/M or CP/M-compatible disk-based operating system. Your retailer or SSG can advise on specifics. (CP/M is a product of Digital Research.)

Circle 353 on inquiry card.
On Beginning a New Project...

This week, I began a new project. It is one which could be begun by many of our readers, that of building a new computer system. In photo 1 we see what my last project turned into after four years of effort at various levels: a 6800 processor with some 28 K of programmable memory, sockets for 8 K of 2708 read only memory, a Sykes 9000 series floppy disk sub-system, a tape sub-system, and communications via parallel ports to two other computers: an Altair and my ALF Products AD-8 music synthesizer. As can be seen by the photo, this system is a packaging nightmare.

I now use a cleaner machine, manufactured by Northwest Microcomputer Systems, as my primary computer. The old home brew sits downstairs, unused for the most part. The Pascal oriented machine that is upstairs gives me a software development facility which can support my hardware projects, something I did not previously have to such a degree. However, the Pascal machine does not yet talk to the music synthesizer and the music keyboard, so I still have that problem.

To solve that problem, I have set out on a new project: building a general purpose computer for use as a local controller of the music peripherals. The communication with the main software source, the Pascal machine, will be via a high speed serial communications line when the music machine is not used alone, as in a live performance situation. The processor in this new local controller will be a Motorola 6809. It is perhaps the ultimate 8 bit processor of current technology.

In order to accomplish the musical goal of either self-contained or remote commanding of the synthesizer, such a controller must contain certain minimum functions. It must have a local communications oriented monitor, as well as a monitor oriented toward self contained operation. The communications monitor contains simple binary (not decoded ASCII) command functions for loading memory, examining memory, dumping memory, and jumping to arbitrary locations. This sort of monitor might take 100 or 200 bytes of code in the 6809's instruction set. The self-contained operations monitor...
"My Shugart followed me home."

"After working all day with the computer at work, it's a kick to get down to Basic at home. And one thing that makes it more fun is my Shugart minifloppy™. We use Shugart drives at work, so when I bought my own system I made sure it had a minifloppy drive.

"Why? Shugart invented the minifloppy. The guys who designed our system at work tell me that Shugart is the leader in floppy design and has more drives in use than any other manufacturer. If Shugart drives are reliable enough for hard-working business computers, they've got to be a good value for my home system.

"When I'm working on my programs late at night, I can't wait for cassette storage. My minifloppy gives me fast random access and data transfer. The little minidiskettes™ store plenty of data and file easily too.

"I made the right decision when I bought a system with the minifloppy. When you lay out your own hard-earned cash, you want reliability and performance. Do what I did. Get a system with the minifloppy."

If it isn't Shugart, it isn't minifloppy.

See opposite page for list of manufacturers featuring Shugart's minifloppy in their systems.

TM minifloppy is a registered trademark of Shugart Associates
DIGITIZING DATA BASES

Recently I saw an advertisement for the new Bit Pad One and thought of the numerous uses it presented. One that is especially interesting is building a data base.

The computer could be programmed to print a sentence or word in any form of lettering or type font, from script to Old English by setting a string equal any modified letter of the programmer's choice. With 26 strings, you would have a complete alphabet in any form you like. The computer could identify the Input letter, word, or phrase, match it with the correct string variable, and print that variable (letter). The outcome would range from a letter to a full paragraph typed and printed in any font imagination.

The only way to store such data as these modified letters without investing hours of time in plotting coordinates and typing them in, would be to illustrate the letters on the new Bit Pad One.

I hope all computer enthusiasts can derive as much enjoyment from this amazing device as I anticipate.

Jeff Korn
71 Hillary Ln
Penfield NY 14526

Any way you look at your proposed project, it is a major undertaking. The concept of building data bases from a digitizer is not new, but the programming exercise it involves is sure to be rewarding. RGAC

DIGITAL RADIO OPERATORS

In response to Don Stoner's letter, "Calling all Computers" (December 1978 BYTE, page 159), I thought you might be interested in some details of the new "packet radio license" available in Canada.

The Amateur Digital Radio Operator's Certificate is an Amateur Radio certificate, the holder of which is qualified to operate in some amateur radio bands. Mr. Stoner refers to this as the "Packet Radio Service" and implies that it is separate from the Amateur Radio Service. This is not true. Neither is it true that some of the band will probably go to the GRS (CB) service. As a matter of fact, the DOC seems proud of the fact that Canadian amateurs are the first in the world to implement the technique of packet radio on the amateur bands. They have made liberal bandwidth allowances in several portions of the 220 MHz band specifically for this technique, and it seems unlikely that they would start chopping off portions of this "show case" band to hand over to the GRS service.

The Amateur Digital Certificate allows operation on all amateur frequency bands above 144 MHz. This includes 144 to 148 MHz (2 meters), 220 to 225 MHz, 420 to 450 MHz, 1215 to 1300 MHz and five more bands from 2.3 to 24 GHz. It allows all current modes such as Morse code, single side band voice, FM voice, FSK or AFSK teletypewriter or data, and telescope, as well as several modes of pulse transmission. This is aimed primarily at the computer and electronics hobbyists who would like to participate in computer networking. The requirements (ie: examination) reflect this.

There is no Morse code exam at all.

The written exam has three parts:

- multiple choice questions on Canadian amateur radio regulations,
- questions on radio communications theory and operation (on the Advanced Amateur level),
- the digital exam with questions on computing, analog and digital transmission, packet radio, queuing theory, digital coding, error control and other topics.

The pass requirements are 70 percent per section and the exam is not simple (I've written it), so it seems that they are looking for serious hobbyists to pass this exam.

Those who already hold an amateur or advanced amateur certificate in Canada are allowed to do anything that this new certificate allows (including packet radio) except for the pulse modes of transmission. (FSK is the current favorite for low speed networks and point to point contacts, with some type of PCM for the higher speed networks.) This new license is ideal for those computerists who want to get on the air with their terminal of a computer but could not once stand Morse code.

Personally, I can't wait to finish building my transmitter and get my Z-80 system on the air, and I would like to hear from other Canadian readers who are doing the same. I certainly don't talk to many hams on the HF bands who are interested in computing.

Ron Vanderheem, VE7COR
University of British Columbia
Amateur Radio Club
Box 7 SUB, University of BC
Vancouver BC CANADA

LINEAGE PROGRAMMING

I am a genealogist and would like to get in contact with suppliers of programs for use by genealogists. I have a Digital Equipment Corp PDP-10 with expanded memory, disk, and paper tape.

Mrs G V Creaser
4 Sunny Hill Rd
Northboro MA 01532

Letters

ComputerLand

Huntville, AL (205) 539-1200
Phoenix, AZ (602) 956-5727
Little Rock, AR (501) 244-4608
Belmont, CA (415) 885-4232
Dublin, CA (415) 895-0980
El Cerrito, CA (415) 233-5010
Hayward, CA (415) 538-8080
Lawndale, CA (213) 371-7144
Los Altos, CA (415) 946-4912
Los Angeles, CA (213) 776-8080
Marin, CA Call Directory Information
Pasadena, CA (213) 449-3205
Saddleback Valley, CA (714) 770-0131
San Bernardino, CA (714) 866-6838
San Diego, CA (714) 560-9912
San Diego East, CA (714) 464-5656
San Francisco, CA (415) 456-1592
San Jose, CA (408) 253-8080
Santa Maria, CA (805) 926-1919
Santa Rosa, CA (707) 528-1775
Thousand Oaks, CA (805) 495-2344
Tustin, CA (714) 544-0542
Waltin Creek, CA (415) 935-6502
Colorado Springs, CO (303) 574-4110
Downer, CO (303) 760-7725
Fairfield, CT (203) 265-9252
Newark, DE (302) 738-9566
Boca Raton, FL (305) 368-1122
Fl. Lauderdale, FL (305) 561-2471
Jacksonville, FL (904) 731-2471
Atlanta, GA (404) 935-0406
Honolulu, HI (808) 521-8002
Arilngton Heights, IL (312) 978-1828
Downers Grove, IL (312) 964-7782
Mundelein, IL (312) 949-1300
Niles, IL (312) 967-1714
Orland, IL (309) 422-9901
Peoria, IL (309) 688-8252
Indianapolis, IN Call Directory Information
Overland Park, KS (913) 492-8882
Louisville, KY (502) 425-2308
Rocheville, MD (301) 948-7676
Grand Rapids, MI (616) 942-2931
Southfield, MI (313) 356-8111
Bloomington, MN (612) 886-6414
Rochester, MN (312) 652-9000
Springfield, MO (417) 833-7085
Nashua, NH (603) 889-5338
Cherry Hill, NJ (609) 706-9000
Bergen County, NJ (201) 845-9303
Morristown, NJ (201) 539-4077
Buffalo, NY (716) 836-8511
Ishawa, NY (607) 277-9996
Nassau County, NY (516) 742-2264
Charlotte, NC (704) 536-8500
Cleveland, OH (216) 481-1200
Columbus, OH (614) 858-2215
Portland, OR (503) 620-0170
Harrisburg, PA (717) 763-1116
Austin, TX (512) 452-7071
Dallas, TX (214) 263-2223
South West Houston, TX (713) 977-0909
Houston Bay Area, TX (713) 488-8153
SALT Lake City, UT (801) 364-4416
Tucson, CA (714) 865-5826
Bellevue, WA (206) 746-2070
Federar, WA (206) 839-8938
Tacoma, WA (206) 561-0388
Melbourne, WI (213) 776-2000
Milwaukee, WI INTERNATIONAL
Adelaide, Australia Call Directory Information
Brisbane, Australia 07 221 9777
Perth, Australia Call Directory Information
Sydney, NSW Australia 02-3753
Brussels, Belgium Call Directory Information
Sutton, Canada Call Directory Information
Toronto, Canada Call Directory Information
Winnipeg, Canada (204) 772-9519
Manilla, Philippines 58-36-66

Circle 75 on inquiry card.

June 1979 © BYTE Publications Inc
If the truth is that you want a computer . . . then we want to be your computer store.

We’re ComputerLand, the #1 computer store chain in the U.S. What’s meaningful about that fact is, that ComputerLand has been chosen by more people as having what they’ve been looking for. And, since you’re looking, let us tell you what you’ll find, when you visit a ComputerLand store.

You’ll find a product line that’s continually evaluated to provide you with the widest and best selection in quality, brand name microcomputers anywhere. You’ll find an enthusiastic and knowledgeable staff able to interpret all the equipment specifications, in terms of how they apply to you, and in a way you’ll understand. You’ll find demonstration areas where you can get a firsthand experience of running a computer yourself.

You’ll find educational materials to give you a total insight into the world of microcomputers.

You’ll find a fully equipped service department to provide whatever assistance is required to keep your computer running in top-notch condition. You’ll find computer user’s clubs to join, where you can share ideas with people as enthusiastic as yourself. And, with each new visit, you’ll find excitement—from the people you deal with, the equipment they offer, and from your own ever-growing personal involvement.

Enough about us. How about what computers do. To attempt to describe all the things your computer might do, would be to describe your imagination. So instead, we’ll briefly list some of the many things for which small computers are already being used.

In business, the advent of the versatile and compact microcomputer has put the benefits of computing within reach of small companies. With systems starting at less than $6000, the businessman can computerize things like accounting, inventory control, record keeping, word processing and more. The net result is the reduction of administrative overhead and the improvement of efficiency which allows the business to be managed more effectively.

In the home, a computer can be used for personal budgeting, tracking the stock market, evaluating investment opportunities, controlling heating to conserve energy, running security alarm systems, automating the garden’s watering, storing recipes, designing challenging games, tutoring the children . . . and the list goes on.

In industry, the basic applications are in engineering development, process control, and scientific and analytical work. Users of microcomputers in industry have found them to be reliable, cost-effective tools which provide computing capability to many who would otherwise have to wait for time on a big computer, or work with no computer at all.

And now we come to you, which leads us right back to where we started: If you want a computer, then we want to be your computer store.

Whether you want a computer for the home, business or industry, come to ComputerLand first. We’ll make it easy for you to own your first computer. Because, simply put, we really want your business. When you come right down to it, that’s what makes us #1.

© ComputerLand Corp., 1978

ComputerLand Europe
Europe-Terrassen
8 Rue Jean Engling
Dommeldange, Luxembourg
Phone 43 29 05 Telex 2423
A Model of the Brain for Robot Control

Part 1: Defining Notation

In order to build a computer model of the brain for robot control we must start with a clear understanding of what the brain is for (i.e., its primary function). If one examines what most brains do all of the time, and what our own brains do most of the time, it is clear that the brain is not used primarily for thinking. The brain is first and foremost a control system. All brains, even that of the tiniest insect, control behavior. Some brains can produce very complex behavior, but only the most sophisticated and highly developed brains exhibit the phenomenon of thought. Clearly then, thought is not the central purpose of the brain, but rather, an artifact that arises out of the complex computing mechanisms required to generate and control extremely sophisticated behavior.

This implies that would-be brain modelers should first attempt to understand, and if possible, reproduce the control functions and behavior patterns that exist in insects, birds, mammals, and, in particular, primates. Only after these control systems are successfully modeled can we expect to understand the mechanisms that give rise to intelligence and abstract thought in the human brain.

If the brain is primarily a control system, then any brain model we construct should control something. One of the most obvious candidates is a robot manipulator, since it rather closely resembles a limb, the most common type of device controlled by the brain. We shall therefore first develop a computer model of a basic neurological structure which can compute control functions for a robot manipulator.

We shall then attempt to demonstrate how this basic model can be generalized to compute a broad class of analytic, transcendental, or logical functions and production rules of many multivalued variables. We will show how this same model can learn, remember, and recognize patterns and how it can be interconnected into a hierarchical network for generating sensory interactive, goal directed behavior.

We will suggest how such a hierarchy might remember experiences, solve problems, plan tasks, select goals, answer questions, structure knowledge of the world and events, and understand and generate music or natural language. Finally, we will also suggest some possible experiments and lines of research that might be pursued by one or more ambitious personal computer enthusiasts with limited resources.

The Nature of Computation in the Brain

The brain is, of course, not a single computer, but rather a network of billions of individual computing devices interconnected so as to produce coordinated and unified action. There are millions of photodetectors in each eye and thousands of audio detectors in each ear. The body is embedded with sensors which detect touch, pressure, heat, cold, and pain; chemical analyzers that detect the smell and taste of things; and sensors that measure the position of joints, the tension in tendons, and the length and velocity of contraction of muscles. Inertial sensors measure roll, pitch, and yaw accelerations, and the position of the head with respect to gravitational attraction; and hormone detectors, thermosensors, and blood chemistry analyzers report on the internal biological condition of the organism.

All of this information is analyzed and processed in innumerable computing centers which detect patterns, compare incoming data with stored expectations, and evaluate...
THE FAMOUS GRIVET SERIES OF

INDUSTRIAL ROBOT KITS

PICTURED ABOVE: 3-AXIS MANIPULATOR (KIT NO. 3) WITH ELECTRONICS — $750.00

SEND FOR COMPLETE CATALOG

$10.00

MAIL CHECK OR MONEY ORDER TO: GALLAHER RESEARCH, INC. P.O. BOX 10767, WINSTON-SALEM, N.C. 27108

DEALERS

Computer Shoppe, Inc.
Metairie, LA

Digital Design
Cincinnati, OH

Computer Mart of NY
New York City

Computer Mart of NJ
Iselin, NJ

Minnesota Micro Sys.
Minneapolis, MN

Irisco Du Quebec

Quebec, Canada
Heathkit Electronics Center
Anaheim, CA

Personal Computer Center
Overland Park, KS

Tomorrow/Today
New Port Richey, FL

Computer Ware
Encinitas, CA

Computer Forum
Santa Fe Springs, CA
the results. In many different ways and at many different levels this sensory data stream interacts with the behavior generating system to select goals, modify habits, and direct the actions of millions of muscles and glands to produce what is observed as behavior.

Perhaps the most obvious feature of the brain is that many computations are going on in many different places simultaneously. The brain does not execute sequential programs of instructions under control of a program counter. There is no fetch/execute cycle. The mathematics of finite state automata and Turing machines are not well-suited for describing the basic operations of the brain. In fact, the fundamental computations performed in the brain are not even digital — they are analog. Each neuron in the brain is essentially an analog computer performing complex additions, integrations, differentiations, and all sorts of nonlinear operations on input variables that can number from one to several hundred thousand.

The brain is a digital device only in that information is encoded for transmission from one neuron to another over long transmission lines (called axons) by pulse-frequency or pulse-phase modulation. When these pulse encoded signals reach their destinations, they are reconverted into analog voltages for the computations which take place in the dendrites and cell bodies of the receiving neurons (see “Designing a Robot from Nature” February 1979 BYTE, page 28).

The brain achieves its incredible precision and reliability through redundancy and statistical techniques. Many axons carry information concerning the value of the same variable, each encoded slightly differently. The statistical summation of these many imprecise and noisy information channels results in the reliable transmission of precise messages over long distances. In a similar way, a multiplicity of neurons may compute on roughly the same input variables. Clusters of such computing devices provide statistical precision and reliability orders of magnitude greater than that achievable by any single neuron. The outputs of such clusters of neurons are transmitted and become inputs to other clusters, which perform additional analog computations. These are the variables we have to deal with and the computations we have to simulate if we are to model the brain in any meaningful way.

To those familiar only with fetch/execute machines, this may seem an extremely difficult structure to model. I hope, in the course of these articles, that some of the difficulties...
will be cleared away and the prospects for building such structures will seem less dubious.

The Need for Notation

In order to discuss an engineering design for a robot control system modeled after the brain, we must first devise a mathematical convention and notation to bridge the gap between the structure of the brain and the structure of currently available computers. This is essential if we are to describe behavior precisely and to translate that description into a design for circuits and program statements to generate behavior in a computationally concise manner.

Vectors

One way to describe many variables and deal with many simultaneous multivariant computations is to use vector notation. A vector is simply an ordered set, or list of variables. A vector can specify magnitude and direction. The vector \( V \) in figure 1b has two components \( v_x \) along the X axis and \( v_y \) along the Y axis. The ordered set, or list of components define the vector so that we can write \( V = (v_x, v_y) \).

The components of a vector can also be considered as the coordinates of a point \((v_x, v_y)\) which corresponds to the tip of the vector. The locus of all pairs of components which can exist defines a vector space (for two dimensions the vector space is a surface). A vector can have more than two

Figure 1: Defining space with vectors. A vector is an ordered list of variables which defines a point in space; (a), (b), (c), and (d) depict vectors representing 1, 2, 3, and 4 dimensions, respectively. The number of dimensions in the space is equal to the number of variables in the list. (The illustration in (d) is meant only to be symbolic of a four-dimensional vector, which cannot be visualized in three dimensions.)
Figure 2: If, as time progresses, one or more of the components of a vector W change, the vector will move through space, tracing out a trajectory $T_w$.

Figure 3: If the ordered list of variables which define a vector includes time, the space defined by the vector will have time as one of its axes. As time progresses the vector will move along the time axis. If none of the other variables is time dependent, the trajectory will be a straight line parallel to the time axis, as in (a). If any of the other variables change with time, the trajectory will be some curve with a component along the time axis as in (b).

A vector with three components defines a volume (figure 1c), and a vector with four or more components defines a hyperspace (figure 1d). A hyperspace is impossible to visualize, but is a very useful concept for our discussion.

A vector in a higher dimensional space can usually be visualized as a projection onto a lower dimensional space. For example, typical mechanical drawings portray front, side, and top views of a three-dimensional form projected onto a two-dimensional sheet of paper. Each projection can either illustrate a cut through the object at a particular plane along the projection axis, or a superposition of all the salient features of the object collapsed into the plane of the illustration. In the collapsed version, the fact that two points or lines intersect in the projected image does not necessarily mean that they coincide or intersect in the higher dimensional space -- they may simply lie behind each other along the projection axis. The projection operator ignores variable differences which correspond to distance along the projection axis.

It is not necessary to make the projection axis coincident with any of the coordinate axes. For example, in the oblique projection (perspective drawing) of figure 1c, the projection axis (the normal line to the paper through the origin of the coordinate system) is not aligned with any of the coordinate axes. The lines in the drawing represent the projections of lines in a three-dimensional space onto the two-dimensional surface of the paper. In a similar way we can project higher dimensional vectors and hyperspaces of any dimension onto a two-dimensional drawing. Figure 1d illustrates a four-dimensional vector projected onto a two-dimensional drawing.

States and Trajectories

A vector can specify a state. This is the primary use we shall make of vectors in this discussion. A state is defined by an ordered set of variables. For example, the state of the weather might be characterized by a state vector $W = (w_1, w_2, w_3, w_4)$ where:

- $w_1$ = temperature,
- $w_2$ = humidity,
- $w_3$ = wind speed,
- $w_4$ = rate of precipitation.

Now the weather, like many things, is not constant. It varies with time. Each of the state variables (temperature, humidity, wind speed, and rate of precipitation) is time dependent. Thus, as time passes, the point defined by $W^t$ will move through the four-
dimensional space. Figure 2 illustrates the locus of the point traced out by \( W \) as it moves to define a trajectory \( T_w \).

It will often be convenient to represent time explicitly in our notation. We can easily do this by simply adding one more variable, time \( (t) \), to our state vector, thus increasing by one the number of dimensions in the space defined by the state vector. For example \( W = (w_1, w_2, w_3, w_4, t) \).

As time progresses, any point defined by the state vector moves along the time axis. A state vector whose \( w_i \) components do not vary with time will now trace out a straight line trajectory, parallel to the time axis as shown in figure 3a. If, however, any of the \( w_i \) components is time dependent, the state trajectory will contain velocity components that are orthogonal, as well as parallel to the time axis, as shown in figure 3b.

If we project the state space of all the variables except time onto a two-dimensional surface, we can represent the passage of time by the motion of this two-dimensional plane along the time axis normal to it, as in figure 4. The state trajectory \( T_5 \) is the locus of points traced out by the state vector as time passes.

A large variety of things can be represented as vectors. For example, we can represent an ASCII character as a vector (figure 5). The ordered set of binary digits in the ASCII representation corresponds to the components of a binary vector. Each symbol in the ASCII alphabet is uniquely paired with a vector in an eight-dimensional hyperspace. Each symbol thus corresponds to a point in the hyperspace.

This is an important concept, because it allows us to define any set of symbols as vectors or points in hyperspace. Any string of symbols then becomes a trajectory through the hyperspace. For example, the string of symbols, "the cat chased the rat," can be described as a trajectory through a hyperspace defined by any set of variables defining the English alphabet (plus a blank character). This also applies to the string WXYZ when:

W is the command: Reach to Position A;
X is the command: Grasp;
Y is the command: Move to Position C;
Z is the command: Release.

We need not restrict ourselves to binary vectors. Symbols may be represented by vectors with continuously variable components as well. This allows us to introduce the concept of fuzzy symbols. If the hyperspace is continuous, then each point which corresponds to a symbol has some neighbor-
Figure 6: Each point in hyperspace, corresponding to a particular symbol such as a or e, has some neighborhood of points around it which are closer to it than to any other symbol. Variations from the exact, or ideal position of a symbol vector may derive from noise in a transmission channel or from differences between the observed symbol and the ideal.

Figure 7: Functions can be expressed in a number of different ways. Here the functional relationship between Y and X is expressed as an equation and a graph.
\[ y = f(x) \]

which reads: \( y \) equals a function \( f \) of \( x \).

The function:

\[ y = 2x^2 + 3x + 6 \]

is a relationship between \( y \) and \( x \).

Functions can also be expressed as graphs. Figure 7 is a plot of the equation \( y = 2x^2 + 3x + 6 \). Functions may sometimes be defined by tables. The table in figure 8a defines the Boolean AND function \( Z = X \cdot Y \).

This function can also be drawn as a circuit element (see figure 8b) which performs the AND function on two inputs.

Tables can also be used to define non-Boolean functions. Tables of logarithms or trigonometric functions are good examples of this. Of course, a table defines a continuous function exactly only at the discrete points represented in the table. Thus, the accuracy of a continuous function represented by a table depends on the number of table entries (ie: the resolution on the input variables). Accuracy can, of course, be increased by interpolation techniques.

In general, the number of entries required to compute a function by a table lookup is proportional to \( R^N \), where \( R \) is the resolution of each input variable, and \( N \) is the number of input variables. This exponential increase in size of the table required is the principal reason that multidimensional functions are seldom computed by table lookup.

Modern mathematics often expresses functional relationships in terms of mappings from a set of states defined by independent variables onto a set of states defined by dependent variables. In one notation, this is expressed by the string \( f: C \rightarrow E \)

which reads, "\( f \) is a relationship which maps the set of causes \( C \) into the set of effects \( E \)." It means that for any particular state in the set \( C \), the relationship \( f \) will compute a state in the set \( E \). This is shown in figure 9.

We have already shown that states can be denoted by vectors and sets of states by sets of points in vector hyperspaces. Thus, the notion of a function being a mapping from one set of states to another naturally extends to a mapping of points in one vector hyperspace onto points in another.

Suppose, for example, we define an operator \( h \) as a function which maps the input \( S = (s_1, s_2, s_3, \ldots s_N) \) onto the output scalar variable \( p \). We can write this as:

\[ p = h(S) \]

or

\[ p = h(s_1, s_2, \ldots s_N) \]

Figure 8: Functions can also be expressed as tables and circuits. Here the Boolean function \( Z = X \cdot Y \) is expressed as a table, a circuit, and an equation.

Figure 9: A function can also be expressed as a mapping from one set onto another. Here the function \( F \) maps the set of causes \( C \) onto the set of effects \( E \) such that for every cause in \( C \) there is an effect in \( E \). In our discussion we will be concerned only with single valued functions such that there is only one effect for each cause. We will, however, allow more than one cause to have the same effect (ie: more than one point in \( C \) can map onto the same point in \( E \)).

Figure 10: We will define the operator \( h \) as a function which maps the input vector \( S \) into the output scalar variable \( p \).

Figure 11: We will define the set of operators \( H = (h_1, h_2, \ldots h_l) \) as a function which maps the input vector \( S \) into the output vector \( P \).
Figure 7.2: The operator \( H \) maps every input vector \( S \) in input space into an output vector \( P \) in output space. \( H \) thus maps the trajectory \( T_s \) into the trajectory \( T_p \).

We can also draw the functional operator as a circuit element or "black box" as in figure 10. (A black box is an engineering concept sometimes used to depict a process with inputs and outputs. The viewer sees the effects on the output of changes to the input, but the internal workings of the process remain hidden in a black box.)

If we assume that we have \( L \) such operators, \( h_1, h_2, \ldots, h_L \), each operating on the input vector \( S \) in figure 11, we have a mapping:

\[
H : S \rightarrow P \text{ or } P = H(S)
\]

where the operator \( H = (h_1, h_2, \ldots, h_L) \) maps every input vector \( S \) into an output vector \( P \). Now since \( S \) is a vector (or point) in input space and \( P \) is a vector (or point) in output space, we can represent the function \( H \) as a mapping from input space onto output space, as shown in figure 12.

For the purposes of our discussion we require that both the input and output space be bounded and that each \( S \) will map into one and only one \( P \). Several different \( S \) vectors may map into the same \( P \) vector, however. Of course, if any of the variables in \( S \) are time dependent, \( S \) will trace out a trajectory \( T_s \) through input space. The operator \( H \) will map each point \( S \) on \( T_s \) into a point \( P \) on a trajectory \( T_p \) in output space.

**Goal Seeking Control Systems**

We are now ready to consider the structure of control systems for sensory interactive, goal directed behavior. The simplest form of goal seeking device is the servomechanism. The setpoint, or reference input to the servomechanism, is a simple form of command. Feedback from a sensing device, which monitors the state of the output or the results of action produced by the input, is compared with the command. If there is any discrepancy between commanded action and the results, an error signal is generated which acts on the output in the proper direction and by the proper amount to reduce the error. The system thus follows the setpoint, or, put another way, it seeks the goal set by the input command.

Now almost all servomechanism theory deals with a one-dimensional command, a one-dimensional feedback, and a one-dimensional output. Our vector notation will allow us to generalize from this one-dimensional case to the multidimensional case with little difficulty.

Assume we have the multivariable servomechanism shown in figure 13. The function \( H \) operates on the input variables in \( S \) and computes an output \( P = H(S) \). Note that we have partitioned the input vector \( S \) into two vectors: \( C = (s_1, s_2, \ldots, s_i, 0, \ldots, 0) \) and \( F = (0, \ldots, 0, s_{i+1}, \ldots, s_N) \); such that \( S = C + F \).

If \( i = 1, N = 2, L = 1 \), and \( H \) computes some function of the difference between \( C \) and \( F \), we have a classical servomechanism.

In our more general case \( C \) may be any vector, and in some cases it may be a sym-
In California, a store owner charts sales on his Apple Computer. On weekends though, he totes Apple home to help plan family finances with his wife. And for the kids to explore the new world of personal computers.

A hobbyist in Michigan starts a local Apple Computer Club, to challenge other members to computer games of skill and to trade programs.

Innovative folks everywhere have discovered that the era of the personal computer has already begun—with Apple.

Educators and students use Apple in the classroom. Businessmen trust Apple with the books. Parents are making Apple the newest family pastime. And kids of all ages are finding how much fun computers can be, and have no time for TV once they’ve discovered Apple.

Visit your local computer store
The excitement starts in your local computer store. It’s a friendly place, owned by one of your neighbors. He’ll show you exactly what you can use a personal computer for.

What to look for
Your local computer store has several different brands to show you. So the salesman can recommend the one that best meets your needs. Chances are, it will be an Apple Computer. Apple is the one you can program yourself. So there’s no limit to the things you can do. Most important, Apple’s the one with more expansion capability. That means a lot. Because the more you use your Apple, the more uses you’ll discover. So your best bet is a personal computer that can grow with you as your skill and involvement grow. Apple’s the one.

It’s your move
Grab a piece of the future for yourself. Visit your local computer store. We’ll give you the address of the Apple dealer nearest you when you call our toll-free number. Then drop by and sink your teeth into an Apple.

800-538-9696. In California, 800-662-9238.
A stationary command vector establishes a setpoint, and as time progresses the feedback vector varies from $F'$ to $F_2$ to $F_3$. The $S$ vector thus traces out a trajectory $T_5$. The $H$ operator computes an output $P$ for each input $S$ and so produces an output trajectory $T_P$. The variation in $F$ may be caused by external forces imposed by the environment, or by actions produced by the output, or both. One or more of the variables in the feedback vector $F$ may even be taken directly from the output vector $P$. In the latter case the $H$ operator becomes the transition function for a finite state automaton. In any of these cases the result is that a single command vector $C$ produces a sequence of output vectors $T_P$. The process is driven by the sequence of feedback vectors $F_1$, $F_2$, $F_3$. The superscript $F^k$ denotes the vector $F$ at time $t_k$.

The sequence of operations illustrated in figure 14 can also be viewed as a decomposition of a command $C$ into a sequence of subcommands $p^1$, $p^2$, $p^3$. The vector $C$ may be a symbol standing for any number of things such as a task, a goal, or a plan. In such cases the output string $p^1$, $p^2$, $p^3$ represents a sequence of subtasks, subgoals, or subplans, respectively.

Whether figure 14 is a servomechanism or a task decomposition operator, there are many practical problems concerned with stability, speed, gain, delay, phase shift, etc. In our notation these are all embedded in the $H$ functions. If the $H$ functions are correctly formulated and defined over the entire space traversed by the $S$ input, then the output $T_P$ will drive the physical actuators in such a way that the goal is achieved (ie: the error between the command $C$ and the result $P$ is nulled) and stability is maintained under all conditions.

Servomechanisms are, of course, only the simplest form of sensory interactive, goal seeking devices. By themselves they are certainly not capable of explaining the much more complex forms of goal seeking commonly associated with purposive behavior in biological systems. However, when connected together in a nested (or hierarchical) structure, the complexity of behavior in feedback control systems increases dramatically.

Figure 14: A stationary command vector establishes a setpoint, and as time progresses the feedback vector varies from $F^1$ to $F^2$ to $F^3$. The $S$ vector thus traces out a trajectory $T_5$. The $H$ operator computes an output $P$ for each input $S$ and so produces an output trajectory $T_P$. The result is that the input command $C$ is decomposed into a sequence of output subcommands $p^1$, $p^2$, $p^3$.

Figure 15: If the command vector $C$ also changes from time to time, it will trace out a trajectory $T_C$. 

The feedback vector may contain information of many different types. It may simply report position or velocity of the controlled outputs, but for a complicated system such as a robot manipulator or the limb of an animal, it may also report the resistance to movement by the environment, the inertial configuration of the manipulator structure, and other parameters relevant to the problem of making rapid and precise movements.
Hierarchical Control

Assume that the command vector C in figure 14 changes such that it steps along the trajectory Tc as shown in figure 15. The result is that the sequence of input commands C1, C2, C3, followed by the sequence C4, C5 produces the sequence of output vectors P1, P2, P3, P4, P5. In this case, the subsequence P1, P2, P3 is called by the commands C1, C2, C3 and driven by the feedback F1, F2, F3. The subsequence P4, P5 is called by C4, C5 and driven by F4, F5, etc.

If we now represent time explicitly, the C, F, and P vectors and trajectories of figure 15 appear as shown in figure 16. The fact that C remains constant while the feedback changes from F1 to F2 to F3 means that the trajectory Tc is parallel to the time axis over that interval. The jump from C1, C2, C3 to C4, C5 causes an abrupt shift in the Tc trajectory in the time interval between F3 and F4.

Note that each instant can be represented by a plane (or set of coplanar regions) perpendicular to the time axis. Each plane contains a point from each trajectory and represents a snapshot of all the vectors simultaneously at a specific instant in time.

We are now ready to consider a hierarchy of servomechanisms, or task decomposition operators, as shown in figure 17a. Here the highest-level input command C4 is a symbolic vector denoting the complex task (ASSEMBLE AB). Some of the components in C4 may denote modifiers and arguments for the assemble task. The subscript Ck denotes the C vector at the kth level in the hierarchy.

Note that in figure 17 vectors are not repeatedly drawn for each instant of time during the trajectory segments, when they are reasonably constant. Thus, C4 is shown only at the beginning and end of the trajectory segment labeled (ASSEMBLE AB). C2 is shown only at the transition points between (REACH to A), (GRASP), (MOVE TO C), etc. It should be kept in mind, however, that H4 computes P4 continuously and produces an output at every instant of time, just as H1 computes P1.

The feedback F4 may contain highly processed visual scene analysis data which identifies the general layout of the work space, and thereby determines which output vectors P4 (and hence which simple task commands C3) should be selected and in which order. F4 may also contain data from P4 and P3 which indicates the state of completion of the decomposition of C4. F4 combines with C4 to define the complete input vector S4. The H4 operator produces an output vector P4 = H4(S4).

Text continued on page 24
We’ve worked like mad to
Now, we're cooking. Our boys in the lab have turned circuit chefs these past three months to create a smorgasbord of deliciously assembled boards to support your APPLE II*, TRS-80† or S-100 bus systems. Feast your eyes on our monstrous selection in the menu below. Then, order enough to satisfy your hunger for experimentation for months to come. Contact your local computer store, or call us direct. Bon appetit!

California Computer Systems
309 Laurelwood Road · Santa Clara, CA
(408) 988-1620 · 95050

So Nobody Goes Away Mad.

APPLE II Delicacies

7114 APPLE II Programmable Timer Module $150.00
An MCS941 programmable computer timer for
use as a frequency measurement, event
counting, signal conditioning, or generating
single pulses of controlled duration. Support
includes on-board ROM.

7140 APPLE GP/IEEE 488 Interface $250.00
Interface offering selectable unit addressing
supporting Buses as a 'speak last and control
ner' with on-board ROM.

7110 APPLE Asynchronous Serial Interface $99.95
Interface featuring on-board ROM and
accurate baud rates. All common baud rates
from 50 baud to 19200 baud are available in
conforms to EIA RS449 and a
subset of RS232C.

7172 APPLE Synchronous Serial Interface $99.95
Interface featuring on-board ROM and
accurate baud rates. All common baud rates
from 50 baud to 19200 baud are available in
conforms to EIA RS449 and a
subset of RS232C.

7120 APPLE Parallel Interface $69.95
Interface with dual PIA & on-board ROM.
Supports INTERRUPT
daily chain.

7811 APPLE Arithmetic Processor $39.99
Processor with on-board, power-down ROM.
32-bit floating point arithmetic operation
based on AMD 9511 device.

7470 APPLE 3½ Digit BCD Analog-to-Digital Converter $129.00
±0.05% + 999 VDC range, floating or ground
reference.

7570 APPLE Extender $25.00
7500 APPLE Wire Wrap Board $21.00
7590 APPLE Etch Board $21.00
7510 APPLE Solder Tail Board $21.00
16AM APPLE, TRS-80 16K Add-On Memory $120.00

S-100 Bus Fare

2015 MXVI 16K Static RAM Board $289.00
For expansion even beyond 64K... uses
popular 2114 static RAMs, addressable in 4K
blocks.

2520 Extender Terminator $39.95
With all lines labelled... power lines fused for
added safety... active & dynamic termina-
ton designed to eliminate crosstalk.

2501 Mother Board Kit With Active Terminations & Sockets $119.95
4P10 Four Parallel I/O Board $89.95
2500 Wire Wrap Board $30.00
Accommodates up to 102 16-pin sockets, or 24
40-pin sockets.

2591 Etch Board $32.95
For etching your own S-100 circuit... 1/16-
ounce copper PC board... hard-gold plate fllings.

2510 Solder Tail Board $30.00
Accommodates up to 102 16-pin sockets, or 24
40-pin sockets.

2200 All-Metal Mainframe Box $399.00
12-slot card cage with power supply and fans.
Inputs are 105, 115 and 125V AC... outputs are
+5V at 20 amps and ±16V at 4 amps.

*APPLE II is a registered trademark of Apple Computers, Inc
†TRS-80 is a registered trademark of Radio Shack, a Tandy Co.
At least part of the output $P_4$ becomes part of the input command vector $C_3$ to the next lower level. $C_3$ is also a symbolic vector which identifies one of a library of simple task commands together with the necessary modifiers and arguments. As the feedback $F_4$ varies with time, the input vector $S_4$, and hence the output vector $P_4$, move along a trajectory generating a sequence of simple task commands at $C_3$ such as (FETCH A), (FETCH B), (MATE B TO A), (FASTEN B TO A), etc. as shown in figure 17b.

Feedback at $F_3$ may identify the position and orientation of the parts A and B, and also carry state sequencing information from outputs $P_3$ and $P_2$. As $F_3$ varies with time, it drives the input $S_3$ (and hence $P_3$) along a trajectory generating a sequence of elemental movement commands at $C_2$ such as (REACH TO A), (GRASP), (MOVE TO C), (RELEASE), etc.

Feedback at $F_2$ may contain information from proximity sensors indicating the fine positioning error between the fingers and the objects to be manipulated, together with state sequencing information derived from $P_2$ and $P_1$. The operator $H_2$ produces $P_2$, which denotes the proper velocity vectors $C_1$ for the manipulator hand in joint angle coordinates.

Feedback $F_2$ also provides joint angle position data necessary for the coordinate transformations performed by $H_2$. $P_2$ provides reference, or setpoint commands, $C_1$ to the servomechanism operator $H_1$. $F_1$ provides position, velocity, and force information for the traditional servocomputations. The output $P_1$ is a set of drive signals to the actuators.

Feedback enters this hierarchy at every level. At the lowest levels, the feedback is unprocessed (or nearly so) and hence is fast acting with very short delays. At higher levels, feedback data passes through more and more stages of an ascending, sensory processing hierarchy. Feedback thus closes a real time control loop at each level in the hierarchy. The lower level loops are simple and fast acting. The higher level loops are more sophisticated and slower.

At each level the feedback vector $F$ drives the output vector $P$ along its trajectory. Thus, at each level of the hierarchy, the time rate of change of the output vector $P_i$ will be of the same order of magnitude as the feedback vector $F_i$, and considerably more rapid than the command vector $C_i$. The result is that each stage of the behavior generating hierarchy effectively decomposes an input task represented by a slowly changing $C_i$ into a string of subtasks represented by a more rapidly changing $P_i$.

At this point we perhaps should emphasize that the difference in time rate of change of the vectors at various levels in the hierarchy does not imply that the $H$ operators are computing slower at the higher levels than at the lower. We will, in fact, assume that every $H$ operator transforms $S$ into $P$ with the same computational delay $\Delta t$ at all levels of the hierarchy. That is:

$$P_i(t) = H_i(S_i(t-\Delta t))$$

at every level. The slower time rate of change of $P$ vectors at the higher levels stems from the fact that the $F$ vectors driving the higher levels convey information about events which occur less frequently. In some cases certain components of higher level $F$ vectors may require the integration of information over long time intervals or the recognition of symbolic messages with long word lengths.

When we represent time explicitly as in figure 17, we can label the relatively straight segments of the $T_c$ trajectories as tasks and subtasks. Transitions between the subtasks in a sequence correspond to abrupt changes in $T_c$.

If we do not represent time explicitly, the relatively constant $C$ vectors correspond to nodes, as in figure 15. The resulting tree structure represents a classical AND/OR decomposition of a task into sequences of subtasks, where the discrete $C_i$ vectors correspond to OR nodes and the rapidly changing sequences of $P_i$ vectors become sets of AND nodes under those OR nodes.

Intentional or Purposive Behavior

Figure 17 illustrates the power of the hierarchy of multivariant servomechanisms to generate a lengthy sequence of behavior which is both goal directed and appropriate to the environment. Such behavior appears to an external observer to be intentional, or purposive. The top level input command is a goal, or task, which is successively decomposed into subgoals, or subtasks, at each stage of the control hierarchy until at the lowest level output signals drive the muscles (or other actuators) producing observable behavior.

To the extent that the $F$ vectors at the various levels contain sensory information from the environment, the task decompositions at those levels will be capable of responding to the environment. The type of response to each $F$ vector depends on the $H$ function at that level. If the $F$ vector at any level is made up solely of internal variables,

Text continued on page 28
save time and money by joining McGraw-Hill's COMPUTER PROFESSIONALS' BOOK CLUB

This professional club is designed to meet your day-to-day on-the-job needs by providing practical books in your field on a regular basis at below publisher prices. If you're missing out on important technical literature—if today's high cost of reading curbs the growth of your library—here's the solution to your problem.

The Computer Professionals' Book Club was organized for you, to provide an economical reading program that cannot fail to be of value. Administered by Club consultants, their understanding of the standards and values of the literature in your field guarantees the appropriateness of the selections. How the Club operates: Thirteen times a year you receive free of charge The Computer Professionals' Book Club Bulletin. This announces and describes the Club's featured book of the month as well as alternate selections available at special members' prices. If you want to examine the Club's feature of the month, you do nothing. If you prefer one of the alternate selections—or if you want no book at all—you notify the Club by returning the card enclosed with each Bulletin.

As a Club Member, you agree only to the purchase of four books (including your first selection) over a two-year period. Considering the many books published annually, there will surely be at least four you would want to own anyway. By joining the club, you save both money and the trouble of searching for the best books.

MAIL THIS COUPON TODAY

P.O. Box 582, Hightstown, New Jersey 08520

Please enroll me as a member and send me the three books indicated.

I am entitled to receive The Computer Professionals' Book Club Bulletin. This announces and describes the Club's featured book of the month as well as alternate selections available at special members' prices. If you want to examine the Club's feature of the month, you do nothing. If you prefer one of the alternate selections—or if you want no book at all—you notify the Club by returning the card enclosed with each Bulletin.

As a Club Member, you agree only to the purchase of four books (including your first selection) over a two-year period. Considering the many books published annually, there will surely be at least four you would want to own anyway. By joining the club, you save both money and the trouble of searching for the best books.

Two special bonus books come to you for $2.95 with your first club selection

Be sure to consider these books as well—

Two bonus special offers come to you for $2.95 with your first club selection

Books are selected from a wide range of publishers

---

any two of these great professional books for only

values up to $69.95

Introduction offer to new members of the COMPUTER PROFESSIONALS' BOOK CLUB

by joining McGraw-Hill's COMPUTER PROFESSIONALS' BOOK CLUB

any two

of these great professional books

for only

$2.95

values up to $69.95

Two special bonus books come to you for $2.95 with your first club selection

Be sure to consider these books as well—

Two bonus special offers come to you for $2.95 with your first club selection

Books are selected from a wide range of publishers

---

THE COMPUTER PROFESSIONALS' BOOK CLUB Bulletin, this announces and describes the Club's featured book of the month as well as alternate selections available at special members' prices. If you want to examine the Club's feature of the month, you do nothing. If you prefer one of the alternate selections—or if you want no book at all—you notify the Club by returning the card enclosed with each Bulletin.

As a Club Member, you agree only to the purchase of four books (including your first selection) over a two-year period. Considering the many books published annually, there will surely be at least four you would want to own anyway. By joining the club, you save both money and the trouble of searching for the best books.

MAIL THIS COUPON TODAY

P.O. Box 582, Hightstown, New Jersey 08520

Please enroll me as a member and send me the three books indicated.

I am entitled to receive The Computer Professionals' Book Club Bulletin. This announces and describes the Club's featured book of the month as well as alternate selections available at special members' prices. If you want to examine the Club's feature of the month, you do nothing. If you prefer one of the alternate selections—or if you want no book at all—you notify the Club by returning the card enclosed with each Bulletin.

As a Club Member, you agree only to the purchase of four books (including your first selection) over a two-year period. Considering the many books published annually, there will surely be at least four you would want to own anyway. By joining the club, you save both money and the trouble of searching for the best books.
Figure 17: A hierarchy of H operators produces sensory interactive, goal directed behavior. The highest level input command $C_4$ defines a goal, which in this example is (ASSEMBLE AB). The feedback $F_4$ carries highly processed sensory data describing the state of environment in which the assemble command must operate, including the state of the lower level $P$ vectors. The $H_4$ operator maps each input $S_4$ into an output $P_4$. As $F_4$ changes the goal (ASSEMBLE AB) is decomposed into a sequence of subgoals (FETCH A), (FETCH B), (MATE B to A), (FASTEN B to A). At each level in the hierarchy a different type of feedback data with a different time-rate-of-change drives the decomposition of a higher level command into a sequence of lower level subcommands. Finally, at the lowest level the $P_0$ vector consists of motor drive signals which actuate observable behavior $C_0$. 
I've finally found a personal computer I respect. It's not surprising that professionals get excited about the Compucolor II. It's a totally-integrated 8080A system with full color graphics display, built-in 51K minidisk drive, and the best cost performance ratio available in a personal computer.

The complete system is only $1495* And that price includes 8K user RAM, RS-232C compatibility and random access file capabilities.

Our 8 foreground and background colors will boost your comprehension, while introducing you to an exciting new dimension in BASIC programming. The vector graphics have 16,484 individually-accessible plot blocks. And the 13" diagonal measure screen gives you 32 lines of 64 ASCII characters. You also have the flexibility that comes with 16K Extended Disk BASIC ROM.

Compucolor II offers a number of other options and accessories, like a second disk drive and expanded keyboard, as well as expandability to 32K of user RAM. Of course we also have a whole library of low-cost Sof-Disk™ programs, including an assembler and text editor.

Visit your nearest computer store for details. And while you're there, do some comparison testing. With all due respect to the others, once you see it, you'll be sold on the Compucolor II.

Compucolor Corporation  Post Office Box 569  Norcross, Georgia 30071  Telephone 404/449-5996

Unretouched photo of screen
* U.S. Domestic price
Figure 18: Around each trajectory representing an ideal task performance there exists an envelope of nearly ideal trajectories which correspond to successful, but not perfect, task performance. If the H functions are defined throughout these envelopes so as to drive the system back toward the ideal whenever it deviates, then the trajectory will be stable and task performance can be successful despite perturbations and unexpected events.

Figure 19: If the H functions at the lower levels are sufficiently well defined, small perturbations from the ideal performance can be corrected by low level feedback without requiring any change in the command from higher levels.

Figure 20: If the lower level H functions are not adequately defined, or if the perturbations are too large for the lower level to cope, then feedback to the higher levels produces changes in the task decomposition at a higher level. The result is an alternative strategy.

Text continued from page 24:
then the decomposition at that level will be stereotyped and insensitive to conditions in the environment.

Whether or not the hierarchy is driven by external or internal variables, or both, the highest level input command commits the entire structure to an organized and coordinated sequence of actions which under normal conditions will achieve the goal or accomplish the task. The selection of a high level input command in a biological organism thus corresponds to an intent or purpose, which, depending on circumstances, may or may not be successfully achieved through the resulting hierarchical decomposition into action.

Obtaining Successful Performance

The success or failure of any particular task performance, or goal seeking action, depends on whether or not the H functions at each level are capable of providing the correct mappings so as to maintain the output trajectory within a region of successful performance, despite perturbations and uncertainties in the environment.

At all levels, variations in the F vectors due to irregularities in the environment cause T5 trajectories to vary from one task performance to the next. This implies that while there may exist a set of ideal trajectories through S and P space at each level of the hierarchy corresponding to an ideal task performance, there also must be an envelope of nearly ideal trajectories which correspond to successful, but not perfect, task performance. This is illustrated in figure 18.

The H functions must not only be defined along the T5 trajectories corresponding to ideal performance, but also in the regions around the ideal performance. Consequently, any deviation from the ideal is treated as an error signal which generates an action designed to restore the actual trajectory to the ideal, or at least to maintain it within the region of successful performance.

Small perturbations can usually be corrected by low level feedback loops, as shown in figure 19. These involve relatively little sensory data processing, and hence are fast acting. Larger perturbations in the environment may overwhelm the lower level feedback loops, and require strategy changes at higher levels in order to maintain the system within the region of successful performance. This is illustrated in figure 20. Major changes in the environment are detected at higher levels after being processed through several levels of pattern recognizers. This produces differences in the F vector at the higher level
Graphics for small systems were too expensive... Until Now

HIPLÔT™
digital plotters

The perfect small system output device
- Displays data in easy to read graphical format
- Both serial and parallel inputs built-in
- Uses standard 9½” x 11” paper
- Plotting speed up to 2.4 ips
- Resolution of both 0.01 and 0.005 in.
- Baud rate and step size easily changed
- Completely assembled and ready to use
- Priced at $1085*

HI PAD™
digitizers

The perfect small system input device
- Resolution and repeatability of 0.005 in.
- Origin is completely relocatable
- RS232C and 8 bit parallel interface selectable at the connector
- Accuracies of ± 0.015 In. (0.4mm)
- Optional LC display shows actual values being inputted
- Digitizing surface 11" x 11"
- Priced at $795 *

*U.S. Domestic Price Only
TM Trademark of Houston Instrument

For rush literature requests
or local sales office information only,
persons outside Texas call toll free 1-800-531-5205.

ONE HOUSTON SQUARE AUSTIN, TEXAS 78753
(512) 837-2920 TWX 910-881-2022
EUROPEAN OFFICE
Rochesterlaan 8 8240 Gistel Belgium
Phone 059277445 Telex Bausch 81398

Circle 171 on inquiry card.
Figure 27: The command and control hierarchy proposed by Tinbergen to account for the behavior of the male 3 spined stickleback fish. The heavy line indicates the particular type of behavior vector actually selected by the feedback shown at the various levels of the hierarchy on the left. This figure represents a snapshot in time corresponding to one of the two-dimensional surfaces shown in figure 16.

which in turn produces different C vectors to lower levels. The result is an alternative higher level strategy to cope with the perturbation.

Of course, if the $H$ functions do not provide stability, or if the environment is so perverse that the system is overwhelmed, then the trajectories diverge from the region of successful performance and failure occurs.

Over-learned tasks correspond to those for which the $H$ functions at the lower levels are sufficiently well defined over a large enough region of input space so as to maintain the terminal trajectory well within regions of stability and success without requiring intervention by the higher levels for strategy modification. Thus, a highly skilled and well-practiced performer, such as a water skier, can execute extremely difficult maneuvers with apparent ease despite large perturbations such as waves. His lower level $H$ functions are well defined over large regions of space corresponding to large perturbations in the environment. He is thus capable of compensating for these perturbations quickly and precisely so as to maintain successful performance without intervention by higher levels. Such a performance is characterized by a minimum amount of physical and mental effort.

We say, “He skis effortlessly without even thinking.” What we mean is that his lower level corrections are so quick and precise that his performance never deviates significantly from the ideal. There is never any need for higher level loops to make emergency changes in strategy. On the other hand, a novice skier (whose $H$ functions are poorly defined, even near the ideal trajectory, and completely undefined elsewhere) may have great difficulty maintaining a successful performance at all. He is continually forced to bring higher levels into play to prevent failure, and even the slightest perturbation from the ideal is likely to result in a watery catastrophe. He trains very hard, and fails often, because his responses are late and often misdirected. His performance is erratic and hardly ever near the ideal.

However, practice makes perfect, at least in creatures with the capacity to learn. Each time a trajectory is traversed, if there is some way of knowing what mistakes were made, corrections can be made to the $H$ functions in those regions of input spaces which are traversed. The degree and precision of these corrections, and the algorithm by which they are computed, determine the rate of convergence (if any) of the learning process to a stable and efficient success trajectory.

There are many interesting questions about learning, generalization, and the mechanisms by which $H$ functions are created and modified at the various hierarchical levels in biological brains. However, we will defer these issues until part 2 (July 1979 BYTE).

Task Decomposition and Goal Seeking

Note that figure 17 illustrates only a single specific performance of a particular task. None of the alternative trajectories which might have occurred under different circumstances with a different set of $F$ vectors are indicated. These alternatives which might have occurred can be illustrated in the plane orthogonal to the time axis.

Figure 21 illustrates the set of alternative $C$ vectors available at various levels in the behavior-generating hierarchy of the male 3 spined stickleback fish. This figure
New easy-to-use educational module.
Your best ticket to the microprocessor world.
Ideal for teaching. Yourself. Or others.

TI's new TM990/189 University Module is a stand-alone learning lab. Fully assembled and designed for maximum hands-on experience. To ease and simplify learning and teaching.

Outstanding features include powerful 16-bit microprocessor with easy-to-learn, easy-to-use minicomputer instruction set; 45-key alphanumeric keyboard and ten-digit seven-segment display for easy assembly-language programming; ROM-resident software including system monitor for program debug and symbolic assembler; audio cassette interface; easy-to-add EIA and TTY interface; 1K-byte RAM expandable to 2K; 4K-byte ROM and 2K-byte expansion EPROM socket; 16-bit

programmable I/O controller; user addressable LEDs, and sound indicator.

A 570-page tutorial text accompanies the module. It is a detailed guide for self-paced learning, or the basis for a three-hour university course. Chapters include an overview of microprocessors; programming exercises; assembly language; memory systems; I/O concepts and designs; software engineering; product development; a variety of lab experiments, and much more. Also with the module: a 300-page user's guide.

The University Module complete with tutorial text and user's guide is only $299.00.

Order your University Module from your authorized TI distributor. For more information, write Texas Instruments Incorporated, P.O. Box 1443, M/S 6404, Houston, Texas 77001.

TEXAS INSTRUMENTS
MOVING AHEAD IN MICROCOMPUTERS

Circle 266 on Inquiry card.
The new Pascal Computer System is driven by a unique 16-bit Pascal MICROENGINE™ — the first microprocessor hardware designed exclusively for direct high-level language execution. The processor is incorporated into a single board computer system, the WD/90, which directly executes Pascal Intermediate code generated by the University of California at San Diego (UCSD) Pascal compiler, Release 111.0. Since P-code output by the Pascal compiler represents an ideal architecture for a computer executing Pascal programs and since the WD/90 directly executes P-code (no interpreter), these programs execute up to five or more times faster than equivalent systems.

WESTERN DIGITAL
3128 Redhill Avenue, Box 2180 • Newport Beach, CA 92663
(714) 557-3550, TWX 910-595-1139

The WD/90 Pascal MICROENGINE™ Computer includes: • Pascal MICROENGINE™ processor • 64K bytes of RAM Memory • Two RS-232 asynchronous/synchronous ports (110-19.2K baud-full duplex) • Two 8-bit parallel ports (500 kHz maximum data rate) • Floppy disk controller with direct memory access (DMA), switch selectable for: single or double density (IBM format); mini or standard floppy; 1 to 4 drives (same type) • Floating point hardware (proposed IEEE standard) • Memory Mapped I/O • Enclosed power supply • Complete UCSD Pascal Operating System (Release 111.0)

For further information contact:
Distributor: CIT (714) 979-9920
Retail: Your local computer store
OEM: Your WESTERN DIGITAL sales representative

FOR FURTHER INFORMATION CONTACT
DISTRIBUTOR: CIT (714) 979-9920
RETAIL: Your LOCAL COMPUTER Store
OEM: Your WESTERN DIGITAL Sales Representative

Circle 388 on inquiry card.
onComputing

A new quarterly by the staff of BYTE

This totally new publication is entertaining, informative, and uncomplicated. It is edited for the attorney, accountant, writer and other professional or business person aware of the personal computer as a tool for business, education, home entertainment, laboratory work and other applications.

Compiled and edited by the staff of BYTE, latest developments covered in onComputing will include creative uses of the small computer, books for the computer user, how and where to buy your personal computer and numerous features concerning the fascinating world of the microprocessor.

Add onComputing to your library of "must" publications. Act now, subscribe and receive four (4) issues at $8.50 for one year. (U.S.); Canada and Mexico: $10.00.

onComputing
GUIDE TO PERSONAL COMPUTING

SUBSCRIBE NOW! COMPLETE AND MAIL ATTACHED POSTAGE PAID REPLY CARD
onComputing, Inc. □ 70 Main St. □ Peterborough, NH 03458 □ Dial toll free 800-258-5485 (in NH 924-7217)
Figure 22: A set of $T_p$ trajectories in which there is opportunity for branching at many points in time. If behavior can be modified by feedback at many different levels and in many different ways, it appears to be adaptive and flexible. If there are only a few branch points, with only a few alternative actions available at each branch, behavior will appear stereotyped.

in which there is opportunity for branching at several different levels at every step along each trajectory. At each instant in time the $C$ vector to any particular level depends upon what the $C$ and $F$ vectors were to the next higher level at the previous instant. Thus, a change in the $F$ vector at any level causes an alternative $C$ vector to be sent to the level below. Behavior is continuously modified at all levels by external variables, and hence does not appear stereotyped at all.

Many degrees of freedom place great demands on the $H$ functions for maintaining stability and precision of control in such a large space of possibilities. Since successful behavior is only a tiny subset of all possible behaviors, it is clear that most of the potential branches will lead to disaster unless the $H$ functions produce actions which steer the $S$ and $P$ vectors back into the narrow regions surrounding success trajectories. For a multilevel hierarchy with sensory interaction at many different levels, this is extremely complex. However, if the $H$ functions are trainable, then performance can improve through practice. Complex tasks can be learned, imitated, and communicated from one individual to another.

Conclusion

We have now completed the first step in our development. We have described a hierarchical computing structure which can execute goals, or intended tasks, in an unpredictable environment. We have also defined a notation by which the behavior of such a hierarchy can be described clearly and concisely. We have asserted that the complexity of behavior resulting from such a control hierarchy depends on four things:

- the number of levels in the control hierarchy;
- the number of feedback variables which enter each level;
- the sophistication of the $H$ functions which reside at each level;
- the sophistication of the sensory processing systems which extract feedback variables for use by the various $H$ functions.

In part 2 we will describe a computer model of a neurophysiological structure in the brain which computes multivariate $H$ functions. We will then suggest how the brain might use such structures to learn skills, remember events, select goals, and plan future actions.

BIBLIOGRAPHY

Wordsmith is the video text editing system you've been waiting for. Its power, flexibility and simplicity help you carve any text editing task down to size—i.e. in a way you can understand. We wanted a system that allows you to think in traditional ways about text layout, yet at the same time makes the traditionally tedious operations such as cut and paste simple and fast. We think we've done it. We want you to decide for yourself.

**Flexibility**

- **Logical/Physical Page Distinction.** Define your own hardcopy size. Wordsmith remembers the difference between the screen size and the hardcopy page size.
- **Modular Hardcopy Driver.** Drive a Qume® Sprint-5 or TTY-like device directly now. Diablo, NEC and other hardcopy devices soon.
- **Pure Text.** Wordsmith files are pure text with no control characters mixed in. This universal format keeps you as compatible with the world as possible. What you see on the screen is what you get as hardcopy.
- **Page Templates.** Snapshots of the block layout of a page can be saved as named disk files, then later recalled and superimposed on the current page. Use such "templates" for standard multicolumn layouts, common letter formats, and fixed-field forms. A single keystroke dispatches you quickly from block to block as you fill in your page.
- **File Switching.** Moving from document to document to examine, copy, move and change text is like rolling off a log. You're not confined to one disk file at a time anymore.

**Simplicity**

- **Auto Word Break.** Forget the right margin. Wordsmith notices when you won't be able to complete the current word and moves it to the next line for you as you continue typing.
- **Understandable Commands.** The most frequently used commands are single keystrokes. The rest are easily remembered abbreviations.
- **Informative Status Lines.** The top two screen lines constantly display page number information, document name, cursor position, tab stops and status/error phrases. You're always in touch with your document.
- **Protection Against Catastrophic Errors.** It's nearly impossible to ruin your document with a single bad command. Wordsmith's page oriented design and double-checking user interface help you do what you mean.

**Power**

- **Page Oriented Philosophy.** A document is a collection of pages. The screen displays one entire page at a time. Simple random access page flipping commands take you quickly to any page in the document. Equally efficient commands allow you to insert, delete, copy and move pages both within one document and across documents.
- **Extensive Block Manipulation Capabilities.** Using "windows", portions of text, charts, etc., can be quickly and effortlessly moved around on the current page, or across pages. The shape and size of any window can be changed in real time, with the contained text automatically reformattting itself (heedng word and paragraph boundaries) to conform to the new shape.
- **Instantaneous Formatting.** Compacting (extraneous blank deletion) and right justification are simple commands that tidy up a full page or window's worth of text in the blink of an eye. Random access cursor movement, line and character insert and delete, line and page split and join, and a host of other line and character level commands help you put text in its place quickly and accurately.

**The Wordsmith™ TEXT EDITOR**

Defining the New Generation of Text Editing
from Micro Diversions, Inc.
8455-0 Tyco Rd.
Vienna, Va. 22180
(703) 927-0888

- Direct CP/M® and North Star DOS compatibility
- Available for 40x86, 24x80 and 16x64 memory-mapped video boards
- Fully reentrant for efficient multi-programming environments (5K program space, 5K data area)
- 8080 and Z80 compatibility

**Ordering Information:**

<table>
<thead>
<tr>
<th>Version</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP/M or North Star DOS</td>
<td>$200</td>
</tr>
<tr>
<td>TTY or QUME interface?</td>
<td>$80</td>
</tr>
<tr>
<td>Brand and memory address of video display board?</td>
<td>$15</td>
</tr>
<tr>
<td>Ship on single or double density, 5&quot; or 8&quot; diskette?</td>
<td></td>
</tr>
</tbody>
</table>

Inquire about our custom keyboard.
Simple Maze Traversal Algorithms

This article is a discussion of some solutions to the problem of traversing a maze. The algorithms here represent neither an exhaustive nor a high-powered study of the problem, but rather an intuitive approach. The ideas reflect our thought processes and those of Tony Rossetti in our efforts to compete in IEEE Spectrum magazine's ongoing Micromouse contest.

Problem Specification

The IEEE Spectrum's Micromouse Maze contest began time trials last June at the 1978 National Computer Conference in Anaheim CA. A mechanical "mouse" (ie: robot) must find its way under its own power from the entrance of a maze to the exit. Each mouse is given three tries through the maze, with a time limit on each attempt. The mouse with the shortest logged time wins the contest. The solution to the problem, then, is to find the path through the maze that yields the shortest time.

An important consideration in finding a solution is the characteristics of the maze. The corridors are of uniform width. There are only five types of intersections: right angle; left angle; T; U turn; and mouse-trap. These are shown in figure 1. There are no cross-intersections, nor are there any king's chambers, which are large vacant areas in the maze. This simplifies the traversal algorithms somewhat. Finally, there are exactly one entrance and one exit on the perimeter of the maze, but not necessarily on opposite sides.

Characteristics of the mouse should also be taken into consideration. It must be completely self-contained, having an on board computer and any required memory. Since the mouse must carry its own battery, available power is a limiting factor.

Easy Algorithms

The criteria used in looking for a solution were primarily based on the considerations discussed above. The limited power, program space, memory and processor power were perhaps the most important aspects. Simplicity was also an important element in order to provide easy modification and enhancement of the robot.
The traversal algorithm that suggests itself first is the simplest one: each time the robot encounters an intersection, the rightmost path is followed. This is the equivalent of the robot resting its "right hand" on the right wall of the maze corridor and not lifting it throughout the maze walk (see figure 2). Of course it works in the same way when taking the leftmost path instead of the rightmost. This algorithm certainly meets the requirement of simplicity, and the program is small and uses little memory. It also guarantees a solution, but unfortunately in using this algorithm there only exists one solution, so there is no way to take advantage of the second and third runs through the maze to significantly improve the traversal time.

The resulting path may be a very long, roundabout path through the maze. This, of course, depends on the configuration of the particular maze. Indeed, the possibility exists that the path takes more than the allotted time for the robot to complete. So the leftmost/rightmost algorithm guarantees one solution, but has significant disadvantages.

A variation of this algorithm is one in which, at each intersection, the robot chooses one of the available paths at random. Again, this is an easy and short program to implement. It has the important advantage that a different path is picked every time through the maze, so that there is the chance of picking a fairly short path. A definite drawback, though, is that no solution is guaranteed. The robot may come out the entrance instead of the exit, or may wander around in the maze until the allotted time has run out.

Another slight variation on the leftmost/rightmost algorithm is the straight-ahead first algorithm. If, in this algorithm, a straight-ahead alternative exists at an intersection, that path is chosen (otherwise either the right or left path is taken). Like the former algorithm, this one is short and simple, yielding a unique path; however, this path may not be a solution. This algorithm can have certain advantages, though. When a maze has cross intersections and the entrance and exit are on opposite sides of the maze, the robot gets close to the exit faster. Also, for robots which are mechanically faster at going straight than at turning, this algorithm can minimize the required turns.

All of the solutions discussed above are very simple and, except for the random path algorithm, give only one possible solution for each maze configuration. Since the mouse gets three tries through the maze, a logical next step is to use a different algorithm on each run. For example, choose the rightmost path on the first time through, the
leftmost path the second time, and the straightest path the third time. In this way the mouse is allowed to take advantage of having three tries, and perhaps one will yield a reasonably short time.

Smarter Algorithms

An unfortunate characteristic of mazes built for a competition of this sort is that wall-hugging mice (i.e., those that don't recognize corridors and intersections, but are built to blindly follow the right or left wall) are heavily penalized. This means that the maze probably has a fairly short and direct path from the entrance to the exit, but that this path has so many dead-end offshoots that a wall-hugger ends up covering a large portion of the maze's interior before reaching the exit. This aspect makes it not such a good idea to use only a rightmost or leftmost algorithm. Rather, it argues for using an algorithm that can be smart about picking the path and learning from its mistakes.

Obviously, the only way the robot can learn from its mistakes is by remembering what it did. In this way, the robot can make a first try through the maze using one of the simple algorithms discussed before, remembering the path taken. Then the remembered path can be optimized. This attack gives the potential for significant time improvement.

Remembering the Path Taken

The most difficult part of remembering a path taken through the maze is how to represent that path in the mouse's memory. One straightforward way to do this is to conceptually map the maze onto an X,Y coordinate grid, picking a convenient origin (i.e., the entrance to the maze) and orientation (i.e., forward from the entrance is +X). Since all intersections of corridors are at right angles, any movement will be either parallel to the X axis or parallel to the Y axis, and will have either a positive or negative increment. This mechanism provides a way to uniquely name all intersections in a maze simply by giving the X,Y pair which specifies the distances from the entrance at (0,0). See figures 3 and 4 for examples of naming intersections.

As the mouse visits intersections on its walk through the maze, it can record in its memory the X,Y coordinates of each, thus generating a list of X,Y pairs starting with (0,0) which uniquely describes the particular path taken. Figure 5 shows the coordinate lists representing the leftmost and rightmost paths through the labeled maze of figure 4.
At last, you can get a mammoth 32K memory without paying a beastly price. The SuperRam™ 32K static memory kit is just $649 for S-100 systems.

The latest of George Morrow's heavyweight memory designs for Thinker Toys™, the SuperRam™ 32K features two independent 16K blocks, each addressable and write-protectable. It meets the Proposed IEEE S-100 Standard with full buffering of both data and address lines. Uncommonly efficient, the Morrow design utilizes just 7 ICs for control and buffering, drawing typically 2.6 amps. Ask your local computer shop to order the SuperRam™ 32K kit for you. Or call (415) 524-2101.

Morrow makes memory for

Thinker Toys™
5221 Central Ave, Richmond, CA 94804

"Judy" the elephant courtesy Marine World - Africa USA

Circle 256 on inquiry card.

"See us in booths 98 and 99 at the NCC"
Figure 6: Maze pitfalls. On its first, nonoptimized attempt, the mouse will traverse the entire length of the dead-end corridor. After optimizing the path by deleting backtracked corridors, a shorter path is taken.

Figure 7: Leftmost versus rightmost maze traversal, in which the robot keeps its right or left side against the respective wall while traversing the maze. The leftmost path the mouse would travel is shown in red. Notice that the outer edge of the loop is completely circumvented. When intersection 1 is visited a second time it is clear that this whole section of the maze is fruitless because all corridors leading away from the center of the loop were tried and found to be useless. Since the exit to the maze is along the perimeter of the maze, no corridor going to the inside of the loop could possibly reach the exit. The rightmost path is shown in gray: in this case the whole loop is neatly bypassed. The mirror image of the above maze section can be used to argue similarly for chopping the loop off the rightmost path.

Optimization

Now that the mouse has a way of remembering the path it takes on the first attempt through the maze, the next problem is, how can it find a better (shorter) path for the second attempt? The main motivation behind optimizing a path is to chop off all parts of the path that don’t contribute to getting closer to the exit. That is, remove any part that had to be backtracked.

The first type of backtracking is that in which a corridor is a dead end, and the mouse has to return to the main corridor to continue. Clearly the time spent negotiating this part of the maze is wasted and should be omitted. Figure 6 illustrates this kind of backtrack optimization: every coordinate pair along the backtracked path can be deleted from the list. Notice that this same method works no matter how long the dead end corridor is (i.e.: how many intersections it has).

A second kind of backtracking occurs when the maze contains a loop or cycle. The presence of a loop is indicated when the mouse returns to an intersection that it has previously visited. The whole traversal of the loop can be cut out of the maze walk since that part of the maze is useless and cannot lead to the exit. Figure 7 illustrates how it is always the outer edge of the loop that is traversed. Once an intersection is revisited, all corridors leading away from the center of the loop have been already tried and found to be fruitless (otherwise the mouse would not have returned to the loop entrance). And since the exit is along the perimeter of the maze, no corridor leading to the inside of the loop could
NOW YOU CAN AFFORD
THE WORLD FAMOUS
Diablo Printer Terminal

IPS! PROUDLY ANNOUNCES A PRICE
BREAKTHROUGH ON DAISY WHEEL
PRINTER TERMINALS

Featuring: RS 232 compatibility at 110,
150, 300, and 1200 baud: Print speed of 45
char/sec: Graphics capability: Over 30 print
wheels from 10 to 15 char/inch: 5 ribbons
in color, cloth, film or two color: Form
length adjustable: Spacing adjustable from
120 pitch to .1 pitch: Line spacing adjust-
able from 48 lines/in. to .4 line/in.: Identical
in every respect to its high priced
sister the Diablo HyTerm II* model 1620.

Price: $2,595.00 each in single units, quan-
tity discounts available.

Service: Major cities in the U.S. and Canada.

You have probably waited a long time to purchase your computer printer at a reasonable
price. Wait no longer! The Diablo 1620 lists for $3,240.00 we sell the IPS! 1622 for $2,595.00;
save well over $600.00. For immediate action phone in your order collect and we will ship
your terminal the same day.

We also stock Diablo 1345A (Hytype II*) mechanisms for immediate shipment at the low
price of $1,150.00. Order one now and build your own terminal using your own CPU, or do-
it-yourself by buying our 1622 kit and assemble your own terminal within 10 hours
for $2,295.00

If you've always wanted to turn your computer onto word processing, this is the only way to
go. Ask for our free word processing software.

IPS!
INTERNATIONAL PERIPHERAL SYSTEMS, INC.
1849 N. HELM
FRESNO, CALIFORNIA 93727
CALL (209) 252-3635

*Hyterm and HyType are registered trademarks of Xerox Corp.
possibly reach the exit. Therefore, it doesn't matter that these were unexplored, and every intersection along the loop can be deleted from the optimized path with no loss of important information.

Detecting the two different types of backtracks (straight line and loop) involves answering the same question: has the mouse been here before? The handling of both types of backtracks is also the same too: delete all of the path history between the last visit here and this visit, then continue from there. Up until now, the optimizing process has been discussed in an "after the fact" fashion, as if the whole maze walk path had already been generated from the start to the finish. However, it can be much more efficient if the mouse can perform these optimizations while it is recording the path.

The actual details of the implementation are not important here, since they would depend on the type of microprocessor used. In general, though, assume that the intersection X,Y coordinates are stored in the mouse's memory in a linear fashion (i.e., in an array or list). Furthermore, assume that there is a pointer into the array or list indicating where the next coordinate pair will be stored (i.e., NEXT pointer). In this way, each time the mouse encounters an intersection and is about to record its coordinates as the NEXT position in the path list, it can scan backward from the NEXT pointer to the beginning of the list, looking for an occurrence of the same coordinates. If no occurrence is found, this is the mouse's first visit here. These coordinates can be recorded at the NEXT position in the list, and NEXT can be appropriately incremented to prepare for any successive intersections. If an occurrence of the same coordinate pair is found (i.e., at position I in the list), the mouse has been here before. The easy way to "forget" the backtracked part of the path (between I and NEXT) is for the mouse to reset NEXT to I, then continue normally by incrementing NEXT and looking for another intersection. Figure 8 shows this diagramatically.

Incidentally, if the mouse has relatively low accuracy motors and sensors, it is possible to obtain slightly different readings when encountering an intersection for the second time. Therefore, when checking to determine if this intersection has been visited before, allowances must be made for the inaccuracies. This is easily accomplished by checking to see if X[NEXT] is within plus or minus delta of X[I], and if Y[NEXT] is within plus or minus delta of Y[I], where the delta value reflects the amount of possible deviation, instead of checking for X[NEXT] = X[I] and Y[NEXT] = Y[I].

Although it may seem that a lot of computation is done while the mouse is running the maze (and, after all, speed counts), in fact, the time taken for computation is so small compared to the time it takes for the robot to move to the next intersection that it is hardy noticeable. Another factor which makes doing the optimization during the run even more desirable is that the exit of the maze is not always well defined. This means that the robot merely passes through a corridor and trips a light sensor to stop the timer, and then proceeds to "fall of the edge of the world." This makes it difficult for the mouse to determine that the maze run is finished, and that it should now optimize the recorded path. Optimizing during the run is certainly cleaner and more efficient.

A suitable way to take advantage of the backtracking algorithm would be...
THE DIAGNOSIS:
MEDICAL OFFICE MALAISE

Between insurance forms, Medicare and Medicaid forms, bills, and patient records, the typical medical office today is swamped with paperwork. If the sheer volume isn't enough of a problem, it is also essential that all this be done with speed and accuracy. It has been estimated that Doctors and office staff spend nearly a quarter of their time handling paperwork. Until now, the only alternatives were either hiring more personnel or subcontracting with an outside firm. Obviously, a medical data base management system has great potential for significantly increasing office efficiency and freeing staff for more valuable duties.

THE CURE:
MED2 FROM OHIO MICRO SYSTEMS

MED2 is a reliable, debugged program that generates valuable administrative reports, bills, aging account analysis, and insurance forms. It is the result of over a year of design, testing, and retesting in collaboration with medical offices. It features a large on-line capacity and can be operated by the existing office staff. MED2 is suitable for one person offices or group practices. It adapts readily to GP’s, specialists, dentists, and medical laboratories. MED2 requires a Z80/8080 microcomputer system that supports CP/M and it is available on Micropolis 5.25 in. and IBM 3740 8 in. diskettes.

FREE USERS SEMINAR WITH EVERY MED2 DISK

There is a lot to know about MED2 - more than can be explained in an ad or manual. To show you what MED2 can do, how to use it, and why it is configured as it is, OHIO MICRO SYSTEMS makes an unprecedented offer - a FREE two day user's seminar (lodging included) with every MED2 disk. We believe this is the best way for you to obtain a thorough working knowledge of MED2. You get to see, question, and evaluate MED2 with its designers. The seminar is comprehensive and includes information on procedures in medical offices, customizing MED2 for unique situations, technical aspects of MED2, and marketing strategies. The seminar can be a complete course for an end-user familiar with microcomputers, but it is specifically geared for dealers. MED2 provides an excellent entry for dealers into the large new marketplace of medical offices. There is no question that the need exists. Investing the time in the seminar will open the doors to increased hardware and system sales.

The price of MED2 is $895. A deposit of $200, which applies toward the purchase price, is required for registration in the seminar. If you decide to not purchase MED2 after the seminar, you owe no more. Contact OHIO MICRO SYSTEMS for seminar dates, registration, and further information. Phone (216) 678-5202 or write to us at 500 South Depeyster, Kent, Ohio 44240.

OHIO MICRO SYSTEMS
500 S. DEPEYSTER ST. • KENT, OHIO 44240 • (216) 678-5202

Circle 284 on inquiry card.
Figure 9: Optimization. If a leftmost path were to yield the red path and a rightmost path were to yield the gray path, the common intersections would be A, B, C, and D. By taking the shorter path between each successive pair of intersections, one obtains the shortest total path which has been traversed. Examples of short paths are the gray path from A to B, either path from B to C (since they are the same), and the red path from C to D. The final path is the most direct and shortest path through this section of the maze.

Figure 10: Turning time considerations. Due to the time it takes for the mouse to turn in an intersection, evaluations regarding this difference in the average length traveled per unit time must be made. For example, the mouse moves one unit of length in one unit of time and it takes two units of time to turn in an intersection. Then with the mouse starting in position A in each course, after 12 units of time the mouse has progressed 10 units of length on the left and a full 12 units on the right.

for the mouse to take the rightmost path, optimizing and recording as it went on the first attempt, and similarly take the leftmost path on the second try. Now the mouse has recorded in its memory two different optimized paths. At the beginning of the third attempt, each of the two paths can be measured by a straightforward, length of corridors sum, and the shorter of the two optimized paths can be taken on this final run.

A logical extension of this shorter total path philosophy is to compare the leftmost path list to the rightmost path list, finding all the common intersections. A short total path can then be composed by joining the shorter of the path segments between each common intersection pairs. For example, each complete path might go through the origin, intersection A, intersection B, and the exit point (perhaps along with many other different intersections). Then an optimal path could be made by combining the shorter path between the origin and A, the shorter path between A and B, and shorter path between B and the exit. Conceptually, this is like breaking the maze down into "common denominator" sections and picking the shortest path through each individual section. And, in fact, this path is the shortest one which has been traversed through the maze so far (see figure 9).

However, time is critical, not distance, and most likely the robot corners more slowly than it goes straight (see figure 10). So if the shorter path has many turns in it, and the longer run has few turns, the shorter path may not necessarily yield the shorter time for the run. Therefore, a slightly more sophisticated scheme could measure the paths using a weighted sum (a larger value for turns than for straightaways), and yield values which more closely reflect how fast the robot can negotiate the maze by the different paths.

Conclusions

The algorithms presented here are by no means high-powered or devious, but are more the results of a natural, intuitive approach to the maze traversal problem. They are all straightforward and relatively easy to implement. But even so, they are reliable and produce solutions which are reasonably good, especially when compared with the common wall-hugging tactics.

Clearly, there are still many ways to improve the performance of these algorithms. More contests like the IEEE Spectrum's Micromouse contest will perhaps encourage investigation in this area and will produce much more sophisticated approaches and solutions to the maze problem.
Horizon Disk Capacity Keeps Growing

The Horizon is now capable of 72K bytes on-line! The Horizon can connect to four double density 5½” single-sided disk drives. Each of those drives can access 180K bytes of information. A four drive system accesses 720K bytes! That’s capacity you don’t usually find in a microcomputer, but there’s even more to come! The North Star disk controller board is designed so that two-sided disk drives may be added as soon as they become available from North Star.

Existing Horizons will accommodate the new two-sided drives so North Star owners can simply add additional drives to upgrade their system. Each two-sided drive will access 360K bytes! That means the maximum on-line disk storage for the Horizon will increase to over 1.4 million bytes!

New Cabinet for Disk Drives

North Star additional disk drives are now available with the same high quality wood cover as the Horizon computer! The Additional Drive Cabinet (ADC) is designed to accept either one or two drives for the Horizon or for mounting North Star Micro Disk System drives. Like the Horizon, the ADC is available with either wood or blue metal cover. Included is a new power supply capable of powering one or two drives. The ADC is $129 in kit form. Assembled, with one drive the ADC is $599, with two drives $999.

Pascal Now Available for Horizon

The much-heralded Pascal language is now being offered for use with the North Star Horizon computer. North Star, with the co-operation of the University of California at San Diego, is now delivering a Pascal Program Development System. North Star Pascal is ideally suited for developing large programs because of features such as: long variable names, block-structured control statements, and compilation. North Star Pascal is available on 5½” diskettes for use with the Horizon or Micro Disk System. North Star Pascal will operate with either the Z80 or 8080 microprocessor. Pascal, including documentation, is available in either single or double density versions for $49.

An auxiliary Pascal diskette, containing an 8080/280 assembler and some additional Pascal utilities, is available for $29. Complete information is available at your local retail computer store.

First Double Density, Now Double Memory

The new North Star 32K RAM board (RAM-32) has doubled the memory density of the popular Horizon computer. Available either with the Horizon or other S-100 bus computers, the RAM-32 runs at full speed—no wait states—with the 4 MHz Z80A microprocessor (as well as with slower Z80 and 8080 processors). Addressability of the RAM-32 is switch-selectable in four 8K regions.

North Star RAM features like bank-switching and parity checking are standard. The parity checking capability means that the RAM-32 is constantly diagnosing itself. That’s a plus for your system. The fact that parity checking is a North Star RAM-32 standard is a plus for your pocketbook! There is no extra charge for this important capability.

A Horizon with 48K of RAM can be configured by using one North Star 16K RAM board and a RAM-32. Need more memory? 56K can be configured by using two RAM-32 boards with one 8K region switched off.

NORTH STAR MDS, ZPB, FPB FOR OTHER S-100 COMPUTERS

Upgrade your system with these North Star products — available for any S-100 computer: Micro Disk System—a complete 5½” floppy disk system, Z80 Processor Board, or the Hardware Floating Point Board.

<table>
<thead>
<tr>
<th>RAM Board</th>
<th>Kit</th>
<th>Assembled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizon - 1-16K</td>
<td>$1599</td>
<td>$1899</td>
</tr>
<tr>
<td>Horizon - 1-32K</td>
<td>1849</td>
<td>2099</td>
</tr>
<tr>
<td>Horizon - 2-32K</td>
<td>2249</td>
<td>2549</td>
</tr>
<tr>
<td>RAM-32</td>
<td>599</td>
<td>659</td>
</tr>
<tr>
<td>RAM-16</td>
<td>399</td>
<td>459</td>
</tr>
</tbody>
</table>

Typical Horizon configurations: CRT, Horizon computer, Additional Drive Cabinet (ADC).

NorthStar Computers

2547 Ninth Street
Berkeley, California 94710
(415) 549-0858

Circle 285 on inquiry card.
With A New Concept In Documentation

PRS EXCITING LINE OF PROGRAMS

- **MICROFILE: A NEW DATAFILE MANAGEMENT PROGRAM**
  PRS MICROFILE documentation also solves one of the major concerns of beginners. A special chapter explains how you can interface newly acquired software with your specific configuration.
  PRS gives clear tutorial instructions on the whole matter of I/O patches. In addition, you will always find a complete source listing of the I/O section of our programs. PRS makes every effort to facilitate the implementation of its software within your particular system.
  **Cassette $49.95**
  **Floppy Disk $64.95**

- **DDS II: THE FAMOUS DYNAMIC DEBUGGING SYSTEM**
  DDS II is incredibly powerful. Although designed for microcomputers, it is even more sophisticated than the built-in debugging environments supported by most large mainframes.
  DDS II assembles and disassembles all 8080 code. Performs "software open heart surgery," artfully displaying on the screen all registers, program instructions and memory. Simulates dual screen capability. You can switch on command from the DDS II display to the program output. It's like having two video monitors for the price of one. Updates the display while monitoring the program. Includes a full array of monitoring tools.
  **Cassette $49.95**
  **Floppy Disk $64.95**

- **A2FP: A PLOTTING PROGRAM FOR APPLE II**
  This PRS program is a "modern age" tool for students, engineers and researchers. A2FP plots 2-dimensional functions in HIRES graphics. Uses the full screen (280 x 192 points.) Plots on Cartesian coordinates. Gives complete parameters of plotted curves. Superimposes plots. Offers many plotting modes.
  **Cassette $34.95**

- **T/PM: A TRANSIENT PROGRAM MANAGER FOR THE TRS-80**
  T/PM is a disk operating system similar to those used by main frames. It is written to utilize the full power of the Z-80 instruction set.
  At last, software can now be transportable. All programs written for the C/PM system can now be relocated just once to run on the TRS-80. If a program is written for the TRS-80 using T/PM or other CP/M* like DOS, you can now run that program simply, without patches.
  **Floppy Disk $149.95**
  *Trademark of Digital Research

PRS MAKES A BREAK-THROUGH IN DOCUMENTATION

Every PRS program comes with a complete and instructive handbook. This unique documentation is written in clear and easy-to-understand English. PRS offers you a true fluency in computer-user dialogue.

PRS HAS A POWERFUL CODE

Powerful code means fast and accurate answers. PRS permeates the design of its unique code with "human engineering." And you'll appreciate the delicate balance between machine-human dialogue and resident program-space memory.

PRS PROGRAMS ARE PROTECTED IN A BEAUTIFUL CASSETTE OR DISK FOLDER

The PRS cassette or floppy disk and manual for your PRS programs are protectively nestled in an efficient and durable gold-imprinted folder. Wherever you file it, in your room or office, the decor will be enhanced by its elegance.

PRS SUPPORTS YOUR MAJOR BRANDS

Over 20 packages are currently available. For example: Cuts, Xitan, Tarbell, TRS-80, Micropolis, North*Star. Use the order form on the other page to order your program. Just indicate your version and the configuration of your computer. Mail it to us today. And we will have it fulfilled immediately by a dealer in your area.

VISIT YOUR NEAREST DEALER TODAY

Let your dealer demonstrate the excellence of PRS programs. Let him show you the new concept in PRS documentation. Use the order form to obtain the names of the dealers in your area.
# PROGRAMS

**PRS—THE PROGRAM OF THE MONTH CORPORATION**  
257 Central Park West, New York, N.Y. 10024

<table>
<thead>
<tr>
<th>SOFTWARE</th>
<th>PRICE</th>
<th>QTY.</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. MICROFILE: A new Data File Management System</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Cassette</td>
<td>$49.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Floppy Disk</td>
<td>$64.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Documentation only</td>
<td>$10.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. DDS II The Famous Dynamic Debugging System</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Cassette</td>
<td>$49.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Floppy Disk</td>
<td>$64.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Documentation only</td>
<td>$10.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. CORE: The TRS-80 Co-Resident System Monitor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Cassette</td>
<td>$38.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Floppy Disk</td>
<td>$64.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Documentation only</td>
<td>$10.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. A2FP The APPLE II Function Plotter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Cassette</td>
<td>$34.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Documentation only</td>
<td>$10.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. T/PM: The TRS-80 Transient Program Manager</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Floppy Disk</td>
<td>$149.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Documentation only</td>
<td>$50.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**□ Send me list of dealers in my area**  
**Sub Total**  
**Check enclosed**  
**Less 5% with order**  
**VISA**  
**N.Y.State sales tax**  
**Master Charge**  
**Total**

**□ U.P.S. COD**  
**Account #**  
**Exp. Date**  
**Signature**

**My Computer configuration (specifying disk system)**

**Name**  
**Corporation**  
**Telephone**

**Address (no P.O. Box)**

**City**  
**State**  
**Zip**
Here it is! The most complete, totally integrated, word processing system software you've ever seen on a microcomputer. WORD-START™ really shines in ease of use, with its unique, dynamically activated menu scheme that allows typists to become word processing operators in minutes instead of weeks. For only $495, your 8080/8085/Z-80 with any CRT device becomes a word processing system with the features of a Lanier, Wang, Vydec, Xerox, etc., for far less cost.

Features like ON-SCREEN VISUAL TEXT COMPOSITION, with word wrap, plus dynamic justification and remargination. Imagine being able to type without hitting RETURN, and as WORD-START™ moves you to the next line, the preceding line is redisplayed, justified to your left and right margins! Center a line with a keystroke! Set BOLDFACE and/or underline even in mid-paragraph! Rejustify text to new margins, on-screen, at will!

DYNAMIC PAGINATION shows the printer page breaks during text entry, correction, or review. Dot commands control vertical page layout, CONDITIONAL PAGINATION, page HEADINGS, page NUMBERS, etc. The Integrated PRINT COMMAND can print selected pages only, pause between pages for letterhead loading, and drive any CP/M* list device. WORD-START™ runs with the CP/M interfaced printer and terminal of your choice.

SPECIFICATIONS: status line showing page, line, column of cursor; variable menu suppression for experienced operators; dynamic display of text during entry or on call permits CRT preview of printed copy; full disk buffering (document sizes up to diskette capacity); multiple file/disk edits in a session; CP/M file compatible — also useful for data entry, editing programs, etc. Commands include: cursor up/down/left/right; scroll line/screenful, up/down, oncexvariable rate; insert/overtype; delete character/line/character; variable margin set/release; set/clear tab stops; justif yi/ragged right; block move/copy/delete; search/replace once/n times/global/selective/whole words only; write to/read from additional files; set/go to any of 10 place markers. Additional support provided for CRT's with inverse video/dual intensity, line insert/delete, and erase to end of line. Dialog Interface for easy installation. AND MORE!

Registered WORD-MASTER™.users can get a $100 discount from us or your participating dealer when upgrading to WORD-START™. Offer good for a limited time only.

WORD-START™ operates with any CP/M* operating system, 32K, and either a memory mapped video board or any CRT TERMINAL with cursor control and clear screen (Hazeltine, Lear-Siegler, Soroc, Microterm, Hewlett Packard, Infoton, Beehive, Processor Tech VDM, IMSAI VIO, SD Systems, Altos, Dynabyte, GNAT, etc). We ship on 8" IBM, Micropolis II, or Northstar diskette.

Other fine MicroPro Products include:

<table>
<thead>
<tr>
<th>Software/Manual</th>
<th>Software/Manual</th>
</tr>
</thead>
<tbody>
<tr>
<td>WORD-START™</td>
<td>$495/25</td>
</tr>
<tr>
<td>WORD-Master™</td>
<td>$150/25</td>
</tr>
<tr>
<td>Tex-Writer™</td>
<td>$75/15</td>
</tr>
<tr>
<td>Super-Sort™ I</td>
<td>$250/25</td>
</tr>
<tr>
<td>Super-Sort™ II</td>
<td>$200/25</td>
</tr>
<tr>
<td>Super-Sort™ III</td>
<td>$150/25</td>
</tr>
</tbody>
</table>

MICROPRO INTERNATIONAL CORPORATION
1299 4th Street, San Rafael, California 94901
Telephone (415) 457-8990 Telex 340388 Dealer/OEM inquiries invited

"PROFESSIONAL QUALITY SOFTWARE YOU CAN COUNT ON, NOW"
See Demonstrations at NCC. Personal Computing Booth 42

*CP/M is a trademark of Digital Research Corp.
Mind Over Matter

Add Biofeedback Input to Your Computer

I wouldn't want you to get the wrong idea from photo 1. I haven't given up computers and taken up telling fortunes. Just consider the photo as a slightly dramatized introduction to a topic we've all heard of, but know so little about: biofeedback. In layman's terms, this simply means having the capability to monitor (in this case electronically) physiological processes.

There are a variety of devices on the market referred to as brain wave monitors. Brain waves are but one of the many sources of energy categorized under biofeedback. Their common relationship is that they are all electrical pulses which run through the body as a result of brain or muscle activity. Nerves and muscles within the body generate electricity by electrochemical action similar to that in a battery.

When we want to lift an arm, the brain sends an electrical pulse to the muscles in the arm. Proper magnitude and duration of the signal result in coordinated activity. The actual energy that is transmitted from the brain is very small: on the order of a few hundred microvolts at the most. The most familiar of these signals is the voltage generated by the pumping of the heart. A graph of this voltage versus time is called an electrocardiogram (abbreviated EKG or ECG). An EKG looks like a spiked waveform, with periodic response equivalent to a heartbeat. Many individual muscle contractions contribute to a frequency spectrum of 0.1 to 100 Hz, with an amplitude of about 5 mV.

Another group of signals are the voltages generated using large skeletal muscles like biceps and triceps. A recording of these voltages is called an electromyograph or EMG. Occurring only when the muscles contract, not periodically like the heart, the frequencies are very low, but the voltage is higher: about 5 to 10 mV. Because of their magnitude, these signals are the easiest to monitor.

The last important biomedical signal is composed of very low amplitude voltages within the brain itself. These are recorded by the EEG (electroencephalograph). They exhibit both periodic and pulse mode. The 50 µV signals occupy a band that is generally between 1 and 30 Hz. The signals are further subdivided into delta, theta, alpha, and beta waves. These classifications signify activity in defined frequency bands. Differences in activity seem to reflect particular personality tendencies.

Photo 1: This photo simulates a crystal ball reflection to emphasize the control capabilities associated with this article.
Eour and association are the keys. EKG, EMG, and EEG readings must be carefully interpreted.

Monitoring Internal Electrical Activity

Consider the activity within the brain or the muscles. Each neuron is producing minute voltages. In combination with the voltages of billions of other cells involved in similar activities, the result is fairly significant. The situation can be compared to that of a football stadium before, during, and after a game. A listener outside of the stadium would not hear the shouts of a few individuals, but 50,000 people shouting is quite another story. A further consideration is the progress of the game. Loud noise coming from a particular section of the stadium during the game signifies approval. This same ovation, at the conclusion, can imply the identity of the winner. Observa-

tion and association are the keys. EKG, EMG, and EEG readings must be carefully interpreted.

All of the signals discussed thus far can be monitored with surface electrodes. When the biceps is moved, a small voltage which can be measured will be produced across it (i.e. referenced to some other point on the body). Monitoring this voltage requires a special amplifier with extremely high input impedance and 60 Hz rejection. Care must be taken to use a device which will not load the signal being sensed, nor have such a low signal to noise ratio that one cannot discern intelligible information. The unique device which satisfies these requirements is called an instrumentation amplifier. Any product which is sold to monitor brain waves, EKGs, etc will contain an instrumentation amplifier.

Instrumentation amplifiers are often called differential or data amplifiers. They are closed loop gain blocks with accurately predictable input to output response. They are especially configured to have extremely high input impedances and common mode rejection which makes them ideal for amplifying low level signals in the presence of large common mode voltages. Figure 1 shows the schematic of a typical instrumentation amplifier built from such standard operational amplifiers as LM301s or 741s.

This common circuit consists of three op amps. ICa and ICB are inserted as high impedance input buffers which provide a differential gain of \( 1 + \frac{2R_1}{R_{gain}} \) and unity common mode gain. ICc is a unity gain differential amplifier which combines the voltages from the other amps. The ratio of the differential voltage gain of an amplifier to its common mode gain is enhanced.

Table 1: Comparison chart of three different amplification elements.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Operational Amplifier</th>
<th>Instrumentation Amplifier</th>
<th>Isolation Amplifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feedback Configuration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. User defined feedback such as voltage or current.</td>
<td>1. Committed feedback.</td>
<td>1. Committed feedback.</td>
<td></td>
</tr>
<tr>
<td>2. Can be configured to provide ( \frac{dV}{dt} ), ( \int Vdt ), ( \log V ), etc.</td>
<td>2. Gain adjustable within fixed limits.</td>
<td>2. Gain adjustable within fixed limits.</td>
<td></td>
</tr>
<tr>
<td>Basic Applications</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Analog computational element.</td>
<td>3. Prevents ground loops.</td>
<td>3. Prevents ground loops.</td>
<td></td>
</tr>
</tbody>
</table>
by selecting low feedback resistors to reduce the effects of input offsets. A problem arises when selecting matched components to build this otherwise cheap circuit. Slight variations in resistors and op amps can make the difference between a working or non-working circuit. (More on that subject will be discussed later.)

EEG and EMG monitoring requires an instrumentation amplifier because of the low input levels; but, when used in a biomedical application, a further modification to the amplifier’s internal design is necessary. The special device is called an isolation amplifier. Transformers or optical couplers inside the amplifier block isolate the sense inputs of the amplifier from the output circuitry. This means that a 2µV signal could be monitored on a 2000V transmission line and the output connected directly to an analog to digital converter input on your computer. The protection works both ways. This is why any connections to the body are done through isolation amplifiers.

An isolation amplifier is to analog signals as an optoisolator is to digital signals. It prevents ground loops from the data analysis equipment (ie: your computer) through the subject. When the electrodes are attached, skin contact resistance is very low: only a few hundred ohms. A leakage current of just 100µA can be fatal. Table 1 summarizes the differences between the amplifiers we’ve discussed.

Choosing an Isolation Amplifier

There have been many articles on the subject of alpha brain wave and muscle monitors; some even include circuit diagrams for construction of the interfaces. The major thing these articles lack is a caution about matching components, and the critical importance of proper layout. The circuit of figure 1, if breadboarded in the usual fashion, wouldn’t have a chance of working on 50µV levels. Even the testing of a handful of components to obtain matched pairs would be useless without concise wiring and plenty of ground plane shielding to reduce 60 Hz interference. Personally, I don’t like to present circuits with so many strings attached that it takes divine intervention to make them work.

The final most important consideration in this undertaking is to not get electrocuted because of sloppy technique. At this point I’d like to draw the line between this article and other construction oriented articles. A cheap method of attaining minimal isolation is to use batteries to power an instrumentation amplifier. This sounds fine in theory, but it is very risky in practice. Too often a...
standard power supply is substituted for the batteries, or a loosely wired component falls against a live wire on another circuit.

Fortunately we can get both safety and performance if we don’t assume that everything has to be constructed from scratch. It is a much better idea to take advantage of commercially available isolation amplifiers. (You wouldn’t build a 4 bit digital counter from transistors, would you?) A perfect choice for this application is the Underwriters Laboratory approved Analog Devices 284J isolation amplifier shown in photo 2. It provides plus or minus 2500 V isolation, 110 dB common mode rejection, and a gain of 10 V per volt. For the experimenter this eliminates building the only tricky section of the interface. An added benefit is that the isolation is now an internal function of the 284J and not a function of installation. Since the ultimate aim of this article is to produce a biofeedback interface for a computer, I don’t want anyone getting injured in the process.

Biofeedback Computer Interface

Figure 2 is the schematic of a circuit which is capable of sensing the minute voltages we’ve been discussing, and signifying to the computer when a present level has been attained. This is a bare bones, basic interface designed specifically for signal acquisition. It would seem to me that this is the area which would give most people problems. The circuit consists of an isolation amplifier module, two gain stages, and a comparator to sense peak level. The completed circuit is shown in photo 3.

All connections to the body are done through M1. The high and low input terminals are attached across the area to be monitored. If it is an EKG output, you should attach the terminals as shown. For biceps input, these two probes would go on the upper arm and the guard connected to the wrist. All leads between the body and the board must be shielded or 60 Hz will be all that is seen on the output. Gain on the 284J amplifier is set by connecting a resistor between pins 1 and 2. When they are shorted as shown, the result is a gain of 10.

ICs 1 and 2 are configured as common inverting amplifiers, each having a gain of 10. Since the signals we want to amplify are relatively low frequency AC, a capacitor is attached at the input of the first amplifier to filter out the DC component of M1’s output. In most cases of muscle monitoring, this total gain of 1000 is sufficient. Picking up brain waves will require additional amplification. Changing the 100 kΩ resistor
Figure 2: Schematic diagram of biofeedback monitor. IC4 is a type 284J isolation amplifier costing $59 plus shipping from Analog Devices, Rte 1 Industrial Park, POB 280, Norwood MA 02062. +V is anywhere from 9 to 15 V and -V is from -9 to -15 V. All capacitors are 100 V ceramic unless otherwise noted. All circuitry should be mounted on a ground plane to reduce AC pickup. Connecting wires should be as short as possible. The electrode cable must be shielded to obtain proper operation.

Table 2: Power pin connections for figure 2 schematic.

<table>
<thead>
<tr>
<th>Number</th>
<th>Type</th>
<th>+5 V</th>
<th>GND</th>
<th>+V</th>
<th>-V</th>
</tr>
</thead>
<tbody>
<tr>
<td>IC1</td>
<td>LM301A</td>
<td>—</td>
<td>—</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>IC2</td>
<td>LM301A</td>
<td>—</td>
<td>—</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>IC3</td>
<td>LM741</td>
<td>7</td>
<td>4</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>IC4</td>
<td>74121</td>
<td>14</td>
<td>7</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

The electrode cable must be shielded to obtain proper operation.

on IC2 to 1 MΩ will increase it another order of magnitude to 10,000. Be aware that raising the amplification also raises the noise on the output. Capacitors in the feedback loops are used in an attempt to keep this noise to a minimum. The amplified analog signal is available at pin 6 of IC2. It can be attached to an oscilloscope if you care to watch yourself in action.

IC3 and IC4 are the interface to the computer. IC3 is a comparator with normally high output. When the signal level from IC2 exceeds the trigger voltage set on R2, IC3 pin 6 goes low, firing the one shot IC4. This signal is in turn connected to a parallel input bit of the computer. Offset potentiometer R1 is adjusted to give 0 V on IC2 pin 6 when M1 is removed and M1 pin 10 is grounded.

Using the Muscle Monitor

Monitoring muscle voltages is much easier than monitoring brain waves. To adequately accomplish the latter, sharp bandpass filters which can separate brain waves from other signal sources must be added to figure 1. As it stands, it cannot differentiate between alpha or theta waves and is optimized for muscle pickup.

To sense the electrical activity of a muscle such as the biceps, three electrodes are necessary. It is not enough to merely wrap three wires around your arm. Special electrodes such as the type shown in photo 4 are necessary. These are referred to as pregelled silver-silver chloride disposable electrodes and they are available through medical supply outlets. The electrodes (shown in photo 5) have a spongy center section saturated with a gel to reduce skin contact resistance. The best results will be obtained by using these or similar attachments.

In the case of the forearm muscles, the
CAST A SPELL.
WIN A SORCERER.
If you've written software in Altair Basic, you've written "spells" for the Exidy Sorcerer.

Now, make it pay off!

There's never enough software. Particularly good software. That's why Exidy is sponsoring a software contest where nobody loses.

Altair programs run on Sorcerer. The Sorcerer computer's Standard Basic is compatible with Altair 4K and BK Basic. So our contest is open to programs — we like to think of them as "spells" or "Sorcery" — written in all three of those Basic versions.

And maybe 99 more good programs. We'll publish a bound book of the best programs entered — up to 100 of them, with full credit to each author. If you enter you can have a copy for just the printing and mailing cost. And if your program is included, you get the book free.

WIN THIS EXIDY SORCERER.

And maybe a free Exidy Sorcerer: Submit one of the four programs judged "best," and win a free Sorcerer computer. (Or choose Sorcerer accessories of equal value.) There'll be one winner in each of the following categories: Business, Education, Fun & Games, and Home/Personal management.

Test-run your entry free. Take your program to any participating Sorcerer dealer. Trade one of yours for one of ours. Just for entering a program in our contest, we'll send you a new, professionally written and documented program. Free. It's a classic game of concentration that's a fun mind-stretcher for both kids and adults. Plus you'll get our new 20" by 24" color poster.

Rules:
1) Entries, including documentation, must be printed by computer or typed double spaced on 8½ by 11 paper, with your name on every page.
2) Enter as many times as you like. This coupon, or a copy of it, must be completed and attached to all entries.
3) Enter at any participating Exidy Sorcerer dealer, or mail entries postpaid to the address on this coupon.
4) Entries must be received by midnight, Aug. 31, 1979. Winners will be notified by Nov. 30, 1979. For a list of winners, send a self-addressed, stamped envelope marked "Winners List" to the coupon address.
5) You warrant, by your signature on this coupon, that all program and documentation material included in your entry is entirely your own original creation, and that no rights to it have been given or sold to any other party, and you agree to allow Exidy to use, publish, distribute, modify, and edit it as it sees fit.
6) All entries become the property of Exidy, Inc. No entries will be returned, nor any questions answered regarding individual entries. No royalties, payments or consideration beyond the items set forth in this advertisement will be given to any entrant.
7) Judging will be by a panel of experts chosen by, and including representatives of, Exidy, Inc. Judges may assign programs to whichever entry category they consider appropriate. Decision of the Judges is final.
8) Employees of Exidy, Inc., its dealers, distributors, advertising agencies and media not eligible. Void where prohibited, taxed or restricted by law.
Photo 5: The electrode has a saturated spongy center which serves to reduce skin contact resistance. It is necessary to use this type of connection to the body if satisfactory results are to be obtained.

Text continued from page 53:

high electrode (shown in photo 6) is placed on the wrist, the low electrode on the upper arm, and the guard on my chest, close to the shoulder. When the muscles of that arm are flexed, a large pulse will appear at the analog output terminal of the interface. It is best seen with an oscilloscope. Every movement produces some noticeable deviation in the trace. If the trigger adjustment R2 is set above the ambient noise at the peak of this large pulse, it will fire the one shot every time the muscle is flexed. Actually, adjustment can be much finer. With the electrodes placed as in figure 1 (the guard is on my chest again), they can pick up something as insignificant as moving your eyebrows or gritting your teeth. The setting is made higher than the level produced when talking or breathing, so that it can be used as a suitable control input to the computer.

Biofeedback Computer Control

Control is the name of the game. Consider someone who is almost totally paralyzed. This system could be used (perhaps by sensing eyebrow movement) as an on/off switch to a more sophisticated controller. I've seen one computer aid for the handicapped which consisted of an alphanumeric sequencing display. Letters could be individually chosen and eventually combined to produce whole written messages. A lot can be accomplished with a single bit of input if the software is written with time as a pertinent consideration. A single switch could signify a particular choice if each was presented in sequence with time allotted to answer. That is the premise of the BASIC program in listing 1.

This is a simple program written in Micro Com 8 K Zapple BASIC. It presents the operator with a series of seven choices, and branches to special subroutines as a result of these choices. It presumes that the user can see and signify positive response by a high logic level on bit 0 of input port 3. This bit is tied to the output of our eyebrow twitch monitor. Output port 17 has seven lights attached to bits 1 through 7 (bit 0 not used). The program lights the first light, and the user decides whether or not the computer should perform the activity signified by bit 1. If so, the user merely furrows his or her brow and the program jumps to the designated activity. In this simple illustration, I merely flash the light a few times to indicate which was chosen. Should the operator not care for the first choice, the program sequences to the next choice, and so on. Before hook-
One of three exciting new options from Ohio Scientific.

Color. With it there is a big difference. And now, Ohio Scientific offers a lustrous 16 color option on all its C2 Series Computer Systems, past and present. New orders for C2-4P and C2-8P’s can now request the color option. Upgrade kits are available for all existing C2’s. When coupled with the C2’s demonstrated high resolution graphics, the new color display is striking.

The relatively easy add-on of color and other options discussed here are interfaced through the new 540 B video board and are realized without extensive modification or excessive cost because the C2 family of computers feature exceptional “design for the future” modular construction that permits one sector of the computer to be modified without affecting other sectors.

Sound.
The sound option further enhances enjoyment of the C2’s while broadening their scope of applications. Games of logic and dexterity now seem to come alive when sound pops out from on-screen happenings.

This new option is implemented through the new 542 Rev B keyboard available with new C2 orders or as part of an upgrade kit. In addition to a standard tone generator, this new board also contains a D/A (digital to analog) converter that takes advantage of the power and ultra high speed of the C2’s 6502 microprocessor to enable users to generate both limited band-width speech and complex musical chords.

AC-12 Remote AC Control System.
This unique option enables a C2 user to create a computerized wireless home control facility with simple effort and at heretofore unheard of low cost. The AC-12 provides a control signal on the home’s AC power line not unlike the manner in which wireless intercoms function. The AC-12 will plug into any C2 computer that has the new 540B video board.

The basic system contains a command console and four remote modules. The remotes can be appliance modules that can switch up to 15 amps, lamp modules that can provide on-off, dimming and brightening, or wall switch modules.

The AC-12 has a special Home Control OS-65D V 3.0 Mini-Floppy Disk Operating System that provides a wide range of capabilities not the least of which is “Foreground and Background” operation. This allows the computer to monitor time and inputs for the Home Control System, while running other BASIC programs!

New options:
Color and Sound Option on C2-4P and C2-8P ......................... Add $200
CA-11B 540B color video board for system upgrades (does not include 542B sound keyboard) ......................... $225
CA-11C 540B color video board and 542B sound keyboard. (For upgrades) ......................... $299
AC-12 Remote AC control system, including console, four remotes and software. For use on any system with a 540B video board ......................... $175

Color. Sound. AC Remote Control.
Three more examples of Ohio Scientific’s continuing enhancement of its computer products and user benefits.

Contact your local Ohio Scientific dealer.

Ohio Scientific
1333 S. Chillicothe Road • Aurora, Ohio 44202
(216) 562-3101

Circle 290 on inquiry card.
100 REM This program demonstrates how the computer can be
110 REM used to provide control output from an EMG digital input
120 REM EMG input is on port 3 bit 0. No stimulus is logic 0
130 REM While muscle activity is indicated by logic 1.
140 REM Text appears on the screen / lights on the lights until the
150 REM output port 17. The computer sequences thru the lights until the
160 REM operator signifies a choice by --"THINKING"-- about it!!!
170 REM
180 REM Copyright 1979 STEVE CIARCIA
190 REM
200 REM
210 FOR I = 0 TO 300 : NEXT D
220 REM
230 REM This routine sequentially flashes bits 1 through 7 of port 17
240 REM if only exists when an input flag has been set by the EMG monitor
250 B=1
260 X=2 IB : OUT 17 , X
270 GOSUB 440
280 IF F=1 THEN OUT 17, 1 : GOTO 210
290 B=2 THEN OUT 17, 2 : GOTO 210
300 B=3 THEN OUT 17, 3 : GOTO 210
310 B=4 THEN OUT 17, 4 : GOTO 210
320 B=5 THEN OUT 17, 5 : GOTO 210
330 B=6 THEN OUT 17, 6 : GOTO 210
340 B=7 THEN OUT 17, 7 : GOTO 210
350 IF B=7 THEN STOP
360 REM
370 REM
380 FOR T=0 TO 10
390 REM
400 REM
410 REM
420 REM This routine reads the EMG monitor on port 3 bit 0
430 REM if signal is present it sets flag F=1
440 A=0: IF F=0 THEN GOSUB 210
450 IF F=1 THEN GOSUB 210
460 REM
470 REM A-M-1 IF A=200 THEN RETURN :REM dive operator line to respond
480 GOTO 420
490 F=1
500 REM
510 IF G=1 THEN G=0 : GOSUB 210
520 REM
530 REM
540 REM
550 REM These 7 routines can be replaced with outputs to
560 REM individual control programs.
570 PRINT "e=1" : GOSUB 210
580 PRINT "e=2" : GOSUB 210
590 PRINT "e=3" : GOSUB 210
600 PRINT "e=4" : GOSUB 210
610 PRINT "e=5" : GOSUB 210
620 PRINT "e=6" : GOSUB 210
630 PRINT "e=7" : GOSUB 210
640 REM
650 REM
660 REM This routine flashes individual light to indicate selection
670 FOR I = 0 TO 10
680 OUT 17 , I
690 FOR II = 0 TO 9 : NEXT II
700 OUT 17 , II
710 FOR III = 0 TO 9 : NEXT III
720 NEXT I
730 RETURN

Listing 1: BASIC program to sense input from the biofeedback monitor. This program scans the cursor through several choices and waits a short period of time. If the user squints or blinks within the allotted period, that choice is designated. If it is not designated, it cycles to the next choice. This particular program just blinks the chosen objective to indicate that the interface is working. The required body connections for picking up eyebrow movement are shown in photo 1.

up, the program can be easily tested with the muscle monitor by temporarily attaching a normally closed, pushbutton switch on port 3 bit 0.

Conclusion

All of this effort for a single bit of data acquisition may appear unjustified, but it can prove to be exceedingly significant in situations where no other means of computer interaction is available. At the least, the interface should provide a substantial base for biofeedback experiments. With additional amplification and filtering to monitor brain waves, a whole series of challenging experiments come to mind. Personal computing need not be relegated to the level of canned amusements and commercial presentations. A refinement of this interface could be the one critical design feature which would open the field of personal computing to individuals who are otherwise physically unable to take advantage of it.

If you have any questions on this or any other "Ciarica's Circuit Cellar" article, or just a good idea, please don't hesitate to write. While it may take some time, I do eventually answer all inquiries. Please enclose a self-addressed stamped envelope.

Next month the "Circuit Cellar" topic will be sound generators.

PET PRINTER ADAPTER

GET HARD COPY FROM YOUR
COMMODORE PET USING A
STANDARD RS-232 PRINTER

PET PRINTER ADAPTER

The CmC ADA 1200 drives an
RS-232 printer from the PET
IEEE-488 bus. Now, the PET
owner can obtain hard copy
listings and can type letters,
manuscripts, mailing labels,
tables of data, pictures, in-
voices, graphs, checks, needle-
point patterns, etc., using a
standard RS-232 printer or
terminal.

$98.50 ADA 1200B
$169.00 ADA 1200C

$98.50 ADA 1200B
Assembled and tested

$169.00 ADA 1200C
With case, power supply
and RS-232 connector

Order direct or contact your local computer store.
Add $3.00 for postage and handling per order.

CONNECTICUT MICROCOMPUTER
152 POCONO RD, BROOKFIELD, CT 06804
(203) 775-9659
TLX: 7104560052

Circle 78 on inquiry card.
The party's over for all dumb terminals and a lot of smart ones too. But, at $798 (quantity 25), the party's just beginning for Intertec's InterTube II.

Standard features to celebrate include a full 24 line by 80 character display, 128 upper and lower case ASCII characters, reverse video, complete cursor addressing and control, an 18 key numeric keypad, special function keys, blinking, protected fields, character and line insert/delete, editing, eleven special graphics symbols, a 25th status line which displays the terminal operating mode and an RS-232 printer port.

You'll discover even more reasons to celebrate when you sit down in front of an InterTube II. Our wide bandwidth monitor produces crisp, sharp characters everywhere on the screen. InterTube's Z-80 processor enables a host of operator oriented features to boost the efficiency of both software and programmers. And, InterTube's rugged modular design combined with its built-in self-test mode insures quick and reliable servicing.

InterTube's price/performance ratio can satisfy your requirements whether they be a sophisticated data entry application or a simple inquiry/response environment. So, there's really no reason to think "dumb" when you can afford to be so smart!

Join the thousands of InterTube celebrations going on around the country at this very moment. Call us at the number below and start your own celebration (BYOB—we'll bring the InterTube).

2300 Broad River Road, Columbia, S. C. 29210
(803) 798-9100 TWX: 810-666-2115

Circle 182 on inquiry card.
The sales literature for the Apple II lists the specifications for the high resolution color graphics mode this way:

- 280 horizontal by 192 vertical resolution.
- Four colors: black, white, violet, and green.
- Displays 8 K bytes.

The specifications don't sound all that exciting. The resolution seems about right, but why are there so few colors? And why did they pick green and violet instead of, say, red and blue? Well, as it happens, the colors in the Apple II high resolution graphics can be red and green, or blue and yellow, or almost any two complementary colors you want. What's more, on many color television sets you can obtain as many as four colors along with black and white, as demonstrated by the accompanying photograph.

More Colors for Your Apple

The classic approach to computer generated color is to generate separate signals for the red, green, and blue inputs of a color monitor. However, color monitors are expensive; it's more economical to use an ordinary color television set. Now instead of generating three simultaneous video signals, we have to generate a composite signal that resembles the standard broadcast signal the television set was designed to receive.

It's not merely that the signal has to be put onto a regular television channel by means of a radio frequency modulator; although that's certainly necessary, there's a lot more to it. Since all the fascinating features of the Apple II high resolution color graphics are the results of the way the Apple II designers solved this problem, let's take a look at just what they did.

The Color Signal

The standards for broadcast color television signals were established by NTSC (National Television Systems Committee) and approved by the Federal Communications Commission in 1953. In order to retain the existing system of black and white television broadcasting, the committee system adds color information to a signal which is practically identical to the black and white standard. The resulting composite signal includes a black and white component that amplitude modulates the television carrier frequency in the usual way, and a color component which rides on a 3.58 MHz subcarrier.

This superposition of color and black and white information is necessary in order to crowd a full color video signal into a channel whose high frequency response is limited to just over 4 MHz. The fact that human vision does not resolve image details in color allows us to limit the resolution of the color component of the signal to a maximum of 1.5 MHz. In fact, only part of the color signal gets even this much; the rest is limited to 0.5 MHz.

This narrow band color signal modulates a 3.58 MHz subcarrier which is then added to the black and white picture information. The color subcarrier modulation is a combination of amplitude and phase modulation: the amplitude of the subcarrier corresponds to the amount of color at each point on the screen, while the choice of color is determined by the phase of the color frequency relative to a 3.58 MHz reference signal. This reference signal is generated in the television set from a burst of 3.58 MHz transmitted in the interval between the lines of the picture.

A high subcarrier frequency reduces interference between the color and black and white components because the black and white signal contains less energy at high frequencies. Interference is further reduced by the fact that the subcarrier frequency is an odd multiple of half the picture scanning rates, both horizontal and vertical. This makes any color signal that gets into the black and white video reverse polarity on successive lines; the interference makes little dots in the picture, but the dots on one line will have "undots" above and below. These will tend to average out when viewed from a reasonable distance.

This is where the signal generated by the Apple II deviates radically from the standard signal. First of all, the Apple II signal omits a technique called interlacing, thus reducing the number of horizontal scanning lines by half and likewise the amount of information needed to fill the screen. Noninterlacing is common among low cost computer video displays. The significant deviation from the standard, however, is a slight change in the horizontal and vertical scanning rates such that the interference between the color and the black and white components is maximized, rather than minimized. This is not as strange as it sounds, because this is what en-
ables the Apple II to generate color graphics with a signal made up only of ones and zeroes.

An Example

To see what this does to our display, suppose we try to display two small white dots side by side. The smaller the dots and the closer they are to each other, the higher the highest frequency picture signal going into the television set. But everything the Apple II puts out at the high end of the frequency range gets decoded as color, so that, even before our dots are made too small and too close together for a black and white set to be able to distinguish, something else has happened: they have merged into a single dot, and it isn't white, but color.

In other words, the resolution we can get using this method is somewhat limited compared with the separate red, green, blue approach, although it is produced with correspondingly less screen memory (ie: 8 K bytes compared with 24 K bytes). But even if the color interference were minimized, the television set's receiving circuits limit the horizontal resolution to about 300. Incidentally, this is why the Apple II displays only 40 characters in each line of text; the more popular 64 or 80 characters cannot be resolved by a standard color television.

Bits and Resolution

As we have seen, the Apple II produces color by simply putting its smallest dots at the right size and spacing: namely, the color subcarrier frequency. Each dot is really a half cycle, so the dot rate is twice the subcarrier frequency, or something over 7 MHz. Let's see how many of these dots will fit on one horizontal line. There is one horizontal scan every 63.5 µs, but part of this time is needed to get the electron beam into position to start the next line, and to keep the lines in synchronization. The picture signal is shut off, or blanked, during this time. That leaves about 45 µs, but just to play it
safe and to make sure that none of our valuable data gets cut off by the television set's normal overscan (the picture is set up to be bigger than the actual screen so there won't be any unsightly black borders), Apple II uses only about 40 µs of each line for data. This works out to 280 dots per line. In text mode, with 40 characters per line, this gives a character time of about 1 µs, which corresponds to the Apple II's system clock. Each character takes seven dot times, five for the character and two for spacing between characters.

The question is, exactly what does horizontal resolution of 280 refer to? Well, we can put a single dot at any of 280 different positions across the screen, but our dot will be colored, since it is a half cycle at the color subcarrier frequency. And if we put two dots too close together, they merge. Obviously, if the two dots are actually touching, no set could resolve them — this is really a single spot which happens to be two dots wide. But even if we put a black dot in between, we'll see only one dot, in color, because the dot spacing matches the color subcarrier frequency. Only by putting two or more black dots between our white dots will we be able to see a clear separation.

These relationships are diagramed in figure 1. The color reference signal is shown at the top. Any signal component at this frequency, even a single dot, will be displayed as colored. Theoretically, a double width dot contains no color frequency component, and hence will be displayed as white.

### Apple II High Resolution Colors

Now we can see how the trade-off between color and resolution affects the way our computer bits are displayed by the television set. But let's look on the bright side: with the right bit patterns, we can put colors onto the screen. Let's ignore the resolution problem for a while and investigate the colors.

If we fill the screen memory with ones, the display will be all white; all zeroes paints it black. If we alternate ones and zeroes horizontally, we have a signal which is right at the color frequency, so it is displayed as a solid color. Now comes the interesting part — what color is it? As I mentioned earlier, the color is determined by the phase of the picture signal's color frequency component relative to the color reference signal, which is generated by the television set from the 3.58 MHz color burst which we transmit during the horizontal blanking interval. So our question becomes, "How can we control the relative phase of these two signals?"

First of all, our computer bits are output every half cycle of the color reference frequency. This means we can change the phase by 180 degrees by simply inverting the bit pattern so that alternating ones and zeroes become alternating zeroes and ones. Interestingly enough, since the color spectrum is allocated the 360 degrees of possible phase angles that we can have, complementing the bits also complements the color; that is, phase inversion amounts to 180 degrees of phase shift, and complementary colors are 180 degrees apart. The relation of color to phase angle is shown in figure 2. If the alternating bits are in phase with the color reference signal, the color will be yellow-green; out of phase bits will give us blue-violet. This determines the two colors Apple II specifies in addition to black and white. But there is another way to change the relative phase of our computer bits.

While we can't do this under computer control, we can manually adjust both the Apple II video circuit and the color television set so as to change the phase of the color reference signal itself. The Apple II control is labeled color trim; the television set's control for this is usually called tint or

---

**Figure 1:** Colors produced by various bit patterns in relation to the color reference signal.
The Only Computer Reference Book You Need.

The Only Reference Book You’ll Ever Need.

The only book that gives you all the ingredients for a successful computer system. Interested in the Apple II²™? You’ll need an FCC-approved RF modulator to connect it to your color television set. We tell what they are, where to get one, and how to hook it up.

Thinking of using Radio Shack’s TRS-80™ for a low-cost word processing system? You’ll need an upper-case/ lower case modification for the keyboard. We’ll tell you what it involves, where to get it done, or how to do it yourself.

Software? We’ve sampled canned software and will tell you what suits our taste. Rather do it yourself? We have algorithms in our machine-independent “Cookbook” language for everything from fast sorts to phototypesetter hyphenation. Plus a crash course in BASIC for those who know FORTRAN. And much, much more.

Last but not least: The Cookbook Yellow Pages, a complete guide to small computer services and products. We update the Yellow Pages every two months—and send them to you free with the latest additions, corrections, and improvements of our white pages. You just plug them into our loose-leaf binder.

Get with The Cookbook. The Best Is Yet to Come.

Send me The Cookbook. I enclose $15 plus $1.50 for shipping, which will be by UPS unless I’ve marked this form U.S. mail (___ check here). California residents add $.98 sales tax. Allow up to four weeks for possible out-of-stock conditions. Make checks payable to “The Computer Cookbook”. Mastercharge and VISA accepted with 13-digit card number and 4-digit expiration date.

Name
Street
City _______ _______ _______ _______ Zip

Mail to: The Computer Cookbook / P.O. Box 4084 / Berkeley, CA 94704

Circle 52 on inquiry card.
hue. The combined range of adjustment of these two controls is usually enough to go at least halfway around the color circle of figure 2, putting one or the other of our complementary pairs of colors at any point on the circle. Thus we can adjust for any pair of complementary colors we want: blue and yellow, green-blue and orange, cyan and red, green and magenta, or yellow-green and violet. So long as we don't require the ultimate in horizontal resolution, we can have any two complementary colors plus black and white for our high resolution graphics using only ones and zeroes as data. If the colors listed above and in figure 2 don't seem exactly complementary, it's largely because of the broad range of hues to which we carelessly apply the name blue. If we let the television picture-tube phosphors define our red, green, and blue, then the complementary colors are those of figure 2. The television set is adjusted such that red + green + blue = white. Since complementary pairs also add together to give white, it follows that the sum of any two of the three primaries gives the complement of the third: for example, the complement of red is actually green + blue, or cyan.

Extra Colors

Studying the Apple II specifications in the light of the National Television Systems Committee color standards led me to expect it to work this way, but that isn't quite the end of the story. After I got my Apple II, as I was casually watching the random sine wave program on the high resolution demonstration tape, there in living color was a display with four colors. After a bit of head scratching and experimenting with the adjustments on my portable color set, I think I have the explanation.

First of all, the single dot patterns give the two complementary colors, just like it says in the script. Alternating double dots, which ought to be displayed as black and white, actually show up as a weaker version of the same pair of complementary colors if the television set is adjusted normally, that is, with the fine tuning just backed off from the setting that first produces sound bars in the picture. But if I back the fine tuning farther away from this setting (any automatic fine tuning or tint controls should be switched off), just before the color signal drops out, the weak colors on the double dot patterns brighten and shift to another pair of complementary colors. The exact colors depend upon the setting of the tint control, but they are more than 30 degrees from the first pair, so if the single dot patterns give red and green, for example, the double dot patterns appear as orange and blue.

It's hard to figure out how the double dot patterns get displayed in color since they are square waves at half the color frequency and ought to contain a zero component at 3.58 MHz. Apparently the video detector circuit in the set produces enough second harmonic distortion to activate the color circuits. Mistuning puts this signal near the cutoff of the color bandpass filter where there is maximum phase distortion. I tried this out on the more expensive television set at the store where I bought my Apple II, and although it's more difficult to get the adjustments just right, the extra colors are there. Ironically enough, this trick seems to work better on cheap sets.

So there you have it. Whether you prefer colors or resolution, the Apple II high resolution graphics will put out all you can get through the antenna terminals of a color television set with just different patterns of ones and zeroes. To find out what your set will do, you need to display vertical lines with the single dot and double dot patterns. An easy way to do this is to load the Apple II high resolution demonstration tape and select the program that sums two sine waves. When the program asks for two frequencies, enter 63 and 64 to get the pattern shown in photo 1. Other numbers you may want to try are combinations of 31, 32, 33, 63, 64,
The Intecolor 8070 business system. At twice the price, it would still be inexpensive.

Because ISC is the world's leading manufacturer of color terminals, we're able to offer unparalleled color performance—at phenomenal prices.

* Our 8070 Series 1 Business System is a perfect example of reliable, yet extremely reasonable products. It's a complete 8080A microcomputer system that includes the following standard features: A dual floppy disk drive with 591K bytes of storage; a 19" color data display with an easily readable 80 characters x 48 line format; and a 60 CPS Impact Matrix printer. All for a remarkable $7000, single unit price.

And that price doesn't stop at hardware. Intecolor's 18K Business BASIC in ROM has 16 digit accuracy and a

PRINT USING feature that tails output to any specifications.

If you need greater storage capabilities, choose the 8071—same system, but with a dual double-headed floppy disk drive. Giving you 1182K bytes of storage, for only $800 more, single unit.

Either way, the Intecolor Series 1 can relieve your business of a considerable amount of paperwork, without costing you a great deal of money.

(Terms—5% discount for prepayment, or net 20 days)

For more information and a complete demonstration, see your nearest computer store, or contact your ISC sales representative.

Color Communicates Better
APPLE OWNERS:
You chose the best.
Now, make it better!
With our exclusive Superchip (ROM firmware) your APPLE can deliver the best of both—graphics and text-processing.

- Full ASCII character set (lower case)
- 31 other, useful non-ASCII characters
- User-defined characters with our Character Edit Cassette
- Enhanced editing capabilities for program and data modification
  And, it works with your existing APPLE programs—Integer BASIC and Applesoft ROM.
- The Character Edit program defines each new character in a magnified format with a few easy key strokes.
- Since you can now build characters, you can also create new character sets—foreign alphabets, music, games, whatever.

NOW YOU CAN ALSO GET
- Disk Interface Program—Superchip now runs with Disk II
- Word Processor I—a disk-based mini-word processing system.
  (Requires Disk Interface Program, above.)
The Superchip plugs into your APPLE with no modification.

ORDER
NOW
SUPERCHIP Character Edit cassette
Disk Interface Program cassette
Word Processor I cassette
Shipping Charge (each)

I attach check or money order for $___________.
Or, charge my: □ VISA □ Master Charge
Bank Card No. ____________________________
Expiration Date ___________________________
Name ___________________________________
Address ___________________________________
City ______ State ______ Zip ______
Signature ___________________________________
Telephone orders accepted with charge card:
214-358-1307

ECLECTIC CORP.
2830 Walnut Hill Lane, Dallas, Texas 75229
A Subsidiary: TANO Corporation

65, and 95. Apparently there is a lot of sampling error when the frequencies you select don't fit the table the program uses to generate the sine waves. If you experiment until you find the limits of your particular television set, you'll know how to make high resolution pictures on your Apple II in just about any colors you want.

BIBLIOGRAPHY

Addendum

The following comments were received from Steve Wozniak of Apple Computers:

Thank you for passing along Allen Watson's article on the Apple II high resolution colors.

As Allen discussed, Apple II high resolution colors are the result of alternating zeroes and ones on the screen. The exact colors generated depend on the phase (or timing) relationship between the display signal and the color reference phase. By adjusting the television controls, any desired color pair may be displayed.

Oddly enough, only the seven least significant bits of the Apple II high resolution refresh memory bytes are used (examples are shown in figure 7). A simple modification allows the high order bit of each to specify one of two color sets by generating a 90 degree phase shift of displayed information. (Yet more colors may now be obtained by applying the technique suggested by Allen.)

Adding the High Order Bit Modification to the Apple II

1. Remove the Apple II printed circuit board from its enclosure.

   (a) Remove the ten screws securing the plastic top piece to the metal bottom plate. Six of these are flat head screws around the perimeter of the bottom plate and four are round head screws located at the front lip of the computer. All are removed with a Phillips head screwdriver. Do not remove the screws securing the power supply or nylon insulating standoffs.

   (b) Lift the plastic top piece from the bottom plate while taking care not to damage the ribbon cable connecting the keyboard to the printed circuit board. This cable will have to be disconnected from one or the other.

June 1979 © BYTE Publications Inc
Circle 114 on inquiry card.
At Last! After Two Years and $250,000... Software Programs for the Multi-Billion Dollar Real Estate Market.

There are 240,000 offices nationwide serving the ever-growing Real Estate market. Not surprising when you consider that 60% of the United States' assets are represented in Real Estate properties.

Until now, there has been virtually no interfacing of data processing with this powerful, potent market. Until REALTY SOFTWARE CO., that is. We've combined the best of both worlds and spared no expense in producing Software that is sophisticated enough for the largest Realtor... yet extremely easy to use.

In fact, our instruction manual offers Screen-by-screen displays enabling a novice to breeze through the entire program!

We've already sold complete systems to Realtors for $19,990! You can get in on the action for less than 3% of that amount!

Our floppy disk PROPERTY MANAGEMENT program runs on DEC station 78 & 88 series and type 8080 or type Z-80 with 48K of memory, single density dual disks operating under CP/M®, a 132 character printer and a CRT terminal.

MAIL COUPON OR CALL...
TOLL-FREE
(800) 648-5311

ATTENTION DEALERS: Realty Software Co.'s Software systems for the Real Estate market can be profitable for you. Inquire today for full details on programs including Portfolio Analysis, Tax Deferred Exchanges, Income Tax Analysis, Cash Flow Analysis, Amortization & Depreciation and much, much more. RSVP by phone or mail.

Mail to: REALTY SOFTWARE CO.
2126 Lombard St. / San Francisco, CA 94123

I'll cash in on the multi-billion dollar Real Estate Market! Send me your PROPERTY MANAGEMENT software complete with 200 pg. manual for $595.00 (shipping & insurance included / CA residents add sales tax).

Mail coupon or call toll-free (800) 648-5311

CIRCLE 323 ON INQUIRY CARD.
Figure 3: Circuit which must be added to the Apple II to add more colors to the high resolution display. (Caution: Adding this circuit voids the warranty.) A starred assignment (*) indicates that the connection is made to a pin which is out of its normal socket. Besides the connections which are shown, also connect pin (B8-14) to (A8-6) which is out of its socket, and (B8-7) to (A8-13) which has also been removed from its socket. The power connections to the 74LS02 are +5 V to pin 14 and ground connected to pin 7.

(c) Disconnect the power supply from the printed circuit board.

(d) Remove the #8 nut and lockwasher securing the center of the printed circuit board. These will not be found on the earlier Apple II computers.

(e) Carefully disengage each of six nylon insulating standoffs from the printed circuit board (seven on earlier versions).

(f) Lift the printed circuit board from the bottom plate.

2. Above the board wiring method.

(a) Lift the following IC (integrated circuit) pins from their sockets.

<table>
<thead>
<tr>
<th>IC</th>
<th>Pin Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>A8</td>
<td>1</td>
</tr>
<tr>
<td>A8</td>
<td>6</td>
</tr>
<tr>
<td>A8</td>
<td>13</td>
</tr>
<tr>
<td>A9</td>
<td>1</td>
</tr>
<tr>
<td>A9</td>
<td>2</td>
</tr>
<tr>
<td>A9</td>
<td>9</td>
</tr>
</tbody>
</table>

(b) Mount a 74LS74 (dual D flip-flop) and a 74LS02 (quad NOR gate) in the Apple II breadboard area (A11 to A14 region).

(c) Wire the circuit in figure 3.

3. Below the board wiring method.

(a) Desolder all pins of socket A8. Lift the socket and its 74LS257 integrated circuit off the printed circuit board taking care not to destroy it. Cut the trace between pins 6 and 13 of A8 on the top side of the board. Also cut the trace between pins 13 and 15 on the top. Reinsert socket A8 and the 74LS257. Be careful.

(b) Cut traces going to the following pins on the bottom of the Apple II board. Each pin should have a single trace going to it. Be careful.

<table>
<thead>
<tr>
<th>IC</th>
<th>Pin Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>A9</td>
<td>1</td>
</tr>
<tr>
<td>A9</td>
<td>2</td>
</tr>
<tr>
<td>A9</td>
<td>9</td>
</tr>
<tr>
<td>A8</td>
<td>6</td>
</tr>
<tr>
<td>A8</td>
<td>13</td>
</tr>
</tbody>
</table>

(d) Connect pin 15 of ICA9 to ground (pin 8 of ICA7 on the keyboard socket is a nearby ground).

(e) Mount the 74LS74 and 74LS02 as per step (b) of the above the board wiring method.

(f) Wire the circuit of the above the board wiring method, step (c). All wires are on the bottom of the Apple II board and no pins need be removed from their sockets or soldered to.

4. Reassemble the Apple II and make sure it is operational. If not, check all wiring very carefully. Make sure that all integrated circuits are in their sockets and properly oriented.

5. The following color values are now applicable to the high resolution subroutines:

<table>
<thead>
<tr>
<th>Color</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BLACK2</td>
<td>128</td>
</tr>
<tr>
<td>ORANGE</td>
<td>170</td>
</tr>
<tr>
<td>BLUE</td>
<td>213</td>
</tr>
<tr>
<td>WHITE2</td>
<td>255</td>
</tr>
</tbody>
</table>

For example, the program below draws an orange line from location (10, 20) to (200, 140). It is assumed that the high resolution routines are already in memory locations hexadecimal 800 thru BFF.

```plaintext
0 X0 = Y0 = COLR
5 INIT = 2048 : PLOT = 2830 : LINE = 2836
7 ORANGE = 170 : CALL INIT
10 X0 = 10 : Y0 = 20 : COLR = ORANGE : CALL PLOT
20 X0 = 200 : Y0 = 140 : CALL LINE
30 END
```
Look how soft you can have it with a Compucolor II® personal computer.

When you have a Compucolor II — the exciting color personal computer with a built-in mini-disk drive — you really have it soft. $19.95 is all you pay for most Compucolor Sof-Disk™ albums.* They're formatted to run only on the Compucolor II, and each contains at least three programs. That's far better value and variety than you get with programmed cassette tapes. And the Sof-Disks you see here are just a sampling. New introductions are added each month.

To start your collection of mind-blowing games and other useful programs, visit your nearest computer store. Or, if there's no dealer in your area, clip the coupon and mail your order today.

First things first! If you'd like more information, simply check the coupon for a free brochure about the Compucolor II.

---

*See ad for varying prices on Assembler, Text Editor, and Personal Data Base Sof-Disks.
A Home for Your Computer

Joseph Dawes
2510 Broadway
Big Spring TX 79720

If you're good at woodworking, here's a project that will save you a lot of time and trouble: build a cabinet for your computer! A carefully planned cabinet, as any ham or hi fi buff knows, serves to increase the utility and enjoyability of the equipment inside it.

I started planning my computer system cabinet as soon as I scattered my components around the cabinet I had made for my amateur radio gear. First of all, the cassette unit had to be fastened down: I quickly tired of holding it in place with one hand while unplugging something or changing a cassette. The power supply was constantly running warm and I knew it should be on stilts to increase heat loss. My separate video monitor could have ended up either beside the processor-keyboard cabinet or on top of it, but I quickly decided to reserve the top of the processor cabinet for a desk. The monitor would be beside the processor but angled toward the operating position for improved visibility. The keyboard had to be at a comfortable typing height, somewhere from 28 to 30 inches from the floor.

With these parameters in mind, I had to decide on cabinet style. The styles that first came to mind were the living room furniture piece with finely grained wood and the hobby room piece with modest wood grain or painted wood. However, circumstances led me to develop a somewhat different cabinet style. I hope my final design will prompt readers to forge ahead with their own cabinet ideas.

The need to transport the system outside my home, combined with my dislike for connecting and disconnecting wires, dictated the cabinet design shown in figure 1 and photos 1 through 3. If I wanted to demonstrate it at the school where I teach or elsewhere, it would have to be operable as soon as it was opened and plugged in. Nothing kills interest more than 30 minutes of wire fiddling.

The cabinet shown is sturdy enough to take some licks in a truck or car. While it is closed and bolted, a bicycle chain can be run through the two U-bolts and around the nearest oak tree, making it very inconvenient to move or to open without some commotion. When the lid is taken off the equipment base, it can be turned up one side to become a pedestal upon which the equipment base can be set. The whole affair is quite stable when set upon a reasonably level surface, and the lid interior provides knee room and space for keeping notebooks and demolished programs. When closed it can be sat upon, and, although there's absolutely no way to lug it around in a VW beetle, it will fit in the back (not the trunk) of my 2 door Falcon with a little imaginative stevedoring. In short it does what I require very nicely, and if I had to...
Figure 1: Plans for building the author's computer system cabinet. The unit is built from 5/8 inch plywood and features two U-bolts for adding an antitheft chain. All components are mounted on the floor of the cabinet. See accompanying photos.

build it over again I can think of very little I would change. After I painted the inside of the lid, it looked fine in a corner of the living room. What more could one ask?

Some comments on construction details might be helpful. The size of the equipment base is dictated strictly by the dimensions of the equipment to be placed on it. The width of the base, however, should not be much wider than 25 inches or the work surface will be too high for operating comfort when the cabinet is open (unless you like to stand while you work). Note that all equipment must fit within the dotted line perimeter shown in the equipment base drawing. Otherwise, equipment may get damaged by the bolt rails! I cut the plywood pieces for the lid with a smooth cutting plywood blade in my table saw and took great care to make cuts exactly to dimension, because the whole lid was assembled by gluing the side pieces to the top. The small gluing blocks are tack-nailed in place while the glue dries. These blocks are for structural reinforcement and do not hold the lid together while the glue sets. Bar or pipe clamps must be used to provide the necessary pressure. A cabinet-making friend or a school shop might be a good source for these if you have none. The only permanent metal fasteners used are the two screws through the base into each runner, and they serve primarily as gluing clamps as well.

The bolt rails are glued around the inside edge of the lid (Be certain to recess them a
ANNOUNCING

New from DEC
LA34 DECwriter IV
$1,199.00

- 110 or 300 baud, RS 232C serial
- Upper/lower case, 9 x 7 dot matrix
- Friction feed, paper width to 15"
- 10, 12, 13.2, 16.5 characters/linch
- 2, 3, 4, 6, 8, or 12 lines/linch
- 22"W x 7"H x 15 1/2"D, 25 lbs.

To Order: Send certified check (personal or company checks require two weeks to clear) including handling & 6% sales tax if delivered within California.

Handling: Less than $2,000, add 2%; over $2,000, add 3%. Everything shipped freight collect in factory cartons with manufacturer's warranty. Visit MICROMAIL at the National Computer Conference — Personal Computing Festival, New York City, June 5-7, Booth 128.

To Order: Send certified check (personal or company checks require two weeks to clear) including handling* and 6% sales tax if delivered within California.

*Handling: Less than $2,000, add 2%; over $2,000, add 3%. Everything shipped freight collect in factory cartons with manufacturer's warranty. Visit MICROMAIL at the National Computer Conference — Personal Computing Festival, New York City, June 5-7, Booth 128.

New from DIABLO
DIABLO 1640 $2,690.00
Receive-only $2,331.00
High-quality daisywheel printing at 45 cps.

DIABLO 1650 $2,779.00
Receive-only $2,419.00
Metal daisywheel printing at 40 cps.

SOROC IQ 120 $795.00
- RS 232C, upper/lower case full ASCII
- Numeric keypad, protected fields
- Cursor keys plus addressable cursor
- Auxiliary extension port

SOROC IQ 140 $1,250.00
- RS 232C and 20mA current loop
- Extensive editing features
- 25th line terminal status display
- 16 function keys (32 with shift)

To Order: Send certified check (personal or company checks require two weeks to clear) including handling* and 6% sales tax if delivered within California.

To Order: Send certified check (personal or company checks require two weeks to clear) including handling* and 6% sales tax if delivered within California.

To Order: Send certified check (personal or company checks require two weeks to clear) including handling* and 6% sales tax if delivered within California.

To Order: Send certified check (personal or company checks require two weeks to clear) including handling* and 6% sales tax if delivered within California.

To Order: Send certified check (personal or company checks require two weeks to clear) including handling* and 6% sales tax if delivered within California.

To Order: Send certified check (personal or company checks require two weeks to clear) including handling* and 6% sales tax if delivered within California.

To Order: Send certified check (personal or company checks require two weeks to clear) including handling* and 6% sales tax if delivered within California.
Tinker, Tailor, Soldier, Sailor . . . Doctor, Lawyer . . . the Chieftain's here.

No matter whether you're a serious hobbyist or a serious businessman, the Chieftain 6800 microcomputer with capabilities that surpass the Z-80 is made for you.

Smoke Signal's quality-packed Chieftain I features two 5.25-inch mini-floppy drives and Chieftain II features two 8-inch floppy drives.

Both microcomputers provide 32K static memory, two serial I/O ports, a 2 MHz processor board, a 2K RAM monitor, a nine-slot motherboard with built-in baud rate generator and gold connectors for high reliability. The Chieftain's stylish leather-grained cabinet houses the above with its own cooling fan and regulated power supply.

Every Chieftain is complete with system software and is totally burned-in as well as tested to further insure high reliability.

And it's expandable to 64K memory with up to 2 megabytes floppy disk storage.

So see your nearest Smoke Signal dealer, he'll be glad to show you how to get your wampum's worth. Systems start at $2,595.

---

Send information on your Chieftain microcomputer
☐ Send name of nearest dealer
Name ____________________________
Address __________________________
Company __________________________
City ______________________________
State/Zip __________________________

SMOKE SIGNAL BROADCASTING
31336 Via Colinas, Westlake Village, California 91361, (213) 889-9340
Dealer inquiries invited.

---

Hail to the Chieftain
Smoke Signal Broadcasting, 31336 Via Colinas, Westlake Village, CA 91361, (213) 889-9340

Circle 328 on inquiry card.
Talk to a Turtle
Build a Computer Controlled Robot

What do personal computer experimenters do with their microcomputers when computer games lose their appeal and they tire of programming things like, "140 FOR X = 1 to 500: PRINT X: NEXT X"? The exciting idea of adding a computer controlled robot suggests building your own R2-D2 robot from *Star Wars*. It might not be wise to start with a project as sophisticated as duplicating R2-D2, but there is a way you can begin a robot project on a smaller scale. It works, too!

The Terrapin Turtle is a fascinating robot project that most experimenters can fully assemble in four hours. It runs forward, backward, turns left or right, blinks light emitting diode eyes, and can talk in a two tone beep. Its shell is mounted on a spindle that engages one of four microswitches. These relay a signal back to the computer

Photo 1: Jeffrey Dunn (foreground) and Richard Voss check off the Turtle components against the parts list.
over its 10 foot umbilical cord, indicating when the Turtle has run into something from either front, right, left, or rear side. If you direct the Turtle on an exploratory trip around the room, its journey can be recorded by your microcomputer. On completing its journey, the Turtle can actually draw a map of its path using an internal ball point pen.

The Terrapin Turtle illustrated in this article was assembled by high school students at the Union County Career Center in North Carolina. The total assembly time was four hours from start to initial test. This article is not intended for use as a construction project, but rather to introduce you to computer controlled robots.

Assembling the Terrapin Turtle

The cardinal rule for assembling any electronic kit is to begin by checking off each component on the parts list. Photo 1 shows Jeffrey Dunn and Richard Voss checking the components of the Turtle kit.

<table>
<thead>
<tr>
<th>Resistors</th>
<th>Capacity</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>510 ohm W</td>
<td>R9, R10</td>
<td></td>
</tr>
<tr>
<td>100 ohm W</td>
<td>R21, R30</td>
<td></td>
</tr>
<tr>
<td>15 K ohm W</td>
<td>R5, R6, R7, R8, R29, R22</td>
<td></td>
</tr>
<tr>
<td>50 K ohm W</td>
<td>R19, R20</td>
<td></td>
</tr>
<tr>
<td>1 K ohm potentiometers</td>
<td>P1, P2, P3, P4</td>
<td></td>
</tr>
<tr>
<td>9 V zener</td>
<td>D10</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Capacitors</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1, C3</td>
<td>0.1 mF 35 V</td>
</tr>
<tr>
<td>C2</td>
<td>500 mF 35 V</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Diodes</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1N4000</td>
<td>D1, D2, D3, D4, D5, D6, D7, D8, D9</td>
</tr>
<tr>
<td>3.9 V zener</td>
<td>D10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transistors</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2N2222</td>
<td>Q1, Q2, Q3, Q4, Q5, Q6, Q7</td>
</tr>
<tr>
<td>GE-040C4</td>
<td>Q8, Q9, Q10, Q11, Q12, Q13, Q14, Q15, Q19</td>
</tr>
</tbody>
</table>

Table 1: The Turtle component part list. The complete Turtle kit, including all hardware, printed circuits, electronic components is available from Terrapin Inc for $300.

Photo 2: The foil side of the Turtle's printed circuit board.  
Photo 3: The component side of the circuit board.
against the parts list. Once assured that everything was included in the kit, the printed circuit board was examined for possible scratches. Photo 2 shows the etch side of the 5 inch diameter printed circuit board. Photo 3 shows the component side. It was quickly noted that not all resistor values were printed on the component side, and that there was no identifying resistor number to relate any resistor to the schematic. The instruction booklet stated that eighteen 1000 ohm resistors should be placed where the resistor symbols did not have a value indicated. Figure 1 is a supplemental instruction that identifies each component corresponding to the schematic diagram.

Richard Voss was in charge of assembling the printed circuit board for the Union County Career Center's Turtle. Photo 4 shows the soldering of the Darlington transistors that control both of the Turtle's drive motors. Notice the micro-tip, low wattage soldering iron and 0.020 inch (0.05 cm) diameter solder being used. All too frequently electronic kits are damaged during assembly by the use of high wattage soldering tools which damage the heat sensitive foil and apply too much solder. An excess of solder can short out both the closely spaced component pads and the circuit paths with solder bridges. Once the soldering has been
If you're looking for outstanding value in S-100 boards you can't afford to overlook the "Blue Boards" from SSM. The best combination of design, quality and price available anywhere. Innovative designs that feature versatility and reliable performance. Quality backed by a strong warranty. And prices that won't let you down.

But value goes beyond the boards themselves. It's reflected in the company that stands behind them. And SSM has been known for unparalleled customer service since the beginning of the personal computing industry.

With one of the broadest product lines in the S-100 marketplace, it's likely that SSM has the board you need. So, if you're looking for value, ask for the "Blue Boards." They're available at over 150 computer stores nationwide and abroad.

SSM
2116 Walsh Avenue
Santa Clara, CA 95050 (408) 246-2707

Send for our free brochure and find out why SSM has become the favorite of discerning Hobbyists and OEMs.
finished, it is wise to recheck the placement of the components, just to be doubly sure.

Care must be exercised to keep the tabs on the Darlington transistors from touching one another. A small piece of plastic tape on each tab will save the transistor should the tabs accidentally be brought together while under power. Photo 5 shows the final inspection of the assembly of components onto the printed circuit board. Photo 6 shows the completed circuit board.

Figure 2 provides the circuit schematic for the control of the Turtle's left and right motors and the internal ball point pen. The pen is lowered by a 12 V solenoid upon command from the computer. Figure 3 shows the schematic for shell touch sensors, lights, and sound control. The figure also shows the power attachment points for the operation of the Turtle's electronics and motors. A 12 V, 3 A power source is required for the best performance. The Turtle can operate, however, with a power source of 1 A capacity if the 3 A source is not available. The Turtle illustrated in this article was powered by a 4 A regulated power supply.

Photo 7 shows the final assembly of the printed circuit board onto the motor housing. The most difficult part of the entire assembly was forcing the rubber tires onto the wheels. It is almost impossible to do this
by yourself — a second set of hands will be needed to mount the rubber tire onto the wheel. Photo 8 shows the assembled Turtle minus its sensor shell and the two power supplies used for testing without the use of a microcomputer. The Turtle is controlled with a TTL (transistor-transistor logic) voltage of 0 V and +2 V. This may cause some problems for parallel interfaces that function between 0 V and +5 V. The higher voltages can damage the 2N2222 Darlington tran-

Text continued on page 84
Figure 2: Schematic of the Turtle's motor control and pen control circuitry.
TRS-80, Apple II, Sorcerer, SOL and Southwest Tech 6800 owners: get more out of your personal computer.

Get into action with G2 Bullseye, Sea Battle, Confrontation and Attack!
Sharpen your analytical abilities with G2's Outwit I, Outwit II and Mind Bender.
Take a chance with G2's Beat the House. Check out your health with Clinic.
And enjoy the challenging experience of two new G2 computer simulations: The Market and Wildcatting.

Or get serious with three powerful new languages. Level III Basic for the TRS-80. Extended Basic for the SOL. And Standard Basic for the Southwest Tech 6800. All written by Microsoft—the Basic wizards. Exclusively from G2.

Our software has more so your computer does more. Great programming. Highest quality cassette. The most comprehensive instruction manual available. Plus source listing print-out of every application program in Basic. You can learn how the programs were written. We even encourage you to do your own re-programming to improve your skills!

G2 software is available from computer retailers nationwide. If your local retailer doesn't have it, ask him to become a G2 dealer by calling us toll-free: (800) 538-8340 (U.S.A.) or (800) 672-8691 (California).

THE REASON YOU BOUGHT YOUR COMPUTER.
Figure 3: Schematic of the Turtle’s touch sensor, lights, and horn control circuitry.
The Anadex 80 Column Printer.

First check the specs. Then check the price.

Our new 80-column dot matrix line printer – the DP-8000 – combines high performance and operating convenience with a low price that's worth checking into.

☐ Check Performance
The DP-8000 features a precision engineered, heavy duty printing mechanism that can print the complete 96 ASCII character set, bidirectionally, at 84 LPM.

☐ Check the Interface
Included at no extra cost, are two input connectors (see photo) that provide three basic ASCII compatible interfaces: EIA Std. RS232C, for interfacing at up to 96000 Baud with most mini-computers and modems; the 20/60 ma current drive mode required by Teletype® ASR33-35 printers; and the parallel-bit, serial character synchronous Centronics compatible interface.

The DP-8000 includes 12 lines of internal FIFO buffer storage and can accept data continuously or in bursts. Optionally, increased buffer storage of 2048 characters can be supplied for CRT dump and similar applications.

☐ Check Printer Quality
A 9 x 7 character font provides virtually half-dot resolution for clean crisp print quality on the original plus three copies.

Precise paper positioning is ensured by a sprocket-feed paper advance, user-programmable Top of Form control, and up to 8 vertical tab positions.

☐ Check Convenience
For operating ease, the DP-8000 accepts paper through the rear or bottom of the unit, provides programmable Skip Over Perforation control, and Out of Paper indication and logic signal.

☐ Check the low Price
The best news is the price. A complete DP-8000 is unit-priced at under $1000, with substantial discounts in larger quantities.

Once you've checked out the performance and price, we think you'll agree that the DP-8000 is definitely worth checking into.
Text continued from page 79:

istor driver. Photo 9 shows the attachment of the plastic Turtle shell.

Does the Turtle work? Yes it does, even with a makeshift computer keyboard temporarily substituting for the parallel interface of our computer. The students studied the keyboard's ASCII code and developed a list of keys necessary to command the Turtle's movements, lights, and horn. The Turtle will go under full computer control as soon as an expansion interface can be acquired for our TRS-80 microcomputer.

Those wishing to investigate the Turtle kit, its capabilities, and its cost may obtain full details by writing to:

Terrapin Inc
33 Edinborough St Sixth Floor
Boston MA 02111
Attention: David L McClees, President

In addition, the following address is furnished for those wishing additional information on the application of robots:

United States Robotics Society
Box 26484
Albuquerque NM 87125
Attention: Glenn R Norris, President
Color. VP-590 add-on Color Board allows program control of 8 brilliant colors for graphics, color games. Plus 4 selectable background colors. Includes sockets for 2 auxiliary keypads (VP-580). $69.*

Sound. VP-595 Simple Sound Board provides 256 tone frequencies. Great for supplementing graphics with sound effects or music. Set tone and duration with easy instructions. $24.*

Music. VP-550 Super Sound Board turns your VIP into a music synthesizer. 2 sound channels. Program control of frequency, time and amplitude envelope (voice) independently in each channel. Program directly from sheet music! Sync provision for controlling multiple VIPs, multitrack recording or other synthesizers. $49.*

Memory. VP-570 RAM Expansion Board adds 4K bytes of memory. Jumper locates RAM in any 4K block of up to 32K of memory. On-board memory protect switch. $95.*

EPROM Programmer. VP-565 EPROM Programmer Board comes complete with software to program, copy and verify 5-volt 2716 EPROMs—comparable to units costing much more than the VP-565 and VIP put together! Programming voltages generated on board. ZIF PROM socket included. $99.*

EPROM Interface. VP-560 EPROM Interface Board locates two 5-volt 2716 EPROMs (4K bytes total) anywhere in 32K of memory. VIP RAM can be re-allocated. $34.*

ASCII Keyboard** Fully encoded, 128-character ASCII encoded alpha-numeric keyboard. 58 light touch keys including 2 user defined keys! Selectable upper and lower case. Handsomely styled. Under $50.*

COSMAC VIP lets you add computer power a board at a time.

With these new easy-to-buy options, the versatile RCA COSMAC VIP (CDP18S711) means even more excitement. More challenges in graphics, games and control functions. For everyone, from youngster to serious hobbyist. And the basic VIP computer system starts at just $249* assembled and ready to operate.

Simple but powerful—not just a toy.

Built around an RCA COSMAC microprocessor, the VIP includes 2K of RAM, ROM monitor. Audio tone with a built-in speaker. Plus 8-bit input and 8-bit output port to interface relays, sensors or other peripherals. It’s easy to program and operate. Powerful CHIP-8 interpretive language gets you into programming the first evening. Complete documentation provided.

Take the first step now. Check your local computer store or electronics parts house. Or contact RCA VIP Marketing, New Holland Avenue, Lancaster, PA 17604. Phone (717) 291-5848.

* Suggested retail price. CDP18S711 does not include video monitor or cassette recorder.
** Available 3rd Quarter, 1979

See the RCA VIP at the 3rd Annual National Small Computer Show at the New York Coliseum, August 23-26, booth 4211.

The fun way into computers.
Few people have ever had the experience of attempting to trace their way through a real maze, so I'm going to ask you to settle back and allow your imagination plenty of freedom.

The absolute darkness surrounding you is barely broken by the candle you carry in your hand. You see enough to know that you are in a featureless corridor, but how far it extends, you can only guess. Somewhere within this maze is a massive gold plate. If you can find this plate, it will become yours and you will be removed to safety.

You are allowed to leave any kind of signs you wish to mark your trail. You know that any corridor you are in will eventually come to a dead end, but it may have any number of similar corridors branching off it. The overall dimensions of the maze are such that the average person could explore it in its entirety before becoming exhausted, if he or she didn't waste a lot of time and energy going in circles.

The Beginning

Years ago I read a brief article about a mechanical mouse that could find its way through simple mazes. Embedded within the walls of the mazes were a number of switches which served as sensors for the brain. The brain was a collection of relays whose points and coils functioned as a large switching network. By trial and error, this mass of hardware could direct the mouse through the maze until it reached the exit.

Over the years, I kept this idea in the back of my mind. I was interested in building such a maze, but the cost and complexity of the project were greater than the potential satisfaction. After I purchased my personal computer, these obstacles disappeared. If I was willing to accept a computer simulation of this project, I could fulfill my dream at no extra expense.

I would need to write a program, of course, but I felt that this would be an easier task than designing and building a complete hardware project. As I began to consider what features to include in my program, I came to realize that in several respects, the computer simulation would be superior to the real thing. One important difference was that I could have a maze of greater complexity than would have been feasible with a mechanical version.

Another advantage was the ease with which new mazes could be prepared. Watching repeated runs through the same maze would eventually get monotonous. The choice between shifting and aligning plywood panels or pushing a few keys was no contest. Finally, my entire computer system fits neatly on a small desk. The maze I had visualized making was about the size of my living room.

For several weeks I spent much of my spare time considering various ideas for the program. This allowed me the opportunity to explore a wide range of possible features without having to do any actual programming. Gradually, I evolved a straightforward set of goals that I felt would provide an interesting simulation, but would

What follows is the story of how I created a program that would allow my computer to run through mazes similar to the one I've just described. I've included a general description of how the program operates, instructions for using it, and a complete listing of the program.

I regret that I am unable to give you a motion picture of this program in operation. The best I can do is to explain that I first create a maze as simple or complex as I wish on the screen of my video display. I have the cursor operating in its optional nonblinking mode and it therefore appears to be a solid rectangle. As soon as I turn control over to the program, it begins to maneuver the cursor in and out of the various pathways of the maze. The cursor will dodge up and down, back and forth until it eventually finds its goal. The sight of this mad little cursor zooming around the walls of the maze is absolutely fascinating.

Even if you don't intend to get this program up and running, I invite you to come along and explore some areas I found to be quite interesting.
not be beyond my capability as a programmer.

With these basic goals in mind, I sat down and drew up the simple flowchart you see in figure 1. In graphic form, it indicates that the first function of the program is to assist the user in creating the maze. Once the maze has been prepared, the computer will run the maze until it reaches its goal. At this point, the user can run the same maze again or prepare a new one.

A tremendous number of details had yet to be worked out, but this diagram gave me a secure starting point. Before I could proceed any further I had to make a major decision. From a practical standpoint, designing the program to print out successive sets of coordinates for its moves seemed to be fairly simple. This would mean, however, that the user would have to manually move a marker around on a diagram of the maze. My decision to display the maze on the video display and let the computer move the cursor through the maze increased my work, but made the program far more interesting.

Runs Mazes

Program

If you will take a few moments to study figure 2, you will discover that it is really an expanded version of the first block in figure 1. The series of tasks outlined in figure 2 must be performed by the computer and the user in order to set up the maze.

The program begins by having the computer print out a complete list of the commands the user will use to create the maze. After the user indicates his understanding of these commands, the computer issues signals to the display to erase the screen completely. The computer then clears a section of memory that it will later use to remember the maze and the moves through it.

Once the screen and block of memory are cleared, the program prints out a maze and stores a map of it in its special memory. At this point the program allows the user to use a few one letter commands (such as U for up and L for left) to modify the maze. As each command is issued, the program coordinates the making of changes on the screen and the storing of these changes in its block of memory. Once satisfied with the maze modifications, the user issues a final command to signal this fact to the computer. The program will respond by beginning to run the maze.

Maze Creation

The following additional information should help to clarify the above remarks. Once I decided to have the maze displayed on the screen, I needed to select a method of getting the maze onto the screen. One method would have been to allow the user to draw the maze on a blank screen. By properly positionining the cursor, the user could have printed a series of Xs anywhere that a wall was desired. I felt that this approach would work, but due to the heavy burden it would place upon the user, I selected another method.
Figure 3: Horizontal paths of maze.

```
  x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x
  x x xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
  x x
  x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x
  x x
  x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x
  x x
  x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x
  x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x
  x x
  x x xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
  x x
  x x
```

Figure 4: Vertical paths of maze.

```
  x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x
  x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x
  x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x
  x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x
  x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x
  x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x
  x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x
  x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x
  x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x
  x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x
  x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x
  x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x
  x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x
  x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x
  x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x
  x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x
  x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x
```  

This concept is illustrated in figure 6. By erasing the blocking Xs along the desired horizontal and vertical pathways, we are able to create a functional maze. We must remain on those pathways and can erase an X only if it is blocking us unduly. In practice, we can only erase an X if there is a space either above and below it, or to the right and left of it.

The above can be a little confusing, even after you are used to it. Because of this, I built a routine into the program which automatically checks every X you try to erase and determines whether or not that particular X may be erased. If a given X may not be erased, your command will be ignored. As a result, you need not worry about making an error, but remember when you try to erase an X and nothing happens, that the program is designed to do this.

Among the Xs which cannot be erased are those which form the borders of the initial maze, meaning that there is no escape from this maze. It doesn't really matter. Unlike other mazes (in which the idea is to escape), the goal of the computer in this program is to find "food", indicated by the letter F.

Command Details

While the program does print out a list of all the valid user commands, I feel it is worthwhile to elaborate. One of the basic principles involved in setting up the maze is the fact that the cursor is not allowed to pass beyond any boundary of the maze. This means that when the cursor reaches the right side of the maze, it will not be able to "wrap-around" and reappear on the left side of the screen. It doesn't matter in which direction you are moving: when you reach a boundary line, you will be stopped from going any further. Should you try to go further, the command will be ignored.

I chose this approach to facilitate coordination of the on-screen maze and its counterpart stored in memory. Coordination of the cursor on the screen and the block or reserved memory is critical to the successful operation of this program. It is important that I included a routine designed to abort the program if certain commands are detected.

Because it is so much easier to remember the letter R for right rather than Control-I for right, I decided to allow the user to use U, D, L and R to cause the cursor to move up, down, left and right. In operation, the program recognizes these easy to remember commands and substitutes the specific control character used by the terminal.
CAREER OPPORTUNITIES FOR MICROCOMPUTER EXPERTS

One of the largest and fastest growing companies in the microcomputer industry is looking for talented people in all areas of microcomputer development, marketing, sales and support. If you have experience in microcomputing and an interest in one of the areas below:

PROGRAMMING:
Applications software for the home of the future and office of the future.
Systems software for English parsing, voice recognition and other advanced I/O devices.

HARDWARE R&D:
Microcomputer networking for home and office and advanced I/O devices.

MARKETING:
Presenting advanced concepts to the personal, small business and educational marketplaces.

SALES:
Computer dealer relations,
New business development.

SUPPORT:
Innovative training approaches for employees, dealers and customers.

Submit your detailed resume in confidence to the Director of Personnel.

OHIO SCIENTIFIC
1333 S. Chillicothe Road • Aurora, Ohio 44202
Figure 5: Complete maze grid, containing all horizontal and vertical components.

Figure 6: Functional maze produced by removing Xs from the grid of figure 5.

device for the intended cursor movement. I followed this approach because it was relatively easy to program and made things easier for the user. However, should the user input one of the actual control characters recognized by the terminal system, synchronization between the on-screen maze and the special block of memory would probably be lost. Rather than permit this to happen, I chose the simple alternative of having the program check each command input by the user. If it detects any control character, it will immediately erase everything on the screen and return to MIKBUG control. The program itself will not be affected, but you will need to reenter the program at its starting address and begin again.

Other Commands

The remaining valid commands are C, H, F, E, and S. These stand for carriage-return, home-up, food, erase and start. Carriage-return moves the cursor to the left of the current line, while the home-up command is used to move the cursor to the upper lefthand corner of the maze.

When you have the cursor positioned directly over an X you wish to remove, use the erase command. Use the food command to replace any X in the raw maze with an F. You may set up several target Fs around the maze, but the program will stop its search as soon as it finds the first one. When you are ready to allow the computer to run the maze you have prepared, issue a start command.

Issuing the start command removes control of events from the user and turns everything over to the computer. As soon as it takes control, the computer checks to see whether the cursor is positioned over an X or a space. At this point, if the cursor is over a space, the computer will begin its search. If, however, the cursor is over an X, the computer will move it to the space in the upper lefthand corner. Either procedure gives the computer a valid point from which to start, and as soon as one has been taken, the computer prepares to make its first move.

Strategy

I now need to discuss, in general terms, the strategy used by the program to move around the maze in search of food. A good place to begin is with figure 7. This type of diagram is referred to as a tree. Such a diagram by itself does nothing. When used as an aid in solving certain types of problems, such trees can make it much easier to visualize relationships of various elements of a problem.

If we assume that each circle represents a combination of factors which could be the desired answer, our task is to devise a scheme of searching through the tree until we find the solution. A number of methods for doing this are available. While the one that I selected is not the best, it is reasonably efficient, provides an interesting simulation, and is so simple to understand that I had no reservations about using it as the basis for the most important part of the program.

The strategy I selected for my program is embodied in the following set of simple rules. The first rule is that once a passage-way is entered for the first time, it is explored until a dead end is reached. During this initial search, any corridors branching off the passage being explored are ignored. The second rule is that after a dead end is reached, special signals are stored in the reserved block of memory until the computer must either change direction or reach a new corridor. These signals mean that it is not necessary to explore that particular corridor, as it is already known that the goal is elsewhere. In effect, the program will later react to these signs in the same way that
"The data from this experiment could affect national defense. That's why we use Scotch® Brand Disk Cartridges."

Ken Bish, Engineer,
Systems Research Laboratories, Inc., Dayton, Ohio

Every Scotch Disk Cartridge is tested and certified error-free before it leaves the factory. Because, for the defense of your data, nothing less than perfection is acceptable.

The disks in Scotch Disk Cartridges are defended by 3M's exclusive CRASHGUARD® protective disk coating. It greatly minimizes the possibility of a head crash, and minimizes the damage, should one occur.

Scotch front-loading Disk Cartridges also feature our exclusive Living Hinge air door, which reduces the possibility of damage to the disk from contact with the air door stop during shipping and handling.

You can get Scotch Disk Cartridges in front or top-loading models. To find out where you can find Scotch Disk Cartridges or virtually any other data recording medium, call toll-free: 800-328-1300. (In Minnesota, call collect: 612-736-9625.) Ask for the Data Recording Products Division.

If it's worth remembering, it's worth Scotch Data Recording Products.
Figure 7: Search tree used by program to find its goal.

Figure 8: Typical search undertaken by computer. Starting at point 1, the cursor moves right to the dead end at point 2. Marking this position with a special code in memory, the cursor moves left, finding the unexplored corridor at point 3. The cursor changes direction to explore this, until stopped at point 4. Leaving a dead end code, the cursor again reverses, and discovers the new passage at point 5. Changing direction and moving towards point 7, the cursor reaches the "food" at point 6 and stops the search.

Search Details

To make these rules clearer, refer to figure 8. Assume that the computer begins its run at position 1. It will move to the right until it reaches the dead end at position 2. Leaving special signals behind itself in memory, the computer will move back to the left until it encounters the new corridor at position 3. As this is an unexplored passage, it will stop retracing its steps toward position 1 and change direction toward position 4. Once it arrives at position 4, it reverses itself and, again leaving the special dead end signs in memory, backs up until it reaches position 5. Here, the computer decides that it has found another unexplored avenue and begins moving toward position 7. Halfway down this corridor it finds the food at position 6 and, having achieved its goal, stops the search.

In addition to the dead end signs, the computer also marks each path it explores with another signal to indicate that it has been there. Both of these signals are stored in the reserved block of memory to serve as guides in choosing the next move. They do not appear on the video display screen (where they would only cause clutter).

If you refer back to figure 7, you will now be able to understand the strategy that I have employed in this program. The procedure is to start at the top and, after arbitrarily choosing one of the branches, descend along it as far as possible. In this instance, we go from A to D. Unable to continue at D, we back up the minimum possible distance to C, where we encounter three unexplored branches. One at a time, we descend from C to E, F, and G. When exploration of these three branches is complete, we have eliminated everything descending from C. Again, we back up the least possible distance. In this case, we move from C back to B. At B we will descend to explore the paths leading to H, I, and J. Once this sequence has been completed, we back up to A. We have, at this point, thoroughly examined one limb of the tree, and use of the same rules over and over will eventually lead us to the goal.

One last point concerning strategy must be covered. Figure 9 illustrates a normal tree with some abnormal additions: closed circular paths, or loops. These may actually be a true representation of a particular problem. They are not, however, used in

Figure 9: Figure 9 illustrates a normal tree with some abnormal additions: closed circular paths, or loops. These may actually be a true representation of a particular problem. They are not, however, used in

it would react to a wall. A third rule is that when the program is retracing previous steps, it will begin exploring new territory as soon as possible.
classic tree diagrams. Experts in the field of artificial intelligence tend to disapprove of such loops for they can raise havoc with simple search strategies like the one I've been explaining. It is entirely possible to enter one of these loops and, following the rules exactly, remain in the loop indefinitely. This can all be summed up in the following rule: do not create loops in the mazes you set up for this program to run through.

Finally, on the matter of loops, figures 10 and 11 are examples of various mazes. Those shown in figure 10 are incorrect because of loops. Those shown in figure 11 are correct.

Run Completion

Now I am going to briefly describe what happens once the computer completes its run. If it was unable to find the goal (because you forgot to include it or placed it out of reach), the program will tell you that it has no valid moves and will ask if you wish to rerun the same maze.

If you indicate that you would like to rerun the same maze, the computer will clean out all the signs it placed in its special block of memory and jump back to that part of the program which allows the user to modify the maze. It will print out a new maze or change the one on the screen. If you desire to start the next run from a new location or further modify the maze, use the same commands you originally used in setting up the maze. When you are ready to begin the new run, input a start command.

When the program actually finds the goal, it goes through the same general routine as when it has no more moves, with one major difference: instead of reporting that it has no more moves, it states that it has found the goal. Beyond this, everything is the same.

If, in either of the above cases, you indicate to the computer that you do not desire to rerun the same maze, the program will erase everything on the screen, completely clear out the special block of memory, and then print out a new initial maze.

Minor Points

A few minor details remain of which you should be aware. Foremost among these is the cursor. I decided to use the cursor to explore the maze because it was the easiest way to do the job. The simulation is very effective when the cursor is operated in the solid mode (as opposed to the normal blinking mode). The program will function perfectly with a blinking cursor, but the visual effect is not as pleasing.

Text continued on page 96
Figure 11: Properly constructed mazes containing no loops.

Photo 1: Time lapse exposure of a complete search of the maze. The camera shutter was left open during the entire time the cursor was traversing the maze. When the cursor retraced its steps, it increased the exposure at that point. Thus, the various shadings indicate in a relative fashion the number of times that the cursor passed a given point. The whitest location is the home position at the upper left corner.
The small computer that won't fence you in.

A lot of semantic nonsense is being tossed around by some of the makers of so-called “personal” computers. To hear them tell it, an investment of a few hundred dollars will give you a computer to run your small business, do financial planning, analyze data in the engineering or scientific lab — and when day is done play games by the hour.

Well, the game part is true. The rest of the claims should be taken with a grain of salt. Only a few personal computers have the capacity to grow and handle meaningful work in a very real sense. And they don't come for peanuts.

Remember, there's no free lunch.

So before you buy any personal computer, consider Sol. It costs more at the start but less in the end. It can grow with your ability to use it. Sol is not cheap. But it’s not a delusion either.

Sol small computers are at the very top of the microcomputer spectrum. They stand up to the capabilities of mini systems costing four times as much.

No wonder we call it the serious solution to the small computer question.

Sol is the small computer system to do the general ledger and the payroll. Solve engineering and scientific problems. Use it for word processing. Program it for computer aided instruction. Use it anywhere you want versatile computer power!

Build computer power with our software.

At Processor Technology we've tailored a group of high-level languages, an assembler and other packages to suit the wide capabilities of our hardware.

Our exclusive Extended BASIC is a fine example. This BASIC features complete matrix functions. It comes on cassette or in a disk version which has random as well as sequential files.

Processor Technology FORTRAN is similar to FORTRAN IV and has a full set of extensions designed for the “stand alone” computer environment.

Our PILOT is an excellent text oriented language for teachers.

Sold and serviced only by the best dealers.

Sol Systems are sold and serviced by an outstanding group of conveniently located computer stores throughout the U.S. and Canada.

For more information contact your nearest dealer in the adjacent list. Or write Department B, Processor Technology, 7100 Johnson Industrial Drive, Pleasanton, CA 94566. Phone (415) 829-2600.

In sum, all small computers are not created equal and Sol users know it to their everlasting satisfaction.

Circle 300 on inquiry card.
Author's Note:

The program shown in listing 1 uses several routines from the MIKBUG monitor. Other monitors (SWTBUG, Smartbug) designed to be compatible with MIKBUG should work with the program. However, the program will not work with other types of monitor systems.

Be careful not to type an actual control character while setting up the maze. If you do, you must restart the program at hexadecimal location 003D.

Listing 1: Since the original Maze program was hand assembled over several hand written pages, the machine generated object code shown here in MIKBUG format is the only verifiable representation. Spaces on each line make reading easier, but do not enter the spaces into the computer. The last pair of digits on each line is a checksum. The starting address is hexadecimal 003D.

Table 1: Control codes used with the Southwest Technical Products Corporation CT-64 video terminal system.

<table>
<thead>
<tr>
<th>Control Character</th>
<th>Hexadecimal Code</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>08</td>
<td>Back Space</td>
</tr>
<tr>
<td>I</td>
<td>09</td>
<td>Forward Space</td>
</tr>
<tr>
<td>J</td>
<td>0A</td>
<td>Line Feed</td>
</tr>
<tr>
<td>K</td>
<td>0B</td>
<td>Move Up</td>
</tr>
<tr>
<td>P</td>
<td>10</td>
<td>Home Up</td>
</tr>
<tr>
<td>U</td>
<td>15</td>
<td>Erase End of Line</td>
</tr>
<tr>
<td>V</td>
<td>16</td>
<td>Erase End of Frame</td>
</tr>
<tr>
<td>M</td>
<td>0D</td>
<td>Carriage Return</td>
</tr>
</tbody>
</table>

Listing 1 continued on page 98

Text continued from page 93:

While I was developing the program, I found it desirable to include a delay routine to slow the speed at which the cursor runs through the maze. This delay is used whenever the program is exploring new territory. It greatly increases the impression that the computer is carefully considering each move. The amount of delay can be varied by changing the contents of one location in memory. The specific address is hexadecimal 06BE. You may use any value between 01 and FF. The maximum amount of delay is about one second, which occurs when location 06BE is set to FF. As the value stored in 06BE is decreased, the amount of delay is reduced until, with a value of 01, it is almost unnoticeable.

Hardware Dependence

One final important topic is the configuration of my system. This program is designed around that configuration, and any other could cause problems. Most 6800 system owners should not have any difficulty, but, to be on the safe side, I'll go over the details quickly.

First, my terminal system is set up to print 32 characters on each line and 16 lines on each page. When I run this program I operate my terminal in the page mode. Table 1 describes all the control characters used by my system to move the cursor around and to erase the screen. The terminal is set to upper case operations.

Loading the Program

The program (listing 1 is in the MIKBUG tape format) is ready for hand entry. To begin entry, assuming that you are under MIKBUG control, type an L (load) and enter each line exactly as it appears. If you make a mistake, the checksum error detection feature of MIKBUG will catch it and cause the terminal to print a question mark. In order to proceed, again enter an L command and retype the line in question.
<table>
<thead>
<tr>
<th>PROGRAM</th>
<th>DESCRIPTION</th>
<th>TRS-80 L1/L2</th>
<th>PET PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>GALACTIC BLOCKADE RUNNER</td>
<td>AN EXCITING SPACE WAR GAME WITH GRAPHICS</td>
<td></td>
<td>$ 9.95</td>
</tr>
<tr>
<td>SCI-FI GAME SAMPLER</td>
<td>3 GAMES—LUNAR LANDER—STAR MONSTER—SPACE BATTLE</td>
<td></td>
<td>$ 7.95</td>
</tr>
<tr>
<td>R/T LUNAR LANDER</td>
<td>A REAL TIME LUNAR LANDER WITH GRAPHICS</td>
<td></td>
<td>$ 7.95</td>
</tr>
<tr>
<td>MICRO-TEXT EDITOR</td>
<td>FORMAT TEXT—SAVE &amp; LOAD TO TAPE—OUTPUT TO PRINTER</td>
<td></td>
<td>$ 9.95</td>
</tr>
<tr>
<td>OTHELLO III</td>
<td>A STRATEGY BOARD GAME—PLAY AGAINST COMPUTER OR OTHERS</td>
<td></td>
<td>$ 7.95</td>
</tr>
<tr>
<td>AIR RAID</td>
<td>A REAL TIME, ARCADE TYPE SHOOTING GAME IN MACH. LANG.</td>
<td></td>
<td>$ 14.95</td>
</tr>
<tr>
<td>MICRO-CHESS</td>
<td>PLAY CHESS WITH YOUR COMPUTER—VARIOUS LEVELS OF DIFF.</td>
<td></td>
<td>$ 9.95</td>
</tr>
<tr>
<td>BRIDGE CHALLENGER</td>
<td>DON'T WAIT FOR OTHERS TO PLAY—YOUR COMPUTER'S READY</td>
<td></td>
<td>$ 14.95</td>
</tr>
<tr>
<td>APPLE 21</td>
<td>BLACKJACK WITH HIRES GRAPHICS</td>
<td></td>
<td>$ 9.95</td>
</tr>
<tr>
<td>STAR WARS/SPACE MAZE</td>
<td>SCI-FI GAMES FOR THE APPLE</td>
<td></td>
<td>$ 12.95</td>
</tr>
<tr>
<td>RENUMBER</td>
<td>RENUMBER YOUR BASIC PROGRAMS—RENUMBERS EVERYTHING</td>
<td></td>
<td>$ 14.95</td>
</tr>
<tr>
<td>DISK RENUMBER</td>
<td>SAME AS ABOVE, BUT ON DISK</td>
<td></td>
<td>$ 19.95</td>
</tr>
<tr>
<td>PILOT 2.0</td>
<td>THE EDUCATIONAL LANGUAGE. IN MACH. LANG.—INC. EDITOR</td>
<td></td>
<td>$ 14.95</td>
</tr>
<tr>
<td>PILOT 3.0</td>
<td>THE DISK VERSION OF THE ABOVE</td>
<td></td>
<td>$ 24.95</td>
</tr>
<tr>
<td>APPLE TALKER</td>
<td>YOUR APPLE SPEAKS! NO NEW HARDWARE REQUIRED</td>
<td></td>
<td>$ 9.95</td>
</tr>
<tr>
<td>APPLE LIST'NER</td>
<td>SPEECH RECOGNITION THE EASY WAY—GREAT WITH THE TALKER</td>
<td></td>
<td>$ 19.95</td>
</tr>
<tr>
<td>TIC-TAC-TALKER</td>
<td>TIC-TAC-TOE USING SPEECH SYNTHESIS AND RECOGNITION</td>
<td></td>
<td>$ 19.95</td>
</tr>
<tr>
<td>FORTRAN</td>
<td>FOR THE TRS-80—SEE MICROSOFT'S ADS</td>
<td></td>
<td>$325.00</td>
</tr>
<tr>
<td>SYSCOP</td>
<td>MAKE BACKUP TRS-80 SYSTEM TAPES THE EASY WAY</td>
<td></td>
<td>$ 9.95</td>
</tr>
<tr>
<td>ANDROID NIM-2</td>
<td>GAME OF NIM WITH ANIMATED ROBOTS AND SOUND</td>
<td></td>
<td>$ 14.95</td>
</tr>
<tr>
<td>SNAKE EGG</td>
<td>A BETTING GAME WITH ANIMATED SNAKES AND SOUND</td>
<td></td>
<td>$ 16.95</td>
</tr>
<tr>
<td>LIFE 2</td>
<td>100 GEN. PER MIN. LIFE &amp; BATTLE OF LIFE W/ANIMATION &amp; SOUND</td>
<td></td>
<td>$ 14.95</td>
</tr>
<tr>
<td>DCC-1</td>
<td>PUT SYSTEM TAPES ON DISK EVEN IF IN SAME MEM AS DOS</td>
<td></td>
<td>$ 14.95</td>
</tr>
<tr>
<td>MUSIC MASTER</td>
<td>ENTER SHEET MUSIC—the TRS-80 THEN COMPILES &amp; PLAYS IT</td>
<td></td>
<td>$ 14.95</td>
</tr>
<tr>
<td>DISK MUSIC MASTER</td>
<td>SAME AS ABOVE BUT ON DISK W/MANY SELECTIONS</td>
<td></td>
<td>$ 24.95</td>
</tr>
<tr>
<td>TRS-80 CP/M</td>
<td>OPENS UP THE WHOLE WORLD OF CP/M SOFTWARE TO THE TRS-80</td>
<td></td>
<td>$150.00</td>
</tr>
<tr>
<td>PET ASTROLOGY</td>
<td>DOES ALL THE COMPUTATIONS FOR YOU</td>
<td></td>
<td>$ 9.95</td>
</tr>
<tr>
<td>PERSONAL FINANCE PKG.</td>
<td>KEEP TRACK OF CHECKS, BUDGET, COMPUTES INTEREST</td>
<td></td>
<td>$ 9.95</td>
</tr>
<tr>
<td>TRS-80 DISK LIB. “A”</td>
<td>9 PROGRAMS ON DISK—INC. BLOC. RON, OTHELLO ETC.</td>
<td></td>
<td>$ 39.95</td>
</tr>
<tr>
<td>BUSINESS AND APPLICATION SOFTWARE</td>
<td>CALL OR WRITE FOR DETAILS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16K MEMORY UPGRADE FOR TRS-80, APPLE &amp; SORCERER COMPUTERS</td>
<td></td>
<td></td>
<td>$ 94.95</td>
</tr>
<tr>
<td>C10 HIGH QUALITY DATA Cassettes W/SCREW HOUSINGS</td>
<td></td>
<td></td>
<td>10/5 10.00</td>
</tr>
<tr>
<td>VERBATUM 5-1/2 INCH BLANK DISKETTES</td>
<td></td>
<td></td>
<td>10/5 34.95</td>
</tr>
</tbody>
</table>

10% OFF IF YOU ORDER 3 SOFTWARE PACKAGES OR MORE

SEND FOR FREE CATALOG—GIVE TYPE OF COMPUTER

TO ORDER BY PHONE OR FOR DEALER INFO—CALL—(617) 682-8131
ADD 75c SHIPPING & HANDLING • MASS. RESIDENTS ADD 5% SALES TAX
MAD HATTER SOFTWARE • 900b SALEM RD • DRACUT, MA 01826

Circle 202 on inquiry card.
I've never seen documentation covering the types of errors the MIKBUG error detection feature will catch, so I purposely made a number of different errors and can report that all were detected. I entered incorrect digits, tried nonhexadecimal characters, rearranged the placement of correct digits and entered the address incorrectly. While I can't guarantee absolute reliability in error detection, I can say that I've entered many programs by hand using this method, and to the best of my knowledge every entry error that I made was caught.

As you successfully enter each line, it is stored in memory. Should you be unable to complete the loading of the entire program in one sitting you may use the tape dump feature of MIKBUG to store what you have entered on cassette or paper tape. At the beginning of your next session, load the tape back into memory and begin hand loading at the point you left off previously.

Eventually you will have the entire program in memory. Before you do anything else, I suggest that you generate a tape of the program. Once that is done, prepare your terminal system to use the program. Set it in the page mode, for upper case operation, with the cursor in a nonblinking mode. The hexadecimal starting address is 0030. Once you have this loaded into addresses A048 and A049, you will be ready to issue the go command.

Because I have entered this entire program by hand on three separate occasions, I can appreciate the feelings of those who think that it’s just too big a job. To assist those who are lacking the time or inclination to hand load this program, I will be happy to supply a Kansas City standard cassette tape of the program for a $5 fee.

Conclusion

This program is serious fun. As written, it provides quite a bit of excitement but, human nature being what it is, the urge to improve things may strike one or more of you. Ideas for improvement could include adding land mines, a limited range requiring stops for fuel, magic spots that transport to another location, and even little Klingons. If these or other ideas excite you, I hope you’ll get busy and write the program to contain them. I’d like to run it.
Listing 1 continued:

S113 0490 0841 3900 0010 OA0A 0904 A620 8120 2735 E2
S113 04AO A601 8120 2735 BD04 EAFE 04E7 8120 272F 19
S113 04BO 09A6 0008 8120 272B 017E 067B BDE0 7E7E F5
S113 04CO 0773 1015 4E4F 20AD 4F56 4553 2804 0000 10
S113 04DO 0000 0000 4086 44B7 04D4 3986 5220 F886 D0
S113 04EO 5520 F48E 4C20 FE00 0000 FP04 E786 2087 76
S113 04FO 04E9 7D04 E927 0609 7A04 E920 F5A6 0039 10
S113 0500 BD06 CE86 5281 04D4 2715 664C B104 D427 37
S113 0510 2786 5581 04D4 2756 8644 B104 D427 3868 9B
S113 0520 09BD E1D1 BD06 BD86 01A7 008D BD06 CEAE 62
S113 0530 0181 2027 EA7E 0597 8608 BDE1 D7BD 06BD 6D
S113 0540 8601 A700 08BD 06CE 09A6 0008 8120 27EB 78
S113 0550 7E55 9786 0ABD E1D1 BD06 BD86 01A7 008D 13
S113 0560 03BD BD06 CEAE 2081 2027 E7E7 0597 860B 43
S113 0570 BDE1 D7BD 06BD 8601 A700 BD04 EABD 06CE 1E
S113 0580 BD04 EAFE 04E7 8120 274E 7E05 9786 20AD LA
S113 0590 2704 084A 20FP 3939 8655 2100 0104 D427 1B86 26
S113 05AE 4C81 04D4 2747 8655 B104 D427 6986 44B1 95
S113 05BO 04D4 275F CE0E C7BE 04BC BD06 6527 11BD EA
S113 05CO 0660 2713 BD06 5427 15BD 0659 2717 2084 D6
S113 05DO 04D5 BD06 0697 39BD 04BD 06BD A3BD E7E7
S113 05EO 0BD8 BD86 3986 0477 00BD 8690 39BD 860D 65
S113 05FO 27DE BD06 6027 BD0D 0659 2708 BD06 5427 3F
S113 0600 0A7E 05CE BD04 E3BD 068C 3986 04A7 00BD 7D
S113 0610 0685 397E 0635 BD06 5427 C3BD 0659 2784 31
S113 0620 BD06 6527 12BD 0600 2703 7E05 CE86 04A7 FD
S113 0630 00BD 06AE 39BD 0654 27A4 BD06 5927 C5BD 65
S113 0640 06BD 2793 BD06 6527 037E 05CE 8604 A700 B2
S113 0650 BD06 9839 A601 8101 3909 A600 0881 0139 2B
S113 0660 A620 8101 39FF 0679 8620 4277 0409 42A0 F6
S113 0670 F9A6 00FE 0679 8610 3900 00BD 0598 7E0E C3
S113 0680 9A86 01A7 0086 09BD E1D1 0839 8601 0700 31
S113 0690 8608 BDE1 D109 3986 01A7 0866 08BD E1D1 E9
S113 06A0 8620 4D37 0409 42A0 0939 8601 A700 860A C5
S113 06B0 BDE1 D186 204D 2704 084A 20F9 39C6 1086 A9
S113 06C0 FP4D 2703 4A20 FPA5 5D27 0220 F39F 07F1 LB
S113 06D0 0086 214D 2704 094A 20F9 8646 A100 2722 D5
S113 06E0 A101 271E A27A 271A A120 2716 A122 2712 41
S113 06F0 A140 270E A161 270A A142 2706 FE07 0039 7F
S113 0700 0000 CE07 08BD E07E 7E07 2C10 1546 4F55 2A
S113 0710 4E44 2049 542E 2052 4552 554E 2053 414D AB
S113 0720 4520 4D45 4A65 3P20 592F 4E04 BDE1 AC81 2F
S113 0730 5927 1381 4E27 0C86 08BD E1D1 8615 BDE1 EA
S113 0740 D120 977F CE08 20A6 0081 0127 GC81 F5
S113 0750 0427 085C 09FF 2709 0820 EE86 20A7 0020 1B
S113 0760 F286 08BD E1D1 8615 BDE1 D186 08BD E1D1 88
S113 0770 7E07 79CE 0716 7E07 058E A042 7E00 4F8E 3E
S113 0780 A042 7E00 4043 BF5E 97A9 AE19 FF6C 8F51 19
S113 0790 DP55 BF37 9739 A44B AF39 9A79 BA16 7ECB B3
S113 07A0 2092 4806 4887 5802 4106 40A2 40C2 4086 2B
S113 07B0 5897 50C5 6087 6808 61D0 5086 5C86 68A2 87
S113 07C0 FE3F 9F79 APBD BFPC FP5D DF77 F7DE 3D62
S113 07D0 FP59 9F5F 8F7F 8F7F BF6D B731 A671 A77B 4C
S113 07E0 0184 1C82 5082 40C7 10B6 4147 50AB 8608 52
S113 07F0 5086 2041 6182 1882 4186 7003 7003 0083 11
Computer Generated Maps,

Part 2

William D Johnston
1808 Pomona Dr
Las Cruces NM 88001

In part 1 (May 1979 BYTE, page 10) we discussed the fundamental techniques involved in the production of computer generated maps and how to apply those techniques to some common map projections. We also presented several simple programs in BASIC which could be easily implemented in your own system to create maps for a variety of purposes. Nevertheless, these simple programs do have their limitations. In this installment we will develop a map projection program which is only slightly more complex, but far more versatile in what it can accomplish.

One of the most interesting projections mentioned in part 1 was the perspective projection, whereby the Earth is shown exactly as it appears to an observer at some specified height above the surface. Several perspective projections were illustrated, but all of these were simplified examples where the observer (or point of projection) was at infinity. It would be much more useful to have a program which would generate maps of the Earth as it appears from any chosen altitude and over any desired location. Such a program would give enormous flexibility to displays for space war games and other such practical applications as creating map overlays for weather satellite photographs.

Although details of a program to produce this type of projection were not discussed, the reader was encouraged to investigate the subject of perspective (or projective) geometry to see how the task could be accomplished. By this time many of you have, no doubt, learned that the solution is really quite simple.

Development of Perspective Projection

The key element of the solution can be explained in the following manner: if a line is extended from the center of the Earth to an observer in space, the point on the surface of the Earth that the line passes through is called the observer’s subpoint. In other words, the observer is directly over this point with respect to the center of the Earth. Now, extend a sight line from the observer to any visible point on the surface of the Earth. You will find that the azimuth angle of the sight line (as measured clockwise from true north) is the same as the great circle bearing from the observer’s subpoint to the distant surface point.

Knowing this, you should have been struck by the realization that you might be able to use the same program that was used to generate azimuthal equidistant maps in part 1, to also generate perspective maps. Can it be used? Almost.

The portion of the program which computes the angular component of the polar form of the map coordinates is indeed the same, and the computation of that angle constitutes the major part of the program. As its name implies, however, the azimuthal equidistant projection portrays radial distances uniformly. In a perspective view, distances are not uniform, but become increasingly compressed toward the Earth's limb (ie: edge of visible disk). All we have to do is replace a single statement in the program to correctly compute the radial distance. We will then have the means to produce a perspective projection of the Earth as viewed from any desired altitude over any desired point. By using a simple logic flag, we can choose between either of the two projections and use the same program to generate both types of maps.

You will also recall from part 1 that polar equidistant maps are simply special cases of the azimuthal equidistant map, while the orthographic equatorial and orthographic polar maps are nothing more than special cases of the perspective projection. We can
Wondering which memory is best for you?

Base 2 offers the following products to the S-100 market at the industry's lowest prices:

8K Static Memory Board
This 8K board is available in two versions. The 8KS-B operates at 450ns for use with 8080 and 8085A microprocessor systems and Z-80 systems operating at 2MHz. The 8KS-Z operates at 250ns and is suitable for use with Z-80 systems operating at 4MHz. Both kits feature factory fresh 2102's (low power on 8KS-B) and includes sockets for all IC's. Support logic is low power Schottky to minimize power consumption. Address and data lines are fully buffered and 4K bank addressing is DIP switch selectable. Memory Protect/Unprotect, selectable wait states and battery backup are also designed into the board. Circuit boards are solder masked and silk-screened for ease of construction. These kits are the best memory value on the market! Available from stock...

- 8KS-B $125 (assembled and tested add $25.00)
- 8KS-Z $145 (assembled and tested add $25.00)

16K Static Memory Board
Base 2 can now offer the same price/performance in a 16K static RAM as in its popular 8K RAM. This kit includes 8K bank addressing with 4K boundary address setting on DIP switches. This low power unit provides on-board bank selection for unlimited expansion... No MUX board required. Using highest quality boards and components we expect this kit to be one of the most popular units on the market. Available in two speed ranges, the 16KS-B operates at 450ns while the 16KS-Z operates at 250ns.

- 16KS-B $275.00 (assembled and tested)
- 16KS-Z $300.00 (assembled and tested)

Z-80 CPU Board
Our Z-80 card is also offered in two speed ranges. The CPZ-1 operates at 2MHz and the CPZ-2 operates at 4MHz. These cards offer the maximum in versatility at unbelievably low cost. A socket is included on the board for a 2708 EPROM which is addressable to any 4K boundary above 32K. The power-on jump feature can be selected to address any 4K boundary above 32K or the on-board 2708. An On-board run-stop flip-flop and optional generation of Memory Write allows the board to run with or without a front panel. The board can be selected to run in either the 8080 mode, to take advantage of existing software, or in the Z-80 mode for maximum efficiency. For use in existing systems, a wait state may be added to the M1 cycle, Memory request cycle, on-board ROM cycle, input cycle and output cycle. DMA grant tri-states all signals from the processor board. All this and more on top quality PC boards, fully socketed with fresh IC's. CPZ-1 $110 CPZ-2 $125

S-100 for Digital Group Systems
This kit offers, at long last, the ability to take advantage of S-100 products within your existing Digital Group mainframe. Once installed, up to four S-100 boards can be used in addition to the existing boards in the D.G. system. The system includes an "intelligent" motherboard, ribbon cables to link existing D.G. CPU to the DGS-100 board and a power wiring harness. The DGS-100 is designed to fit in the 5-3/4" x 12" empty area in the standard D.G. cabinet. It may seem expensive but there's a lot here!

Send for more details on these products. Get on our mailing list for information on more soon to be announced products at factory-direct prices from BASE 2. Why pay more when you can get the best at these prices???

P.O. Box 3548 • Fullerton, Calif. 92634
(714) 992-4344
CA residents add 6% tax
MC/BAC accepted • FOB — U.S. destination
Listing 1: BASIC subroutine for generating general purpose, perspective projection maps.

1000 REM SUBROUTINE TO COMPUTE MAP COORDINATES
1005 REM FOR PERSPECTIVE, MODIFIED PERSPECTIVE,
1010 REM AND AZIMUTHAL EQUIDISTANT PROJECTIONS.
1020 REM
1025 REM THE FOLLOWING FUNCTION MUST BE DEFINED
1030 REM BEFORE THIS SUBROUTINE IS CALLED:
1035 REM
1040 REM FNC(1) COMPUTES THE ARC COSINE OF THE
1045 REM ARGUMENT. THE FUNCTION MUST BE
1050 REM NON-AMBIGUOUS; THAT IS, IT MUST
1055 REM ATTACH THE CORRECT ALGEBRAIC
1060 REM SIGN TO THE RESULT. A GOSUB TO
1065 REM AN ARC COSINE SUBROUTINE MAY BE
1070 REM SUBSTITUTED IF DESIRED.
1075 REM
1080 REM THE FOLLOWING CONSTANTS MUST BE DEFINED
1085 REM BEFORE THIS SUBROUTINE IS CALLED THE
1090 REM FIRST TIME, AND ARE NEVER CHANGED:
1095 REM
1100 REM E ~ 6378.14, THE MEAN RADIUS OF THE
1105 REM EARTH, IN KM.
1110 REM
1115 REM K1 = 1.0
1120 REM
1125 REM K2 = 1.5707963, THE VALUE OF PI/2.
1130 REM
1135 REM K3 = 3.1415927, THE VALUE OF PI.
1140 REM
1145 REM K6 = 6.2831853, THE VALUE OF 2*PI.
1150 REM
1155 REM T = 0.00015, USED AS A TEST VALUE.
1160 REM
1165 REM Z = 0.0
1170 REM
1175 REM
1180 REM THE FOLLOWING VARIABLES MUST BE DEFINED
1185 REM BEFORE THIS SUBROUTINE IS CALLED THE
1190 REM FIRST TIME FOR ANY GIVEN MAP. EACH
1195 REM TIME A NEW MAP IS TO BE STARTED, THESE
1200 REM VARIABLES MUST BE REDEFINED BEFORE
1205 REM CALLING THE SUBROUTINE THE FIRST TIME
1210 REM FOR THAT MAP, AND ARE NOT CHANGED UNTIL
1215 REM THE MAP IS FINISHED:
1220 REM
1225 REM A IS THE GEOGRAPHIC LATITUDE OF THE
1230 REM LOCATION ON WHICH THE MAP IS
1235 REM CENTERED.
1240 REM
1245 REM A1 IS EQUAL TO SIN(A).
1250 REM
1255 REM A2 IS EQUAL TO COS(A).
1260 REM
1265 REM F IS THE MAP SCALE FACTOR TO CONVERT
1270 REM TRUE PROJECTED RADIAL DISTANCE TO
1275 REM THE MAP RADIAL DISTANCE.
1280 REM F = R/ESIN(M), WHERE R IS THE
1285 REM RADIUS OF THE FINISHED MAP, IN CM OR
1290 REM INCHES; E IS AS DEFINED ABOVE; M IS
1295 REM AS DEFINED BELOW.
1300 REM F IS USED ONLY FOR PERSPECTIVE AND
1305 REM MODIFIED PERSPECTIVE PROJECTIONS.
1310 REM
1315 REM F1 IS THE MAP SCALE FACTOR TO CONVERT
1320 REM TRUE ARC DISTANCE TO THE MAP RADIAL
1325 REM DISTANCE. F1 IS USED FOR AZIMUTHAL
1330 REM EQUIDISTANT PROJECTIONS.
1335 REM
1340 REM F1 = R/M, WHERE R IS THE RADIUS OF
1345 REM THE FINISHED MAP, IN CM OR INCHES;
1350 REM AND M IS AS DEFINED BELOW.
1355 REM
1360 REM G IS A PRECOMPUTED FACTOR USED IN THE
1365 REM COMPUTATION OF THE RADIAL COMPONENT.

see that by this very simple modification of the azimuthal equidistant map program, we can use a single subroutine to generate any desired perspective map, as well as all of the orthographic, polar equidistant, and azimuthal equidistant maps illustrated in the earlier article! We will add a few frills that will make the program still more versatile.

Modified Perspective Projection

The azimuthal equidistant map portrays radial distances in a linear fashion. On the other hand, radial distances in a perspective map are computed from an involved trigonometric formula in order to show them as they actually appear when viewed from some point in space. Each of these maps has its own special applications, but also has (as do all maps) certain distortions.

A projection which is a compromise between the kinds of distortions inherent in the azimuthal equidistant and the pure perspective maps can be easily developed. This is done by using the same angular component, but presenting the radial distance in direct proportion to the sine of the arc distance. For the sake of simplicity, I will call this a modified perspective projection. It has been included as an option in the accompanying program. This projection is quite useful, especially when used in conjunction with the pure perspective projection, as we will see in some later examples. As an added bonus, the sine of the arc distance has to be computed anyway to come up with the angular component of the map coordinates, so we don't have to do any extra work to include this projection in the program.

General Purpose Perspective Projection

Program

The program in listing 1 is in the form of a subroutine, and is to be used in the same manner as the subroutines presented in part 1. The subroutine is fully documented by the remarks contained within it, so there is little need to elaborate. In fact, of the 300 lines in the listing, fewer than 60 are executable statements; the other 240 or so are all remarks concerning the use and operation of the program.

As in the case of the earlier programs, certain parameters are initialized, then the subroutine is called once for each pair of coordinates to be converted. A geographic latitude and longitude from the data base (see part 1 for a description of the data base) are supplied to the subroutine each time it
Waiting for the right 16 bit computer?

YOUR WAIT IS OVER!

Marinchip Systems M9900 System - 1

**HARDWARE**
- 16 bit CPU
- S-100 bus (11 slots)
- 60K RAM
- Dual 8" diskettes
  - 24 x 80 display

**SOFTWARE**
- Network operating system
- Extended Commercial BASIC
- PASCAL
- Word Processor

**APPLICATIONS**
- Payroll
- Accounts
- Payable/Receivable
- General Ledger

- If you've been waiting for the right small computer, your wait is over.
- The Marinchip Systems M9900 System-1 combines a 16 bit processor, powerful system software and the most wanted applications into a ready-to-use desktop computing system—a system that delivers the flexibility, performance and convenience made possible only by the combination of a third generation 16 bit processor and the industry compatible S-100 bus.
- If you’ve been waiting for a 16 bit computer, wait no more. The M9900 gives you the TI 9900—not an expanded microprocessor, but a mini-computer on a chip, complete with hardware multiply and divide and multiple register sets. And unlike other 16 bit microprocessors, the 9900 is a member of a complete, compatible, minicomputer family, so if you outgrow the M9900, you don't have to start all over.
- If you’ve been waiting for a more powerful operating system, your wait is over. The M9900’s Network Operating System is a system without limits—designed to grow as computer hardware evolves, without forcing you to change programs every time you change the hardware. The system provides byte addressable files up to four billion bytes in length, complete dynamic allocation and release, random/sequential access and linked directories for complex file structures. The system automatically pages file data to memory to optimize performance. All I/O devices are treated as files, eliminating device-dependent code in applications.
- If you've been waiting for the right basic, the M9900’s Extended Commercial Basic gives you 16 digit accuracy, PRINT USING, random and sequential files, CHAIN with common variables and a choice of interpretive execution for debugging or compilation for production. If you already have applications in BASIC, you’ll be glad to know that the M9900’s BASIC is similar enough to the most popular 8 bit BASIC that conversion won’t be a chore.
- If you’ve been waiting for applications you can really use, you’ll find our Word Processor, Payroll, Accounts Payable and Receivable and General Ledger to be flexible, easily maintained and ready to use when you plug the system in.
- If you've been waiting for a computer you can expand when you need to, the M9900's optional 165 CPS line printer ($2500) and 40 Megabyte removable cartridge disc system ($14,000) will make you happy. And since the M9900 uses the S-100 bus, you can choose accessory boards from the thousands available for S-100 systems—we don’t tie you to our products.
- Finally, the M9900 gives you one advantage no other computer can—it’s made by Marinchip Systems. We’re a computer company, not just a hardware company, software company or applications house. We designed the M9900 from the chips to the applications to bring you a product that advances the state of the art in small computers. Our products are mature, tested items, not dreams, and they’re backed up by complete documentation that’s been called the best in the industry.
- Since we’re responsible for all the M9900, we’re responsive to you. When you have a question, we can give you an answer, not another phone number. If you want to go your own way with the system, we also sell boards and kits that you can put into your own package.
- The wait for the third generation is over, so don’t wait any longer. Call or write today for more detailed information, or order our complete set of manuals.

**Complete system $7500**

**Manuals only $40**

Marinchip Systems

16 St. Jude Road

Mill Valley, CA 94941  ■  (415) 383-1545

Circle 206 on inquiry card.
LISTING 1 CONTINUED FROM PAGE 102:

1370 REM OF THE POLAR FORM OF THE MAP
1375 REM COORDINATES FOR PERSPECTIVE
1380 REM PROJECTIONS ONLY.
1385 REM H2 = E * (H2 - E*COS(C)); WHERE E IS
1390 REM AS DEFINED ABOVE; H2 AND M ARE AS
1395 REM DEFINED BELOW.
1400 REM
1405 REM H2 IS THE SUM OF THE EARTH'S RADIUS AND
1410 REM THE HEIGHT OF THE OBSERVER AND IS
1415 REM USED ONLY FOR PERSPECTIVE AND
1420 REM MODIFIED PERSPECTIVE PROJECTIONS.
1425 REM H2 = E + H; WHERE E IS AS DEFINED
1430 REM ABOVE, AND H IS THE HEIGHT OF THE
1435 REM OBSERVER (POINT OF PROJECTION) ABOVE
1440 REM THE SURFACE OF THE EARTH IN KM.
1445 REM
1450 REM L IS THE AZIMUTH THAT THE OBSERVER IS
1455 REM FACING, FROM 0 TO 2*PI RADIANS.
1460 REM CLOCKWISE FROM TRUE NORTH, AND IS
1465 REM USED ONLY FOR PERSPECTIVE AND
1470 REM MODIFIED PERSPECTIVE PROJECTIONS.
1475 REM
1480 REM J IS A FLAG WHICH INDICATES THE TYPE
1485 REM OF PROJECTION TO BE DONE:
1490 REM J=0; PERSPECTIVE PROJECTION;
1495 REM J=1; MODIFIED PERSPECTIVE PROJECTION,
1500 REM J=2; AZIMUTHAL EQUIDISTANT PROJECTION.
1505 REM
1510 REM L0 IS THE GEOGRAPHIC LONGITUDE OF THE
1515 REM LOCATION ON WHICH THE MAP IS
1520 REM CENTRED.
1525 REM
1530 REM M IS THE MAXIMUM POSSIBLE ANGULAR
1535 REM DISTANCE, IN RADIANS, THAT THE
1540 REM OBSERVER CAN SEE FROM THE POINT OVER
1545 REM WHICH HE IS LOCATED, TO THE LIMB
1550 REM (VISIBLE EDGE) OF THE EARTH, FOR A
1555 REM PERSPECTIVE OR A MODIFIED PERSPECTIVE
1560 REM PROJECTION. THIS BECOMES THE
1565 REM ANGULAR DISTANCE, IN RADIANS, FROM
1570 REM THE MAP CENTER TO THE EDGE OF THE
1575 REM MAP. M = FNC(E/H2); WHERE E AND H2
1580 REM ARE AS DESCRIBED ABOVE, AND FNC IS
1585 REM THE ARC COSINE FUNCTION; AS
1590 REM DESCRIBED ABOVE.
1595 REM
1600 REM FOR AN AZIMUTHAL EQUIDISTANT
1605 REM PROJECTION, M IS NORMALLY SET EQUAL
1610 REM TO PI (WHICH WILL PRODUCE A MAP OF
1615 REM THE ENTIRE EARTH), BUT THE USER MAY
1620 REM ALSO SET IT EQUAL TO ANY VALUE LESS
1625 REM THAN PI IF IT IS DESIRED TO MAP A
1630 REM SMALLER PORTION OF THE EARTH.
1635 REM
1640 REM THE FOLLOWING VARIABLES MUST BE DEFINED
1645 REM PRIOR TO EACH CALL OF THIS SUBROUTINE:
1650 REM
1655 REM L IS THE GEOGRAPHIC LONGITUDE (FROM THE
1660 REM DATA BASE) OF THE POINT BEING
1665 REM PROCESSED.
1670 REM
1675 REM THE FOLLOWING VARIABLES ARE COMPUTED BY
1680 REM THIS SUBROUTINE:
1685 REM
1690 REM B1 IS THE ABSOLUTE VALUE OF L1 (SEE
1695 REM BELOW).
1700 REM
1705 REM C IS THE NORMALIZED ANGULAR COMPONENT
1710 REM OF THE POLAR FORM OF THE MAP
1715 REM COORDINATES.
1720 REM
1725 REM C1 IS THE COSINE OF THE VALUE OF C
1730 REM BEFORE C IS NORMALIZED.
1735 REM
1740 REM D IS THE ANGULAR DISTANCE (THE ARC
1745 REM DISTANCE), IN RADIANS, BETWEEN THE
1750 REM LOCATION ON WHICH THE MAP IS
1755 REM CENTERED AND THE POINT BEING
1760 REM PROCESSED.
1765 REM
1770 REM D1 IS TEMPORARY STORAGE FOR THE SINE
1775 REM OF D.
1780 REM
1785 REM D2 IS TEMPORARY STORAGE FOR THE COSINE
1790 REM OF D.
1795 REM
1800 REM L1 IS THE DIFFERENCE BETWEEN THE
1805 REM LONGITUDE OF THE POINT BEING
1810 REM PROCESSED, AND THE LONGITUDE OF THE
1815 REM LOCATION ON WHICH THE MAP IS
1820 REM CENTERED.
1825 REM
1830 REM P1 IS TEMPORARY STORAGE FOR THE SINE
1835 REM OF THE LATITUDE OF THE POINT BEING
1840 REM PROCESSED.
1845 REM
1850 REM R1 IS THE RADIAL DISTANCE COMPONENT OF
1855 REM THE POLAR FORM OF THE MAP
1860 REM COORDINATES.
1865 REM
1870 REM S IS THE OFF-SCALE FLAG. S=0 MEANS
1875 REM ON-SCALE. S=1 MEANS OFF-SCALE.
1880 REM
1885 REM X IS THE MAP X-COORDINATE, IN CM OR
1890 REM INCHES.
1895 REM
1900 REM Y IS THE MAP Y-COORDINATE, IN CM OR
1905 REM INCHES.
1910 REM
1915 REM 2000 LET S = Z
1920 REM COMPUTE THE DIFFERENCE BETWEEN THE
1925 REM LONGITUDE OF THE POINT BEING PROCESSED

Listing 1 continued on page 106
Of course our Floppys aren't cheap.

Quality never is.

It's no use trying to hide the fact: Maxell Floppy Disks give you the finest quality you can buy no matter how much you spend. And more and more of you are agreeing that your data is worth our perfection.

Our floppys work better with your drive.

Naturally, our floppys conform to ISO and IBM specifications. More important, they have also been approved by major OEMs, the people who recommend only those few floppys they are certain will work best with their hardware. So although we obviously don't know which drive system you are using, it makes no difference. Maxell Floppy Disks are so good they actually work better with any drive.

What it all means for you.

Yes, you can pay less for some other floppys. But lost data is a terrible price to pay when quality is what you want. And Maxell Floppy Disks help you profit in the very parameters you use this medium for: storing more data with virtually no down-time.

The level of modulation uniformity in every Maxell floppy is vital to double density recording and readout. It means no peak shift, complete freedom from dropouts, total absence of particle orientation. Plus longer life, greater overall durability, and significantly less oxide build-up and head abrasion.

So when you have to depend on full data retrieval, a few cents can make a big difference. Depend on Maxell Floppy Disks. They can really save you.

Maxell offers the full range of Floppy Disks from standard 8-inch to 5¼-inch plus Data Cassettes. Dealer inquiries invited.
Listing 1 continued from page 104:

2300 REM AND THE LONGITUDE OF THE LOCATION ON
2400 REM WHICH THE MAP IS CENTERED, THEN
2500 REM NORMALIZE THAT VALUE BETWEEN -PI AND
2550 REM +PI.
2600 LET L1 = L - L0
2700 IF L1 > 360 THEN 3000
2800 LET L1 = L1 - 360
2900 GO TO 5400
3000 IF L1 < 360 THEN 4000
3050 IF L1 > L6 THEN 4400
3200 REM IF THE LONGITUDINAL DIFFERENCE (THE
3250 REM VALUE OF L1) IS WITHIN 0.00015 Radian
3300 REM OF 0 (OR PI) THEN THE DIFFERENCE IS
3350 REM CONSIDERED TO BE EXACTLY 0 (OR PI).
3400 REM SUCH CASES: THE GREAT CIRCLE BEARING, C,
3450 REM CAN HAVE A VALUE OF ONLY 0 OR PI (NOT
3500 REM NECESSARILY RESPECTIVELY), AND THE
3550 REM STATEMENTS FROM HERE THROUGH STATEMENT
3600 REM (LINE) NUMBER 4215 PROCESS THE DATA FOR
3650 REM THESE CONDITIONS.
3700 LET B1 = ABS(L1)
3750 IF B1 > 1 THEN 4050
4000 LET B1 = 0.00015 Radian
4050 IF B1 > 0 THEN 4050
4100 LET D = ASIN(B1 - P)
4150 IF D > M THEN 4300
4200 LET D1 = SIN(D)
4250 LET D2 = COS(D)
4300 LET C = Z
4350 IF P >= A THEN 5000
4400 LET C = K3
4450 GO TO 5000
4500 IF B1 < 1 THEN 4250
4550 IF ABS(K3 - B1) > 1 THEN 4250
4600 LET D = K3 - A - P
4650 IF D > K3 THEN 4100
4700 LET D = K3
4750 IF D > Z THEN 4000
4800 GO TO 4200
4850 LET D = K6 - D
4900 GO TO 4200
4950 LET D = K5 - Z
4200 IF D > M THEN 4300
4250 LET D1 = SIN(D)
4300 LET D2 = COS(D)
4350 GO TO 5000
4400 REM COMPUTE THE ARC DISTANCE, D, AND THE
4450 REM GREAT CIRCLE BEARING, C, BETWEEN THE
4500 REM LOCATION ON WHICH THE MAP IS CENTERED
4550 REM AND THE POINT BEING PROCESSED.
4600 LET P1 = SIN(P)
4650 LET Q2 = A1 * P1 + A2 * COS(P) * COS(L1)
4700 LET D = FNC(Q2)
4750 REM IF THE COMPUTED ARC DISTANCE IS GREATER
4800 REM THAN THE MAXIMUM POSSIBLE ARC DISTANCE
4850 REM FOR THIS MAP THEN THE POINT IS
4900 REM OFF-SCALE, AND CONTROL RETURNS TO THE
4950 REM CALLING POINT AFTER SETTING THE
5000 REM OFF-SCALE FLAG.
5050 IF D <= M THEN 4500
5100 LET S = K1
5150 RETURN
5200 LET D1 = SIN(D)
5250 LET C1 = (P1 - A1 * D2) / (A2 * D1)
5300 IF C1 < -K1 THEN 4300
5350 IF C1 > K1 THEN 4300
5400 LET C = FNC(C1)
5450 REM NORMALIZE THE VALUE OF C, DEPENDING
5500 REM UPON THE RELATIVE LONGITUDES OF THE
5550 REM LOCATION ON WHICH THE MAP IS CENTERED
5600 REM AND THE POINT BEING PROCESSED.
5650 IF L1 >= Z THEN 5000
5700 LET C = K6 - C
5750 REM AT THIS POINT C IS IN THE RANGE FROM
5800 REM 0 TO 2*PI MEASURED C LOCKWISE FROM TRUE
5850 REM NORTH.
5900 REM
5950 REM IF THE VALUE OF I IS NOT 0, ROTATE THE
6000 REM COORDINATES BY THE AMOUNT OF I.
6050 IF I = Z THEN 5500
6100 LET C = C - I
6150 IF C >= Z THEN 5500
6200 LET C = K6 - C
6250 REM REVOLVE THE DIRECTION OF MEASUREMENT OF
6300 REM C AND ROTATE IT BY PI/2, THEN
6350 REM NORMALIZE THE RESULT BETWEEN -PI AND
6400 REM +PI, C THEN REPRESENTS THE NORMALIZED
6450 REM FORM OF THE ANGULAR COMPONENT OF THE
6500 REM POLAR FORM OF THE MAP COORDINATES.
6550 LET C = K2 - C
6600 IF C >= -K3 THEN 6000
6650 LET C = C - K6
6700 REM IF A TRUE PERSPECTIVE PROJECTION IS NOT
6750 REM TO BE USED, GO TO 6500.
6800 IF J <> Z THEN 6500
6850 REM COMPUTE THE RADIAL COMPONENT, R1, OF
6900 REM THE POLAR FORM OF THE MAP COORDINATES
6950 IF I <> K1 THEN 6700
7000 REM FOR A TRUE PERSPECTIVE PROJECTION.
7050 LET R1 = F * (C + D1) / (C2 - E * D2)
7100 GO TO 7000
7150 REM IF A MODIFIED PERSPECTIVE PROJECTION IS
7200 REM NOT TO BE USED, GO TO 6700.
7250 IF J <> K1 THEN 6700
7300 REM COMPUTE THE RADIAL COMPONENT, R1, OF
7350 REM THE POLAR FORM OF THE MAP COORDINATES
7400 REM FOR A MODIFIED PERSPECTIVE PROJECTION.
7450 REM LET R1 = F * E * U1
7500 GO TO 7000
7550 REM COMPUTE THE RADIAL COMPONENT, R1, OF
7600 REM THE POLAR FORM OF THE MAP COORDINATES
7650 REM FOR AN AZIMUTHAL EQUIDISTANT PROJECTION.
7700 LET R1 = F1 * D
7750 REM CONVERT THE POLAR MAP COORDINATES TO
7800 REM RECTANGULAR MAP COORDINATES.
7850 LET X = R1 * COS(C)
7900 LET Y = R1 * SIN(C)
7950 RETURN
8000 LET C = FNC(C1)
8050 REM
THE SEARCH FOR A SMALL COMPUTER SYSTEM STARTS HERE

It's the 3rd Annual National Small Computer Show, presenting the state-of-the-art showcase for micro and mini-systems technology and software. Here you can survey virtually all makes and models of small computers, whether your interest runs to a no-nonsense micro priced in the hundreds of dollars or a powerful mini costing $20,000 or more. They're all here.

The world of small computers is quite large, extending to business and professional offices, scientific research, medicine and bionics, education, the home and hobbyist, therapeutic applications for the handicapped, design and engineering.

A full selection of lectures is presented to provide a grasp of small systems technology, so that you know what to consider when buying a computer or word processor. It's the first step in discovering what a system can really do for you!

NSCS lectures include sessions on system selection, computer languages, word processing functions, artificial intelligence, software applications, and a dozen more topics for people of all interests.

Plan now to attend. There will be about 30,000 square feet of exhibits, and more than 40 hours of lectures from which to choose. Registration fee is only $5.00 per day, including lectures.

Write for our informational brochure from National Small Computer Show, 110 Charlotte Place, Englewood Cliffs, N.J. 07632.

THIRD ANNUAL NATIONAL SMALL COMPUTER SHOW,
Figure 1: A view of the Earth as seen from a point over the southeastern Indian Ocean.

Text continued from page 102:

is called. It returns the rectangular \((X,Y)\) map coordinates (in inches or centimeters) corresponding to that point for the selected projection. The units (inches or centimeters) in which the computerist initially specifies the radius of the finished map automatically determine the units of the map coordinates. All constants, such as \(\pi\) and \(\theta\), have been given variable names because most BASIC interpreters can operate faster on variables than on numeric constants.

Remember that all angular parameters are in radians. The program uses spherical trigonometry to arrive at the solution, and some tests have been included to prevent the trigonometric functions from "blowing up" when the map center and the distant point both lie on the same meridian.

The trigonometric functions can also blow up if you attempt to generate an azimuthal equidistant map centered on either of the two poles (i.e., a polar equidistant map). This can be avoided by simply specifying the latitude of the map center as slightly less than 90° (perhaps 89.99°).

The exact maximum value that can be used will depend upon the precision of your trigonometric routines, but, in any case, you won't be able to see the difference on the finished maps. Incidentally, the longitude that you specify for this kind of map will determine its orientation. This capability was not available with the simplified polar equidistant map program presented in part 1.

For all other types of maps, an option (I) has been included in the program to permit the user to specify the azimuth that the observer in space is facing (i.e., to specify the orientation of the map). While this option has little value for a printed map (which the user can turn in any direction), it comes in handy on a video display which is simulating the view from a window of a maneuvering spacecraft.

Within the limits of resolution of any map that you produce, you can assume, for perspective projections, that if the observer is beyond 10,000,000 km above the Earth, the distance is infinite. If you wish to generate an orthographic map, simply assume a height of 10,000,000 km for the observer, and there will be no detectable difference between the resulting map and a truly orthographic map.

Grid lines generally enhance the appearance of perspective maps. These can be included by generating the geographic coordinates within loops in your main (driver) program, then calling the subroutine to obtain the map coordinates. Keep the number of generated points down to the minimum required to obtain the desired resolution, as it is not difficult to expend more processor time creating the grid than creating the map.

Having covered the major operational features of the program (additional details are contained in the remarks within the listing), let us now look at some specific examples. All of the maps illustrated here were generated using the subroutine given in listing 1. Each map was created for a specific purpose and should give you some ideas as to the applications of this program to your own system.

**Perspective Maps**

Figure 1 provides a good example of what this program can do. Here, the point of projection has been placed at infinity, over a point in the southeastern Indian Ocean. This gives us an excellent view of Australasia, as well as Antarctica. You can create a similar view of any part of the Earth by simply providing the coordinates of the central point. Orthographic perspective
Our Prices are too low to advertise. Please call or write.

We carry a full line of Texas Instruments products

**TERMINALS**

LEAR-SIEGLER

ADM-3A  ADM-31  ADM-42

HAZELTINE

1400  1410  1500  Mod 1 Edit

CALL* for prices

**PRINTERS**

OKIDATA

SL125  110

CALL* for prices

TELETYPE

43

CALL* for price

CENTRONICS

Micro  779-2  700-2  703-0

CALL* for prices

**COMPUTERS**

NORTHSTAR

Horizon II (Kit)

CALL* for price

DIGITAL SYSTEMS

DSC-2  Dble Density  Dual Drive Disk

CALL* for prices

CROMEMCO

System 3

CALL* for price

MORE SPECIALS

Decwriter II  Dume Sprint 5/45  RO  Persci 277 Dble Density  Imel PC 80/15  Anadex DP 8000  Printer

CALL* for prices

SOFTWARE

Here are nine packages that enable you to make full use of the potential in your small computer system:

ACCOUNTS RECEIVABLE

INVENTORY

ORDER ENTRY

WORD PROCESSING

PAYROLL

REAL ESTATE MGT.

MEDICAL-DENTAL

MAILING PROGRAM

SHIPPING & RECEIVING

and MORE!

Microsoft Basic, Fortran, Cobol available

CALL* for prices

We have a full staff of Programmers and Computer Consultants to design, configure and deliver a Turnkey Computer System to meet your specific requirements.

SYNCHRO-SOUND ENTERPRISES, INC.

The Computer People
193-25 Jamaica Avenue, Jamaica, New York 11423
212/468-7687  TWX 710-582-5866

Circle 355 on inquiry card.
projections, such as this one, find widespread use in scientific applications and are also quite attractive when used in games.

Anyone who watches television weather reports regularly should recognize the maps in figures 2a and 2b. These are the views seen by the two primary United States geosynchronous weather satellites, GOES-2 and GOES-3. (Note that these are not orthographic projections; the field of view extends only about 80° from the central point). Sequences of pictures from these satellites are frequently made into film loops and shown as a sort of jerky motion picture. Although the photographs you see on television usually have outline maps drawn on them, the original pictures transmitted by the satellites do not.

A number of enterprising amateur radio operators and experimenters around the world have built equipment to receive the signals directly from the satellites and print out up-to-the-minute weather pictures in their own homes. Through the use of the perspective projection program, one can generate map overlays in the same scale as the received pictures. This is particularly easy if the weather pictures are being displayed on a video screen where the map can be overlaid electronically.

The same principle is applicable to pictures received from some of the lower altitude polar orbiting weather satellites. Many of the early US APT (automatic picture transmission) satellites, such as those in the ESSA series, used a "snapshot" technique to record the images. The satellite would snap a photograph and transmit it in its entirety before snapping another one. By entering into the computer the altitude of the satellite and the coordinates of its subpoint, one could generate a map overlay to fit the photograph snapped by the satellite at that particular point.

When the next picture was snapped a few minutes later, the satellite would have traveled several hundred miles, but by entering the new coordinates a correct map overlay would be created for each picture. In actual practice, a tracking subroutine is usually incorporated to compute the coordinates of the satellite subpoint. (As exotic as this sounds, it requires only a few simple calculations.)
New RAM Prices.
From The Dynamic Memory Company.

16K—$249  32K—$375  48K—$500  64K—$625

Ever since we started making these memory boards over a year ago we have continued to lower our prices to stay competitive. Due to your confidence in us, we are again able to lower our prices! Our reliability has been proven by months of superior performance in thousands of installations. Our low-power boards are being used by quality-minded systems manufacturers across the country and overseas.

4MHz boards now available.
After receiving hundreds of requests, our engineering staff has come up with a new version of our board which runs on 4MHz Z-80 systems. It wasn’t easy to come up with a high speed board which would operate as reliably as our 450ns version, but after months of careful design and testing, we did it. The price of the 250ns board is $10 per 16K additional.

All of our features remain.
Our boards didn’t become great sellers only because of the price. We still offer you our deselect feature which allows our RAM to overlap with any fixed memory areas in your system. Also, the RAM area of our board is fully socketed so that you can expand the board yourself.

Other standard features include:
plug selectable addressing on 16K boundaries (shorting plugs are placed over wire-wrap pins to address the board — located on the top of the board for easy changes), S-100 and Z-80 compatibility and totally invisible refresh — no wait states.

Fully assembled, tested, and guaranteed.
All of our boards go through a rigorous testing procedure. They are then placed on burn-in running a series of memory tests to detect any other possible faults. After you receive the board, you are backed by us with a one year warantee.

Low power consumption keeps your computer from “losing its cool.”
The total power consumption of our 16K board is typically less than 4 watts (+8V @ 300ma, +16V @ 150ma and −16V @ 20ma). Boards with additional memory typically increase power consumption only 1 watt per 16K!

Standard S-100 interface.
Our board is designed to interface with any standard S-100 CPU. All of the timing of the board is independent of the processor chip, and the board is set up for different processors by changing two plugs on the board.

Contact your local dealer.
To find out more about our RAM boards, contact your local dealer. If he is unable to help you, call or write us for a fast response.
Central Data Corporation, 1207 North Hagan Street, Champaign, IL 61820. (217) 359-8010

Central Data
The newer US polar orbiting weather satellites, such as TIROS-N, use a slightly different transmission system which greatly improves the picture quality, the ease of reception, and the amount of data received. It makes the generation of map overlays more difficult, however, and the program presented here cannot be used. (Once you are familiar with the transmission system, it is not difficult to develop a program to do the job.) There are a few satellites, including some of the Soviet Meteor series spacecraft, that still use the older system, but their picture quality is relatively poor and hardly worth the effort to obtain them.

Figure 3 represents the scene below the Oscar 7 amateur radio communications relay satellite as it passes over Atlanta GA. Anyone engaged in satellite communications would do well to have available the capability for such a display. Updated in real time, it provides a continuous panorama of the area visible from the satellite and, hence, the area with which communications through the satellite are possible at any particular time. Any two or more stations can talk to one another as long as they are located within the mapped area. As the satellite moves in its orbit, the mapped area changes, but as long as your own location is within the map you can talk to all other points on the map.

**Modified Perspective Maps**

We have also come upon the ideal occasion to make use of the modified perspective projection. Figure 4 illustrates the same area as that of figure 3, but the modified projection has been used to reduce some of the distortion inherent in the pure perspective version. Note the differences between the figures, especially in the west coast areas of the US, the northern coast of South America, and the upper reaches of Hudson Bay. Remember that both maps cover the same area.
CIS COBOL is more than an efficient COBOL Compiler. It is a complete software development tool for business and office automation systems. It enables the programmer to write applications in a powerful subset of ANSI 74 standard COBOL and to take advantage of CIS COBOL language extensions such as interactive screen handling which are designed to fully exploit the special features of the microcomputer environment. Version 3 of CIS COBOL has many language additions but the compiler still requires only 20K bytes of memory and runs on 8080 and Z80 based microcomputers with 32K to 64K under the popular CP/M* operating system.

CIS COBOL is designed to support interactive applications. Areas of a CRT screen are mapped onto record descriptions in your CIS COBOL program and data is transferred using the ACCEPT and DISPLAY verbs providing full cursor manipulation and data entry facilities to the CRT operator. CIS COBOL language extensions enable the screen position at which the transfer is to start to be specified, protected fields to be defined and the CURSOR position to be detected and set by the program.

CIS COBOL is able to exploit features of the microcomputer. Language extensions in CIS COBOL enable programs to define file names at run time, to read and write text files of variable record length and to access free memory in varying machine configurations. CIS COBOL supports run time subroutines written in assembler and accessed from COBOL by means of the CALL USING verb. Built in subroutines implement facilities to CHAIN programs together, PEEK and POKE memory locations outside your COBOL program and GET and PUT data to special peripheral devices via your microcomputer's I/O ports.

CIS COBOL is orientated toward rapid program development. The compiler accepts input of your source program direct from keyboard as well as from source and library files on disk and generates an object file which the CIS COBOL run time system immediately loads and executes or optionally links and saves as a self loading program. The run time system has built-in indexed and relative I/O packages and contains an interactive debug package to help find errors quickly by stepping through the execution of your CIS COBOL program.

CIS COBOL is supported by intelligent utility programs. When you take delivery of CIS COBOL Version 3 on 8 inch or 5 inch diskette you will receive in addition to the compiler and run time system the CONFIG program which enables you to configure CIS COBOL run time systems to drive many different types of "dumb" CRT terminal such as Lear Siegler ADM3A and Hazeltine 1500, plus the time saving FORMS program which allows you to create and edit screen images of business forms and then automatically generate the corresponding COBOL record descriptions to COPY into your CIS COBOL program.
Maps for Space Games

Let us now take a look at some maps that will be of special interest to space game fans. Figures 5a through 5f comprise a sequence of views of the Earth as seen from the window of a spacecraft taking off from Peterborough NH (where BYTE Publications is located). The particular altitudes used in generating these figures were chosen arbitrarily, but they could just as well be input from the game program itself. A fairly large altitude change is required to get a significant change of scenery (assuming no lateral movement). Therefore, it is not necessary to update the display very often if the spacecraft is ascending or descending vertically. Whenever the craft is moving laterally, however, you will want to change the display more often.

The final two views in the sequence of figure 5 are orthographic; that is, the point of projection is at infinity. Although this is not truly realistic in terms of what space travelers see as they recede from the Earth, it is typical of the display that the ship's navigator might have on his video console, regardless of altitude. (Of course, the navigator would want to have a map display of an area considerably larger than what could be seen out the window.)

The last view of the sequence shows the orientation after the spacecraft has made a 45° turn to the right (assuming the observer of Hudson Bay. While figure 3 reproduces the scene as it appears visually, figure 4 shows more clearly all of the areas with which communications can be established when the satellite is at the given point.

Incidentally, all of the Oscar satellites are at altitudes comparable to those of the various polar orbiting weather satellites. Indeed, they are launched on the same rockets. The Oscars take the place of otherwise useless ballast and are ejected a few minutes before or after the weather birds. Consequently, the pictures transmitted from this type of weather satellite, especially the earlier versions, are views similar to that shown in figure 3.

Text continued on page 122
For Homeowners, Businessmen, Engineers, Hobbyists, Doctors, Lawyers, Men and Women

We have been in business for over nine years building a reputation for providing a quality product at nominal prices — NOT what the traffic will bear. Our software is:

- Versatile — as most programs allow for multiple modes of operation.
- Tutorial — as each program is self-prompting and leads you through the program (most have very detailed instructions contained right in their source code).
- Comprehensive — as an example our PSD program not only computes Power Spectral Densities but also includes FFTs, inverse-transforms, Windows, Sliding Windows, simultaneous FFT's variable data sizes, etc. and as a last word our software is:
- Readable — as all of our programs are reproduced full size for ease in reading.

Our Software Is copyrighted and may not be reproduced or sold.

For Homeowners, Businessmen, Engineers, Hobbyists, Doctors, Lawyers, Men and Women

- Virtually Machine Independent — these programs are written in a subset of Dartmouth Basic but are not oriented for any one particular system. Just in case your Basic might not use one of our functions we have included an appendix in Volume V which gives conversion algorithms for 19 different Basics; that’s right, just look it up and make the substitution for your particular version. If you would like to convert your favorite program into Fortran or APL or any other language, the appendix in Volume V will define the statements and their parameters as used in our programs.

Over 85% of our programs in the first five volumes will execute in most 8K Basic’s with 16K of free user RAM. If you only have 4K Basic, because of its lack of string functions only about 60% of our programs in Volumes I through IV would be usable, however they should execute in only 8K of user RAM.

For those that have specific needs, we can tailor any of our programs for you or we can write one to fit your specific needs.

Vol. I — $24.95
Bookkeeping
Games & Pictures

Vol. II — $24.95
Math/Engineering
Racing/Scatistics
Basic Statement Data

Vol. III — $39.95
Advanced Business
Billing, Inventory
Investments
Paysroll

Vol. IV — $9.95
General Purpose

Vol. V — $9.95
Experimenter's Program

Vol. VI — $39.95
Professional Programs

Vol. VII — $39.95
Homeowner's Programs

AVAILABLE AT MOST COMPUTER STORES
Master Charge and Bank Americard accepted.

Our Software Is copyrighted and may not be reproduced or sold.

Scientific Research
PO. Box 490099-B
Key Biscayne, FL 33149
Phone orders call 800-327-6543
Information — (305) 361-1153

BYTE June 1979
For your SWTP 6800 Computer... PERCOM's™ FLOPPY DISK SYSTEM

the LFD-400

Ready to plug in and run the moment you receive it. Nothing else to buy, no extra memory. No "booting" with PerCom MINIDOS-PLUS™, the remarkable disk operating system on EPROM. Expandable to either two or three drives. Outstanding operating, utility and application programs.

For the low $599.95 price, you not only get the disk drive, drive power supply, SS-50 bus controller/interface card, and MINIDOS-PLUS™, you also receive:

- an attractive metal enclosure
- a fully assembled and tested interconnecting cable
- a 70-page instruction manual that includes operating instructions, schematics, service procedures and a complete listing of MINIDOS™
- technical memo updates — helpful hints which supplement the manual instructions
- a 90-day limited warranty.

SOFTWARE FOR THE LFD-400 SYSTEM

Disk operating and file management systems

INDEX™ The most advanced disk operating and file management system available for the 6800. Interrupt Driven Executive operating system features file- and device-independent, queue-buffered character stream I/O. Linked-file disk architecture, with automatic file creation and allocation for ASCII and binary files, supports sequential and semi-random access disk files. Multi-level file name directory includes name, extension, version, protection and date. Requires 8K RAM at $A000. Diskette includes numerous utilities. $99.95

MINIDOS-PLUS™ An easy-to-use DOS for the small computing system. Supports up to 31 named files. Available on ROM or diskette complete with source listing. $99.95

BASIC Interpreters and Compilers

SUPER BASIC A 10K extended disk BASIC interpreter for the 6800. Faster than SWTP BASIC. Handles data files. Programs may be prepared using a text editor described below. $49.95

BASIC TP-9K BASIC into a random access data file disk BASIC. Includes many speed improvements, and program disk CHAINing. $17.95

STRUBAL+™ A STRuctured Basic Language compiler for the professional programmer. 14-digit floating point, strings, scientific functions, 2-dimen sional arrays. Requires 20K RAM and Linkage Editor (see below). Use of the following text editors to prepare programs. Complete with RUN-TIME and FLOATING POINT packages $249.95

Text Editors and Processors

EDIT69 Hemenway Associates' powerful disk-based text editor. May be used to create programs and data files. Supports MACROS which perform complex, repetitive editing functions. Permits text files larger than available RAM to be created and edited. $39.95

TOUCHUP™ Modifies TSC's Text Editor and Text Processor for PerCom disk operation. ROLL function permits text files larger than available RAM to be created and edited. Supplied on diskette complete with source listing. $17.95

Assemblers

PerCom 6800 SYMBOLIC ASSEMBLER Specify assembly options at time of assembly with this symbolic assembler. Source listing on diskette. $29.95

MACRO-RELOCATING ASSEMBLER Hemenway Associates' assembler for the programming professional. Generates relocatable linking object code. Supports MACROS. Permits conditional assembly. $79.95

LINKAGE EDITOR — for STRUBAL+™ and the MACRO-Re locating assembler $49.95

CROSS REFERENCE Utility program that produces a cross-reference listing of an input source listing file. $29.95

Business Applications

GENERAL LEDGER SYSTEM Accommodates up to 250 accounts. Financial information immediately available — no sorting required. Audit trail information permits tracking from GL record data back to source document. User defines account numbers. $199.95

FULL FUNCTION MAILING LIST 700 addresses per diskette. Powerful search, sort, create and update capability. $99.95

PERCOM FINDER™ General purpose information retrieval system and data base manager. $99.95

Ordering Information

To order, call toll free 1-800-527-1592. COD orders require 30% deposit plus 5% handling charge. Allow three weeks for delivery. Allow three extra weeks if payment is by personal check. Texas residents add 4% sales tax.

PERCOM 'peripherals for personal computing'
Low Cost Add-On Storage for Your TRS-80*. In the Size You Want.

When you're ready for add-on disk storage, we're ready for you. Ready with six mini-disk storage systems — 102K bytes to 591K bytes of additional on-line storage for your TRS-80*.

- Choose either 40-track TFD-100™ drives or 77-track TFD-200™ drives.
- One-, two- and three-drive systems immediately available.
- Systems include Percom PATCH PAK #1™, on disk, at no extra charge. PATCH PAK #1™ de-glitches and upgrades TRSDOS® for 40- and 77-track operation.
- TFD-100™ drives accommodate "flippy disks." Store 205K bytes per mini-disk.
- Low prices. A single-drive TFD-100™ costs just $399. Price includes PATCH PAK #1™ disk.
- Enclosures are finished in system-compatible "Tandy-silver" enamel.

Whether you need a single, 40-track TFD-100™ add-on or a three-drive add-on with 77-track TFD-200™s, you get more data storage for less money from Percom.

Our TFD-100™ drive, for example, lets you store 102.4K bytes of data on one side of a disk — compared to 80K bytes on a TRS-80® mini-disk drive — and 102.4K bytes on the other side, too. Something you can't do with a TRS-80® drive. That's almost 205K bytes per mini-disk.

And the TFD-200™ drives provide 197K bytes of on-line storage per drive. — 197K, 394K and 591K bytes for one-, two and three-drive systems.

PATCH PAK #1™, our upgrade program for your TRSDOS®, not only extends TRSDOS® to accommodate 40- and 77-track drives, it enhances TRSDOS® in other ways as well. PATCH PAK #1™ is supplied with each drive system at no additional charge.

The reason you get more for less from Percom is simple. Peripherals are not a sideline at Percom. Selling disk systems and other peripherals is our main business — the reason you get more engineering, more reliability and more back up support for less money.

In the Product Development Queue . . . a printer interface for using your TRS-80® with any serial printer, and . . . the Electric Crayon™ to map your computer memory onto your color TV screen — for games, animated shows, business displays, graphs, etc. Coming soon.

From PERCOM

One-Drive System
$399. (40-track) & $875. (77-track)

Two-Drive System
$795. (40-track drives) & $1350. (77-track drives)

Three-Drive System
$1195. (40-track drives) & $2025. (77 track drives)

Requires Expansion Interface Level II BASIC & 16K RAM

In the Size You Want.

When you're ready for add-on disk storage, we're ready for you. Ready with six mini-disk storage systems — 102K bytes to 591K bytes of additional on-line storage for your TRS-80*.

- Choose either 40-track TFD-100™ drives or 77-track TFD-200™ drives.
- One-, two- and three-drive systems immediately available.
- Systems include Percom PATCH PAK #1™, on disk, at no extra charge. PATCH PAK #1™ de-glitches and upgrades TRSDOS® for 40- and 77-track operation.
- TFD-100™ drives accommodate "flippy disks." Store 205K bytes per mini-disk.
- Low prices. A single-drive TFD-100™ costs just $399. Price includes PATCH PAK #1™ disk.
- Enclosures are finished in system-compatible "Tandy-silver" enamel.

Whether you need a single, 40-track TFD-100™ add-on or a three-drive add-on with 77-track TFD-200™s, you get more data storage for less money from Percom.

Our TFD-100™ drive, for example, lets you store 102.4K bytes of data on one side of a disk — compared to 80K bytes on a TRS-80® mini-disk drive — and 102.4K bytes on the other side, too. Something you can't do with a TRS-80® drive. That's almost 205K bytes per mini-disk.

And the TFD-200™ drives provide 197K bytes of on-line storage per drive. — 197K, 394K and 591K bytes for one-, two and three-drive systems.

PATCH PAK #1™, our upgrade program for your TRSDOS®, not only extends TRSDOS® to accommodate 40- and 77-track drives, it enhances TRSDOS® in other ways as well. PATCH PAK #1™ is supplied with each drive system at no additional charge.

The reason you get more for less from Percom is simple. Peripherals are not a sideline at Percom. Selling disk systems and other peripherals is our main business — the reason you get more engineering, more reliability and more back up support for less money.

In the Product Development Queue . . . a printer interface for using your TRS-80® with any serial printer, and . . . the Electric Crayon™ to map your computer memory onto your color TV screen — for games, animated shows, business displays, graphs, etc. Coming soon.

Percom peripherals for personal computing

To order add-on mini-disk storage for your TRS-80®, or request additional literature, call Percom's toll-free number: 1-800-527-1592. For detailed Technical Information call (214) 272-3421.

Orders may be paid by check or money order, or charged to Visa or Master Charge credit accounts. Texas residents must add 5% sales tax.

Percom peripherals for personal computing
### P.E.T. ★ Food ★

<table>
<thead>
<tr>
<th>DAY</th>
<th>AMOUNT</th>
<th>METHOD OF PAY</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.33</td>
<td>CASH</td>
<td>PENNZOIL</td>
</tr>
<tr>
<td>2</td>
<td>35.98</td>
<td>MCHG</td>
<td>CRITTERS</td>
</tr>
<tr>
<td>3</td>
<td>288.11</td>
<td>D OF A</td>
<td>WOOL SUIT</td>
</tr>
<tr>
<td>4</td>
<td>12.29</td>
<td>CASH</td>
<td>TOOTHBRUSH</td>
</tr>
<tr>
<td>5</td>
<td>3.95</td>
<td>CHKX186</td>
<td>BOOK</td>
</tr>
<tr>
<td>6</td>
<td>46.57</td>
<td>DASH</td>
<td>2 WEK'S FOOD</td>
</tr>
<tr>
<td>7</td>
<td>316</td>
<td>MCHG</td>
<td>GIFT FOR WIFE</td>
</tr>
<tr>
<td>8</td>
<td>2.75</td>
<td>CASH</td>
<td>PAY FOR 1 HOUR</td>
</tr>
<tr>
<td>9</td>
<td>5.81</td>
<td>CASH</td>
<td>SUIT CLEANED</td>
</tr>
</tbody>
</table>

To go on, press any key.

### Household Finance Part 1

You spent the following amounts in each category for the months of JANUARY FEBRU

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>AMOUNT</th>
<th>CATEGORY</th>
<th>AMOUNT</th>
</tr>
</thead>
<tbody>
<tr>
<td>AUTO</td>
<td>10.45</td>
<td>INCOME</td>
<td>1.75</td>
</tr>
<tr>
<td>CHRISTMAS</td>
<td>46.02</td>
<td>MEDICAL</td>
<td>3.11</td>
</tr>
<tr>
<td>ENTERTAIN</td>
<td>38.50</td>
<td>SAVINGS</td>
<td>5.37</td>
</tr>
<tr>
<td>FOOD</td>
<td>238.74</td>
<td>VACATION</td>
<td>18.23</td>
</tr>
<tr>
<td>HOUSE</td>
<td>53.44</td>
<td>VACATION</td>
<td>2.23</td>
</tr>
</tbody>
</table>

**Total amount spent was 4358.99**

**Total income was 2.75**

Do you want a spending profile for this part of the month?

### Household Finance Part 2

**Part 1** inputs, lists, adds, updates, changes, and deletes items. Writes data to a cassette tape.

**Part 2** reads data tape; gives single item, single month and year-to-date sums.

Both parts ................ $15.00

> Also Available «

**SPACE WAR** .... $10.00

**Household Utility 1**

(3 Programs) ... $12.00

**Dual Joystick Interface** .... $45.00

**SEAWOLF** .... $10.00

**BREAKOUT** .... $10.00

**LIFE** ............. $20.00

ORDERS: Send check, money order, or VISA/Mastercharge (include expiration date) and add $1.50 shipping. Calif. residents add 6% sales tax.

INFORMATION: More information on these and many other currently available programs is available on a free flyer. Write directly to Creative Software.

Creative Software
P.O. BOX 4030, MOUNTAIN VIEW, CA 94040
VIEWED FROM INFINITY, OVER 42°S3N 71°57W, FACING 0 DEG AZIMUTH
PERSPECTIVE PROJECTION PREPARED BY WILLIAM D. JOHNSTON

VIEWED FROM INFINITY, OVER 42°S3N 71°57W, FACING 45 DEG AZIMUTH
PERSPECTIVE PROJECTION PREPARED BY WILLIAM D. JOHNSTON

MORE BANG PER BUCK

The PERKIN-ELMER BANTAM

ALL NEW

$799.00

All the Features of the Hazeltine 1400 & LSI ADM-3A

Plus

Upper/Lower Case
7 x 10 Char Matrix
White or Black Char.
Transparent Mode
Tab Function
Backspace Key
Shiftlock Key
Print Key
Integrated Numeric Pad

$41.61 per month
Lease-Purchase

$1095.00

TELETYPYHE
MODEL 43
KSR

with RS232
10 or 30 CHAR/SEC
132 COLUMNS
UPPER/LOWER CASE

USR-310
Originate
Acoustic
$149.00

Coupler
0-300 Baud
Crystal Controlled
RS232

USR-330
Originate
Auto-Answer
$324.00

Modem
FCC Certified for Direct Connection
to Phone Lines

USR-320 Auto-Answer
Only Modem $299.00

All Units include a 120 day warranty
Optional Maintenance package available

Any Product may be returned
within 10 days for a full refund.

U.S. ROBOTICS, INC.
1035 W. LAKE ST.
CHICAGO, ILL. 60607

Sales (312) 733-0497
General Offices (312) 733-0498
Service (312) 733-0499

June 1979 © BYTE Publications Inc
**DIGITAL RESEARCH**

- CP/M® FDOS — Diskette Operating System complete with Text Editor, Assembler, Debugger, File Manager and system utilities. Available for wide variety of disk systems including North Star, Heilios II, Microcom, ICVM (all systems) and Altair. Supports computers such as Sorcerer, Horizon, S10 System III, Verbatim, Altair 8800, COMPAL-80, DYNABYTE DB82, and ICW Attache. Specify desired configuration. **$145/$25**

- MAC — 6800 Macro Assembler. Full Intel macro definitions. Pseudo Ops include RFC, IRP, REPT, TITLE, PAGE, and MACLIB Z-80 library included. Produces Intel absolute hex output plus symbols file for use by SID (see below) **$100/$15**

- SID — 6800 symbolic debugger. Full trace, pass count and break-point program testing system with back-trace and histogram utilities. When used with MAC, provides full symbolic display of memory labels and equated values. **$65/$15**

- TEX — Text formatter to create paginated, page-numbered and justified copy from source text files, directable to disk or printer. **$85/$15**

- DESPOOL — Program to permit simultaneous printing of data from disk while user executes another program from the console. **$50/$1**

**MICROSOFT**

- Disk Extended BASIC — New version, ANSI compatible with long variable names, WHILE/WEND, chaining, variable length file records. **$300/$25**

- FORTRAN-80 — ANSI 66 (except for COMPLEX) plus many extensions. Includes relocatable object compiler, linking, library and manager. Also includes MACRO-80 (see below). **$400/$25**

- COBOL-80 — ANSI ‘74 Pseudo-compiler with relocatable object runtime package. Format same as FORTRAN-80 and MACRO-80 modules. Complete ISAM, interactive ACCEPT/DISPLAY, COPY, EXTEND. **$625/$25**

- MACRO-80 — 6800/8260 Macro Assembler, Intel and ZigZag mnemonics supported. Relocatable linkable output. Loader, Library Manager and Cross Reference List utilities included. **$140/$15**

- MACRO-80 plus FORTRAN subroutine library available. Library includes ABS, SIGN, EXP, DLOG, SORT, DSORT, ATAN, DATAN etc. **$219/$15**

- EDIT-80 — Very fast random access text editor for text with or without line numbers. Global and intra-line commands supported. File compare utility included. **$80/$15**

**XITAN (software requires Z-80 CPU)**

- Disk BASIC — Fast powerful interactive interpreter. PRIVACY password security. Can dynamically open a large number of files simultaneously for read-only, read-write or read-write, file-sharing by modem. **$150/$20**

- Z-TEL — Text editing language. Expression evaluation iteration and conditional branching ability. Registers available for text and commands. Macro command strings can be saved on disk for re-use. **$65/$20**

- ASM Macro Assembler — Mnemonics per Intel with Z-80 extensions. Macro capabilities with absolute Intel hex or relocatable linkable output modules. **$65/$20**

- LINKER — Link-edits and loads ASM modules. **$65/$20**

- Z-BUG debugger — Trace, break-point tester. Supports decimal, octal and hex modes. Disassemble to ASM mnemonic set. Emulation technique permits full tracing and break-point support through ROM. **$65/$20**

**SOFTWARE SYSTEMS**

- CBASIC-2 Disk Extended BASIC — Non-interactive BASIC with pseudo-code compiler and runtime interpreter. Supports full file control, chaining, integer and extended precision variables etc. Version 1 users can receive Version 2 and new manual for $45 with return of original diskette. Standard CP/M and TRS-80 CP/M versions available. **$90/$15**

**STRUCTURED SYSTEMS GROUP**

- General Ledger — Interactive and flexible system providing proof and report outputs. Customization of COA created interactively. Multiple branch accounting centers. Extensive checking performed at data entry for proof, COA correctness etc. Journal entries may be batched prior to posting. Closes procedures automatically backs up input files. All reports can be tailored as necessary. Requires CBASIC. **$699/$20**

- Accounts Receivable — Open item system with output for internal aged reports and customer-oriented statement and billing purposes. On-Line Inquiry permits information for Customer Service and Credit departments. Interface to General Ledger provided if both systems used. Requires CBASIC. **$699/$20**

- Accounts Payable — Provides aged statements of accounts by vendor with check writing for selected invoices. Can be used alone or with General Ledger and/or with NAD. Requires CBASIC. **$699/$20**

- NAD Name and Address selection system — Interactive mail list creation and maintenance program with output as full reports with reference data or restricted information for mail labels. Transfer system for extraction and transfer of selected records to create new files. Requires CBASIC. **$75/$20**

- QSORT — Fast sort/merge program for files with fixed record length, variable field length information. Up to five ascending or descending keys. Full back-up of input files created. Parameter file created with interactive program which requires CBASIC. Parameter file may be generated with CP/M assembler utility. **$95/$20**
Software for most popular 8080/Z80 computer disk systems, including NORTH STAR, MICROPOLIS, iCOM, SD SYSTEMS, DYNABYTE DB8/2, HELIOS, ALTAIR, TRS-80, 8" IBM and OHIO SCIENTIFIC formats.

**Graham-Dorian Software Systems**

- **Payroll System** - Maintains employee master file. Computes payroll withholding for FICA, Federal and State taxes. Prints payroll register, checks, quarterly reports and W-2 forms. Can generate ad hoc reports and employee form letters with mail labels. Requires CBASIC. Supplied in source code. $605/$35

- **Apartment Management System** - Financial management system for receipts, disbursements and security deposits of apartment projects. Captures data on vacancies, revenues, etc. for annual trend analysis. Daily report shows late rents, vacancy notices, vacancies, income lost through vacancies, etc. Requires CBASIC. Supplied in source code. $605/$35

- **Inventory System** - Captures stock levels, costs, sources, sales, ages, turnover, markup, etc. Transaction information may be entered for reporting by salesman, type of sale, date of sale, etc. Reports available both for accounting and decision making. Requires CBASIC. Supplied in source code. $605/$35

**Other**

- **Z80 Development Package** - Consists of: (1) disk file line editor, with global inter and intra-line facilities; (2) Z80 relocating assembler, Zilog/Mostek mnemonics, conditional assembly and cross reference table capabilities; (3) linking loader producing absolute Intel hex disk file for CP/M LOAD, DDT or SID facilities. Standard CP/M and TRS-80 CP/M versions available. $75/5

- **TextWriter II** - Text formatter to justify and paginate letters and other documents. Special features include insertion of text during execution from other disk files or console, permitting recipe documents to be created from linked fragments on other files. Ideal for contracts, manuals, etc. $75/5

- **DisIntel** - Disk based disassembler to Intel 8080 or TDL/Xitan 260 source code, listing and cross reference files. Intel or TDL/Xitan pseudo ops optional. Runs on 8080. Standard CP/M and TRS-80 CP/M versions available. $65/10

- **DisZilog** - As DisIntel to Zilog/Mostek mnemonic files. Runs on Z80 only. Standard CP/M and TRS-80 CP/M versions available. $65/10

- **Basic Comparison** - A comprehensive features and performance analysis of five 8080 disk BASIC languages - CBASIC, BASIC-E, XYBASIC, Microsoft Disk Extended BASIC, and Xitan's Disk BASIC. Includes results of 21 different benchmark tests for speed and accuracy and lists features and features of each BASIC. (Send 20¢ S.A.S.E.) FREE

**TRS-80 FORTRAN Package** - Professional disk-based language and utility package written by Microsoft creators of Level II BASIC. The package runs on a TRS-80 system with 32K RAM, one or more drives and TRSDOS. The software is supplied on diskettes and consists of a relocatable machine code FORTRAN Compiler, Macro Assembler, a Linking Loader, Subroutine Library, Text Editor. $325

**FREE**

- macro assembler, loader and editor alone $165

**Shipping**

Account # Exp. Date $1.00 for C.O.D.

Signature

My computer configuration (specifying disk system):

Name

Address (No. P.O. Box)

City State Zip

*Effective April 15, 1979*
Azimuthal Equidistant Maps

Figure 6 illustrates a map that is very similar to the azimuthal equidistant (great circle) maps shown in part 1. The primary difference is that we have added a grid of meridians and parallels to figure 6 to give more meaning to geographic distribution. This map projection is extremely useful when applied to such fields as navigation and radio communication, but you must not forget the inherent distortions. The grid system on this map helps dramatize where these distortions lie.

Another azimuthal equidistant projection is presented in figure 7, but the coverage is limited to 90° of arc (half that of the map in figure 6). This not only expands the scale of the map, but it eliminates the portion with the greatest distortion. The example is of an Oscar satellite communications coverage map centered on a location near Geneva, Switzerland. By taking advantage of the fact that radial distances (and, hence, arc distances) from the center are linear in this type of projection, it is a simple matter to draw a circle that will indicate the maximum possible communication range through a given satellite.

The central location (Geneva, in this case) can then communicate to any location within the circle, at some time or another, depending upon the satellite’s position.

The map, in this example, has been overlaid with three different circles to show the maximum range for all of the currently operational satellites (Oscar 7, Oscar 8, and RS:1–2, starting with the inner circle and moving outward). Note the difference...
between this map and those in figures 3 and 4. The map in figure 7 shows all locations with which communication is possible, irrespective of satellite position, whereas the maps of figures 3 and 4 show where communication is possible at some particular moment in time when the satellite is over a given point.

Summary

In part 1 we discussed the fundamental methods and resources required to produce any kind of map on a computer. We also presented several simple programs in BASIC, each containing only about a dozen executable statements, but which are capable of producing a number of attractive and useful map projections.

In this conclusion to “Computer Generated Maps”, we have shown both the need and the means to develop a single, general purpose, map projection program with the flexibility to produce a variety of perspective and azimuthal equidistant maps. The subroutine given in listing 1 is an efficient, functional program which does just that, yet it only contains about 60 executable statements. All of the maps illustrated in this article were produced by that program, and they are only a sampling of its total capability. Whether you plan to generate maps for use with communications satellites, maps for the captain’s console of a spacecraft, or maps for the sake of having maps, the program presented here can enhance your system’s capability enormously and give you many hours of enjoyment.

Figure 7: Another azimuthal equidistant projection is presented here, but we have limited the coverage to 90° of arc. This expands the scale of the map. The three concentric circles that have been superimposed on this map show the maximum possible communications range from the central location, through all of the currently operational amateur radio communications satellites (Oscar 7, Oscar 8, and RS:1—2).
Write faster in BASIC, FORTRAN, or COBOL

Document & modify more easily, too

Human-engineered to do the job better. Yes, you really can get flawless code faster, using the Stirling/Bekdorff™ system of software development tools with structured programming concepts. The 78F2, 78P4, and 78CI are human-engineered to reduce initial errors, improve debugging speed, and aid concept communication. First, use the 78F2 Flowchartix™ to lay out your original concept blocks. Then use it to write a finely detailed flowchart.

54% more logic cells than other flowchart forms, put far more of your program on each page. Each Flowchartix has a full 27 logic cells, not just 50. This saves paper, and makes your finished flowcharts easier to understand. By seeing up to 200 steps of a program on one page, you comprehend program flow more clearly. You save money and storage space, too.

Every matrix cell in the 7 x 11 matrix has a specific label to help you track branch points. When you write program documentation, having a separate reference point for each cell makes your program much easier to describe clearly.

With Flowchartix, you don't need a shape template to draw remarkably regular logic symbols. Guides for the most-used logic symbols are right in each matrix cell, to help you draw most standard flowchart symbols entirely free-hand.

78P4 Print-Out Designers are next. When you finish flowcharting, lay out the printed reports your program will generate. Then when you write code you blaze through the report generation segments right along with the rest of your program.

Unique 70 x 150 matrix accommodates even proportional-spacing word processor formats. The 150-column width can handle practically any printer format. The 78P4 is big, 13" x 22 inches, because we've scaled the cell size to human writing comfort, not machine size, giving nearly twice the character-writing area of other printout design sheets.

Special S-column area records the program line number of the code which creates each printed line. It shows, at a glance, exactly which line of code creates each line of your report. Saving hours of needless search time when you must change the report format (and don't you always have, sooner or later?)

Every sheet of 78C1 gives you 2 form uses for the price of one. Use 78C1's full 20 x 80 column grid area to code regular program steps. Then for interactive or instructional sections, simply keep your characters within the appropriate CRT indicator lines, and you'll automatically know where every character will show on your CRT screen.

28 line x 80 column coding capacity saves you 14 sheets out of every 100, compared to 24 line forms. 36 sheets hold more program steps than 100 sheets of any 24-line form, yet we offer full-size 6mm x 3mm grid blocks to give you comfortable writing room and visual space between lines.

Work with your CRT display, no matter what brand you own. Equipped for both 16 line x 64 column and 24 line x 80 column display formats.

Available in three versions (one for BASIC languages, one for FORTRAN, another for COBOL), the 78C1 is so powerful we include a 7-page instruction manual with every order.

Every tool in the Stirling/Bekdorff system is surface-engineered to take both pen & pencil without blotching. Our tough, extra-heavy 22-p paper is pure enough to use with critical magnetic ink character readers, and gives you crisp, sharp characters with pencil or plastic-tip pen.

Every part of our system uses eye-comfortable soft blue grids. All grid rulings, tints, and division rules are reproduced in a special shade of blue, easy on your eyes even after hours of continuous programming. If you're a professional programmer, you'll particularly appreciate our improvement over the green lines you've been writing on.

A 3-ring binder is one more of our secrets for your success. All your notes, logic concepts, flowcharts, code, CRT layouts, print-out designs, and documentation can be kept together, in order, in one place. When everything you create stays together, debugging and modification is much simpler.

Order your supply of the world's most advanced software development tools right now, before you hatch even one more bug.

Text continued from page 6:

will be a more elaborate set of read only memory code which interacts with the music keyboard and a special function keyboard to be defined. Limited timber setups of the synthesizer can then be made when it is played and isolated from the data base facilities of the Pascal machine.

As for main software, capacity will be needed to execute some form of interpretive real time control software, possibly through the use of a threaded interpretive language somewhat like Forth. Implementations of this sort of language abound: Forth, Urth, IPS, and numerous unnamed homebrew versions. Such interpreters, which are fairly simple to code in machine language without an assembler, provide an excellent path to more significant software in a homemade situation with a new processor. Everyone I know who uses them becomes a fanatic, so there are obviously some strong emotional arguments for flexibility and power that get people addicted. Why not try one?

Hardware reflecting this requirement will perhaps be 4 K bytes of read only memory for the kernel of the interpreter design. Software design and development will, of course, be done in machine language using the Pascal machine as a filing and program development tool.

In addition to the 6809 processor, the hardware of the new machine will probably include 32 K bytes of programmable memory in the low end of address space, 16 K bytes of 2708 read only memory sockets for the various segments of the detail low level software, a serial port for the communications interface, a parallel port for the synthesizer interface, a parallel port for the music keyboard and miscellaneous key switch inputs, several uncommitted parallel ports, and a parallel port for the floppy, borrowed from the older system to be used as a mass storage subsystem.

This new processor will reflect a number of the improvements that have been made in the experimenter's computer system art over the past few years. It will have a much smaller parts count due to the 16 K dynamic memory parts I intend to use and I will pay attention to packaging, as I want to be able to carry the results around. It will be entirely fabricated with convenient Vector Slide-N-Wrap interconnection, although I now use the motorized tool to minimize the chance of open connections which occurred when I used that method by hand. And, of course, there is the thrill of experimenting with a new processor, the 6809 design described by Terry Ritter and Joel Boney in recent issues of BYTE.■
More BYTE BOOKS in your future...
THE BYTE BOOK OF COMPUTER MUSIC combines the best computer music articles from past issues of BYTE Magazine with exciting new material—all written for the computer experimenter interested in this fascinating field.

You will enjoy Hal Chamberlin's "A Sampling of Techniques for Computer Performance of Music", which shows how you can create four-part melodies on your computer. For the budget minded, "A $19 Music Interface" contains practical tutorial information—and organ fans will enjoy reading "Electronic Organ Chips For Use in Computer Music Synthesis".

New material includes "Polyphony Made Easy" and "A Terrain Reader". The first describes a handy circuit that allows you to enter more than one note at a time into your computer from a musical keyboard. The "Terrain Reader" is a remarkable program that creates random music based on land terrain maps.

Other articles range from flights of fancy about the reproductive systems of pianos to Fast Fourier transform programs written in BASIC and 6800 machine language, multi-computer music systems, Walsh Functions, and much more.

For the first time, material difficult to obtain has been collected into one convenient, easy to read book. An ardent do-it-yourselfer or armchair musicologist will find this book to be a useful addition to the library.

SUPERWUMPUS is an exciting computer game incorporating the original structure of the WUMPUS game along with added features to make it even more fascinating. The original game was described in the book What To Do After You Hit Return, published by the People's Computer Company. Programmed in both 6800 assembly language and BASIC, SUPERWUMPUS is not only addictively fun, but also provides a splendid tutorial on setting up unusual data structures (the tunnel and cave system of SUPERWUMPUS forms a dodecahedron). This is a PAPERBYTE™ book.

TINY ASSEMBLER 6800, Version 3.1 is an enhancement of Jack Emmerichs' successful Tiny Assembler. The original version (3.0) was described first in the April and May 1977 issues of BYTE magazine, and later in the PAPERBYTE™ book TINY ASSEMBLER 6800 Version 3.0.

In September 1977, BYTE magazine published an article entitled, "Expanding The Tiny Assembler". This provided a detailed description of the enhancements incorporated into Version 3.1, such as the addition of a "begin" statement, a "virtual symbol table", and a larger subset of the Motorola 6800 assembly language.

All the above articles, plus an updated version of the user's guide, the source, object and PAPERBYTE™ bar code formats of both Version 3.0 and 3.1 make this book the most complete documentation possible for Jack Emmerichs' Tiny Assembler.

SUPERWUMPUS
ISBN 0-931718-03-1
Author: Jack Emmerichs
Pages: 56
Price: $6.00

TINY ASSEMBLER 6800
ISBN 0-931718-08-2
Author: Jack Emmerichs
Pages: 80
Price: $9.00

A walk through this book brings you into Ciarcia's Circuit Cellar for a detailed look at the marvelous projects which let you do useful things with your microcomputer. A collection of more than a year's worth of the popular series in BYTE magazine, Ciarcia's Circuit Cellar includes the six winners of BYTE's On-going Monitor Box (BOMB) award, voted by the readers themselves as the best articles of the month: Control the World (September 1977), Memory Mapped IO (November 1977), Program Your Next EROM in BASIC (March 1978), Tune In and Turn On (April 1978), Talk To Me (June 1978), and Let Your Fingers Do the Talking (August 1978).

Each article is a complete tutorial giving all the details needed to construct each project. Using amusing anecdotes to introduce the articles and an easy-going style, Steve presents each project so that even a neophyte need not be afraid to try it.

Ciarcia's Circuit Cellar
ISBN 0-931718-07-4
Author: Steve Ciarcia
Pages: approx. 128
Price: $8.00
BASEX, a new compact, compiled language for microcomputers, has many of the best features of BASIC and the 8080 assembly language—and it can be run on any of the 8080 style microprocessors: 8080, Z-80, or 8085. This is a PAPERBYTE™ book.

Subroutines in the BASEX operating system typically execute programs up to five times faster than equivalent programs in a BASIC interpreter—while requiring about half the memory space. In addition, BASEX has most of the powerful features of good BASIC interpreters including array variables, text strings, arithmetic operations on signed 16 bit integers, and versatile IO communication functions. And since the two languages, BASEX and BASIC, are so similar, it is possible to easily translate programs using integer arithmetic data from BASIC into BASEX.

The author, Paul Warnes, has also included a BASEX Loader program which is capable of relocating programs anywhere in memory.

SIMULATION is the second volume in the Programming Techniques series. The chapters deal with various aspects of specific types of simulation. Both theoretical and practical applications are included. Particularly stressed is simulation of motion, including wave motion and flying objects. The realm of artificial intelligence is explored, along with simulating robot motion with the microcomputer. Finally, tips on how to simulate electronic circuits on the computer are detailed.

RA6800ML: AN M6800 RELOCATABLE MACRO ASSEMBLER is a two pass assembler for the Motorola 6800 microprocessor. It is designed to run on a minimum system of 16 K bytes of memory, a system console (such as a Teletype terminal), a system monitor (such as Motorola MIKBUG read only memory program or the ICOM Floppy Disk Operating System), and some form of mass file storage (dual cassette recorders or a floppy disk).

The Assembler can produce a program listing, a sorted Symbol Table listing and relocatable object code. The object code is loaded and linked with other assembled modules using the Linking Loader LINK68. (Refer to PAPERBYTE™ publication LINK68: AN M6800 LINKING LOADER for details.)

There is a complete description of the 6800 Assembly language and its components, including outlines of the instruction and address formats, pseudo instructions and macro facilities. Each major routine of the Assembler is described in detail, complete with flow charts and a cross reference showing all calling and called-by routines, pointers, flags, and temporary variables.

In addition, details on interfacing and using the Assembler, error messages generated by the Assembler, and sample IO driver source code listings, and PAPERBYTE™ bar code representation of the Assembler's relocatable object file are all included.

This book provides the necessary background for coding programs in the 6800 assembly language, and for understanding the innermost operations of the Assembler.
LINK68: AN M6800 LINKING LOADER is a one pass linking loader which allows separately translated relocatable object modules to be loaded and linked together to form a single executable load module, and to relocate modules in memory. It produces a load map and a load module in Motorola MIKBUG loader format. The Linking Loader requires 2 K bytes of memory, a system console (such as a Teletype terminal), a system monitor (for instance, Motorola MIKBUG read only memory program or the !COM Floppy Disk Operating System), and some form of mass file storage (dual cassette recorders or a floppy disk).

It was the express purpose of the authors of this book to provide everything necessary for the user to easily learn about the system. In addition to the source code and PAPERBYTE™ bar code listings, there is a detailed description of the major routines of the Linking Loader, including flow charts. While implementing the system, the user has an opportunity to learn about the nature of linking loader design as well as simply acquiring a useful software tool.

ISBN 0-931718-09-0
Authors: Robert D. Grappel & Jack E. Hemenway
Pages: 72
Price: $8.00
Winter 1979

MONDEB: AN ADVANCED M6800 MONITOR-DEBUGGER has all the general features of Motorola's MIKBUG monitor as well as numerous other capabilities. Ease of use was a prime design consideration. The other goal was to achieve minimum memory requirements while retaining maximum versatility. The result is an extremely versatile program. The size of the entire MONDEB is less than 3 K.

Some of the command capabilities of MONDEB include displaying and setting the contents of registers, setting interrupts for debugging, testing a programmable memory range for bad memory locations, changing the display and input base of numbers, displaying the contents of memory, searching for a specified string, copying a range of bytes from one location in memory to another, and defining the location to which control will transfer upon receipt of an interrupt. This is a PAPERBYTE™ book.

ISBN 0-931718-06-6
Author: Don Peters
Pages: 88
Price: $5.00

BAR CODE LOADER. The purpose of this pamphlet is to present the decoding algorithm which was designed by Ken Budnick of Micro-Scan Associates at the request of BYTE Publications, Inc., for the PAPERBYTE™ bar code representation of executable code. The text of this pamphlet was written by Ken, and contains the general algorithm description in flow chart form plus detailed assemblies of program code for 6800, 6502 and 8080 processors. Individuals with computers based on these processors can use the software directly. Individuals with other processors can use the provided functional specifications and detail examples to create equivalent programs.

Author: Ken Budnick
Pages: 32
Price: $2.00

TRACER: A 6800 DEBUGGING PROGRAM is for the programmer looking for good debugging software. TRACER features single step execution using dynamic break points, register examination and modification, and memory examination and modification. This book includes a reprint of "Jack and the Machine Debug" (from the December 1977 issue of BYTE magazine). TRACER program notes, complete assembly and source listing in 6800 assembly language, object program listing, and machine readable PAPERBYTE™ bar codes of the object code.

ISBN 0-931718-02-3
Authors: Robert D. Grappel & Jack E. Hemenway
Pages: 24
Price: $6.00
NCC/NYC TO BE THE BIGGEST COMPUTER SHOW EVER. The National Computer Conference (NCC) will happen again June 6 thru 9. Last year 57, 224 attendees turned out for the show, held in Anaheim CA. This year the NCC will be held in the New York City Coliseum. AFIPS, the sponsoring organization, expects attendance to top that of last year. Approximately 400 companies have reserved 1,700 booth spaces on four floors of the Coliseum, with overflow at the New York Hilton and Americana hotels. Last year 396 companies occupied 1,400 booths.

NCC will have a personal computing adjunct at the Americana Hotel, a few blocks away. It will probably be played down, as it was last year. By way of example, the personal computing exhibitors and speakers were not listed in the regular show program book handed out to each attendee; hence, many attendees last year were unaware of the personal computing part of the show.

S-100 BUS STANDARD TO BE ADOPTED SOON. An IEEE committee has been working on a standard for the S-100 bus for over a year, and adoption is expected very soon. Much of the credit for this standard goes to George Morrow of Thinker Toys.

This standard will do two things. One, it will resolve the conflicts between the use of many bus pins by different manufacturers and eliminate the lack of compatibility between many "S-100 compatible" plug-in boards. Two, and possibly more important, it provides use of the S-100 bus for 16 bit processors for extended addressing of up to 8 M bytes of memory and for master-slave multiprocessor systems. This will make the S-100 bus the most powerful bus around and will, no doubt, continue and increase its popularity.

TI AND HP PC SYSTEMS RUMORS. Texas Instruments and Hewlett-Packard continue to maintain tight lips on their rumored personal computer systems. As TI has said, "TI will not discuss products that have not yet been announced." However, information has leaked out on these units which are expected to have a tremendous impact on the personal computing market. Several rumors have been reported in previous BYTE NEWS columns. The latest is that TI will introduce their entry at either the NCC show in June or the Consumer Electronics Show in July. In either event, it is expected to be ready for the 1979 Christmas market.

The HP computer is also expected to be ready by Christmas, and is anticipated to be a stripped down version of their current table-top system. This means that it will use BASIC and be expandable.

Both HP and TI are expected to have $500 list prices for the basic unit. Key retailers have already been approached by both TI and HP to set up a selective distribution. It is rumored that they will favor selected personal computing stores that can do justice to software requirements.

INTEL TO PRODUCE ANALOG MICROPROCESSOR AND SUPER 8 BIT MICROPROCESSORS. Real time processing of analog signals by microprocessors has been severely limited by the slow speed of most microprocessors. For example, an 8080 clocked at 2 M Hz can, at best, synthesize clean sine waves at about 1 to 2 k Hz, which is the low end of the audio spectrum. This fall, Intel will introduce an integrated circuit which combines an analog-to-digital converter, a digital-to-analog converter, microprocessor and read only memory on a single device. It will be capable of processing analog signals up to 13 k Hz. Called the 2920, the integrated circuit will have a 9 bit conversion register. It could be used in conjunction with an 8080 processor, where the 2920 does the signal processing while the 8080 does the data processing.

Intel has done another clever thing. They have taken an 8086 and limited its data I/O (input/output) to 8 bits and memory addressing to 16 bits. It is called the 8088 and will deliver five times the performance of the 8080 (2 M Hz). Actually, the 8088 is an 8086 split into two 8 bit microprocessors on one integrated circuit, one handling I/O and the other data processing. It offers most of the features of the 8086 (eg: hardware multiply/divide).

NATIONAL SEMICONDUCTOR TO INTRODUCE NEW MICROS. It is nearly three years since National introduced their last microprocessor. (Actually, we must give National credit for pioneering the 16 bit microprocessor with the PACE and IMP-16 microprocessors introduced in 1975.) Now National is bringing out a new CMOS 8 bit microprocessor that will be software compatible with the 8080, have added features and consume less power. Further, they will introduce a 16 bit microprocessor that is a "cut above" the Z-8000 and 68000. Production is expected by the end of the year.

MICROPROCESSORS FOR $1 A PIECE? Maybe not this year... but it is approaching fast. Synertek recently reduced the 100 lot price for the 6502 (used in the PET, Apple, OSI, etc.) from $10 to $7. In high volume they have reduced the price from $4 to $2.50. I can still remember paying $350 for an 8080, just four years ago!
DOUBLE SIDED DISK DRIVES STILL IN LIMITED PRODUCTION. Despite advertising and promotion for double sided disk drives, most makers are still having trouble gearing up from prototype runs to full production. Shugart Associates, for example, does not expect to be in normal production until the end of the year.

COLOR VIDEO TERMINALS COMING ON STRONG. The prices of color video terminals, which until now have been very expensive as compared to black and white video terminals, are expected to decrease substantially within the coming year. Further, they will have more features. The reasons for the price decrease are cost reduction in electronics and increased production, as demand increases. More businesses are finding that the difference in price for color is worth it in many applications, an example being Management Information Systems. We can expect low cost color video terminals on the market for under $1,000.

At the same time, manufacturers are developing driver software for video terminals which exploit the color capability, in particular, combining graphics and alphanumericics. One example would be bit map routines allowing the creation of multiple graphics regions on the video terminal while having alphanumeric regions.

PASCAL NOW AVAILABLE FOR 6800. All 6800 owners who have been envious of the Pascal that is available to other processor users can now have their own Pascal. Control Systems Inc, Kansas City KS, has just introduced a 6800 version of the UCSD Pascal, Version II.

HOW ABOUT A COMPUTER VACATION? Want to combine vacation and hobby? A group of 20 to 50 personal computerists are doing just that during Christmas week. They have organized a weeklong workshop to be held at a Caribbean resort. Families are welcome. If you are interested in participating, write either Dr. Andy Bender, 400 Old Hook Rd, Westwood NJ 07675, or Dr. Jeff Brownstein, 2 Tor Rd, Wappinger Falls NY 12590.

QUIP VERSUS THE DIP. The new 16 bit microprocessors and the 32 bit microprocessors on the drawing boards have created packaging problems for integrated circuit makers. How are they going to get all addressing, data, I/O (input/output) lines on an integrated circuit package? Anyone who handles 40 pin dual-in-line packages knows the handling problem. Well, Intel and 3M have jointly developed a new 64 pin integrated circuit header called QUIP (quad-in-line package). It will have two rows of 16 pins along both edges of the package and will shrink the package from 3 1/8 inches, for a 64 pin dual-in-line package (DIP) to 1 5/8 inches for a QUIP. Further, internal lead paths will decrease, reducing capacitance, resistance and inductance, and allowing higher operating speeds. Pins will still be on 0.1 inch centers and the QUIP will cost 15 percent less than the DIP.

4 K BYTE PROGRAMMABLE MEMORY INTRODUCED. As the size of memory circuits increases, integrated circuit makers are going the byte-size memory route to afford easier interfacing to microprocessor buses. Zilog is the first to introduce an 8 bit byte programmable memory. Called the Z6132, it is a 32 K bit memory organized as 4 K words by 8 bits. It uses a one transistor memory cell and includes on-chip refresh control circuitry. Pinout permits easy use in 16 bit systems. Hardware keeps getting easier!

DOD LOVES ADA. After years of trying to standardize a high level computer language, the United States Department of Defense (DOD) has created a special group for this purpose. The final approved language will be called ADA, after Ada Augusta, Countess of Lovelace, who is credited with being the very first programmer.

The DOD have narrowed their choice to two different Pascal-like designs. The preliminary design is due for delivery in May of this year, with final approval expected at the end of the year.

LIQUID CRYSTAL DISPLAYS IMPROVING. The graphics terminal marketplace is going to see some radical changes within the next few years as new technologies develop to compete with the age old video type graphics terminal technology. Plasma panel and liquid crystal display elements (LCDE) are examples of a new graphics technology. The plasma panels offer higher brightness, no flicker, and touch sensing ability. The LCDE are created by a scanning laser beam. The LCDE have their own memory, and do not have to be refreshed. Further, they offer very high resolution, color and projection capabilities. Both Western Electric and IBM are doing developmental work in this area.

DEC OPENS SECOND RETAIL STORE. Digital Equipment Corp recently opened its second store in Boston. Their first store was opened in New Hampshire in July of last year. More stores are planned for "off the shelf" purchases. Further, the stores will offer services such as mail list generation and word processing.

COMPUTER STORES' FUTURE APPEARS EXCELLENT. According to a recently completed study by marketing research firm Frost and Sullivan, the main distribution channel for microcomputer systems will continue to be the dedicated computer store, for many years. The hobby business will continue to increase, but at a lower rate. The larger increase will come from small business purchases.
Speakeasy Software™ INTRODUCES

WHEELER DEALERS™ IBM

Available at your APPLE dealer

Speakeasy Software Ltd. Dealers: Please contact your distributor.

Box 1220, Kemptville, Ontario, Canada, K0G 1J0

(613) 258-2451

Also available: STOCK OPTIONS • PIGSKIN PLAYOFFS • FINANCIAL ANALYSIS • SPORTSTRIVIA • MICROTRIVIA • TRANSACTIONAL ANALYSIS • WARLORDS • KIDSTUFF • BULLS AND BEARS

Also available: STOCK OPTIONS • PIGSKIN PLAYOFFS • FINANCIAL ANALYSIS • SPORTSTRIVIA • MICROTRIVIA • TRANSACTIONAL ANALYSIS • WARLORDS • KIDSTUFF • BULLS AND BEARS
A scientific revolution is just around the corner, and anyone with a personal computer can participate in it. The last time this happened, 250 years ago, the equipment was the homebrew telescope and the subject was astronomy. Now, astronomy belongs just as much to amateurs as to professionals. This time the particular subject matter is human nature and in a broader scope, the nature of all living systems. Some ancient and thoroughly accepted principles are going to be overturned, and the whole direction of scientific investigation of life processes will change.

The key concept behind this revolution is control theory. Control theory has been developing for almost 40 years, and has already been proposed (by Norbert Wiener) as a revolutionary concept. It has not been easy, however, to see just how control theory can be made part of existing scientific approaches although many people have tried. Most of these attempts have tried to wedge control theory into existing patterns of thought. To apply any new idea in such a way, while ignoring the new conceptual scheme made possible, is to deny the full potential of the new idea.

Many life scientists who have tried to use control theory have tried to imitate the engineering approach, dealing with human beings as part of a man-machine system instead of complete control systems in their own right. Others have used control theory directly to make models of human and animal behavior, but have concentrated on minor subsystems, failing to see that the organism as a whole can be dealt with in terms of the same principles. The result has often been a strange mixture of concepts—a patchwork instead of a system.

Strangely enough, many engineers who do understand control theory haven't done much better. Here the problem is that these engineers tend to accept the basic concepts developed by biologists and psychologists, and to use control theory to explain cause-effect relationships they are told exist—but which in fact do not exist. We will start this development by looking at something called behavior, which biologists and psychologists have assured engineers is very important, thereby leading the engineers astray.

What is all this supposed to mean? A lot is meant, though in different ways. Roboticists, for example, are trying to develop machines which will imitate human organization, and so are the artificial intelligence experimenters. But from whence came the description of the system they are trying to model? Basically, it came from the life sciences. If the life sciences are using the wrong model, it would be essential to know that before much more labor is invested in imitating an imaginary creature.

Perhaps the most general reason control theory is interesting is that it concerns people. There aren’t many sciences left in which important discoveries can be made by amateurs working at their own tables. Control theory opens up an entirely new field of experimentation, a kind that has never been done before in psychology or any other life science.

All that is needed by amateurs who want to participate in these developments is a basic grasp of control theory, an understanding of the procedures that go with it, some basic equipment, and curiosity about human nature. I shall now provide the first two items on that list. The rest is up to you.

The Problem With Behavior

The word behavior is used frequently—we hear about behavioral science, behavior modification, behavior therapy. For example, Science News now has a "Behavior Column";
A Negative Sine

The arcsine and arccosine routines discussed in "Inverse Trig Functions" by Alan Miller (March 1979 BYTE, page 92) will not work for negative values of \( X \). For arcsine, I recommend (in Mr Miller's notation):

\[
\text{DEF FNSN}(X) = \text{ATN}(X/\text{SQR}(1 - X^2))
\]

and for cosine:

\[
\text{DEF FNCS}(X) = 1.570796327 - \text{ATN}(X/\text{SQR}(1 - X^2)).
\]

The constant 1.570796327 is, of course, \( \pi/2 \). These routines give the correct principal value for any value of \( X \) with an absolute value of less than 1.

John A Ball
Oak Hill Rd
Harvard MA 01451

---

Get a
PASCAL ENGINE

Not just a machine that emulates one.

This powerful computer runs the full UCSD Pascal Operating System and includes all of the following items:

- Pascal microengine™
- 64K bytes (32K words) of RAM ex tendable to 128K bytes. (64K words)
- Floppy disc CONTROLLER with direct memory access (DMA) is switch selectable for:
  - single, or double density
  - 8" floppy or mini floppy
  - 1 to 4 drives (same type)
- Complete UCSD Pascal Operating System
  - PASCAL compiler
  - BASIC compiler
  - GRAPHIC package
- File Manager
- Screen oriented editor
- Debugger
- Two RS-232 asynchronous ports
  (110-19,200 baud)
- Two 8-bit parallel ports
- Auto test microdiagnostics
- Documentation

$2,600 Complete with stylized low profile housing and power supply

Prices subject to change without notice.

CUTTING EDGE OF TECHNOLOGY, Inc.
19th floor, 61 Broadway, New York, N.Y. 10006
212-480-0480

Circle 74 on inquiry card.
it was formerly the publication's "Psychology Column". An innocent bystander might conclude that any word this important must have a universally accepted definition, but that is not true. Behavior is a slippery concept.

Here is an example of a person behaving. Chip Chad is seated in front of a teletype-writer pounding keys. What is he doing?

Is he alternately tensing and relaxing muscles in his arms? Yes. Is he moving his fingers up and down? Yes. Is he typing strings of symbols? Yes. Is he adding a return instruction that he forgot at the end of a subroutine? Yes. Is he writing a program for plotting stock market prices? Yes. Is he making a little extra money for a vacation? Yes. Is he justifying his hobby to his family? Yes.

Clearly, each description of what Chip is doing is, in fact, an accurate description of the very same collection of actions. Which one, then, is Chip's behavior? Obviously, they all are expressions of behavior.

Suppose Chip decides that he really doesn't need a subroutine, and substitutes a jump instruction for the return. Now, he is writing the program — obviously the same program — by using a different behavior. Or suppose he buys an input device, and continues working on the subroutine by speaking letters into a microphone. Now he is using different muscles and movements, but he is still doing the same behaviors farther down the list. How could he be doing the same thing by means of doing something different?

Or consider Chip driving a car along a straight road. He is consciously steering. This happens to be a gusty March day, and every five minutes the wind changes speed and direction. Chip is an experienced driver, and continues to steer the car down the road in a straight line. If we look at what his arms are doing, however, we find that they are moving the steering wheel in an apparently random pattern, now centered, now far to the right, now far to the left. Somehow he is managing to produce a constant steering-the-car behavior by means of a behavior that is widely varying. The path of the car doesn't correlate with the position of the steering wheel at all.

Scientists have always thought of behavior as the final product of activity inside the organism. The brain sends commands to the muscles, which create forces, which produce movements, which generate the stable and repeatable patterns we recognize as behavior. There is, in principle, a chain of cause and effect, with the events at the end of the chain being caused by the events at the beginning. Such scientists would say that in the example with Chip at the computer keyboard, we were simply attending to various stages in that chain.

How does that picture fit in with Chip's driving the car in a straight line? The direction in which the car is going is affected by his movements of the steering wheel, and is farther out along the chain of causes and effects. But the wind adds its effects on the direction of the car after Chip's effects in the chain. Somehow he is varying his actions so that when their effects are added to the effects of the randomly varied wind, the result is something constant. If we had been thinking of driving the car in a straight line as Chip's behavior, we have to revise that idea: the direction of the car depends just as much on the wind as on Chip.

It may seem that we have simply moved our definition of behavior closer to Chip. But consider how he moves the steering wheel. The wheel moves when the forces reflected from the front wheels do not exactly balance the forces created by his muscles. As the car goes along, the roadbed tilts and various bumps and dips cause changes in the reflected forces. The wheel may be turned far to the right, into the crosswind, on the average, but maintaining the wheel in that position requires that his muscles be constantly changing tension, as the reflected steering wheel forces fluctuate. We have the same problem as before: Chip produces a varying output that affects the steering wheel, but the steering wheel is also being affected by forces that are independent of what Chip is doing with his muscles. Yet the sum of the muscle forces and those extraneous forces is zero, except when the steering wheel is changing position.

Even if we back up another step and call Chip's muscle tensions his behavior, we have trouble. Muscles are made to contract by signals from the nervous system, but muscles don't respond the same amount to a given signal every time they are used. They fatigue; other muscles interfere with them; joint angles change so that a given muscle tension can produce different amounts and directions of force. The only behavior that Chip produces which can be attributed entirely to Chip and not in part to his environment consists of the nerve signals that leave his nervous system and enter his muscles.

If we want to be completely accurate about Chip's behavior, we should consider the output signals from his nervous system, and leave everything else in his environment. That is what we will do, but by doing that we create the biggest problem of all.

A scientist studying a behavior hopes to learn enough about its rules to predict when
The TARBELL Connection

In an effort to offer products that meet the continually changing demands of the microcomputer industry, TARBELL ELECTRONICS is pleased to offer immediate delivery of these quality components and operating software. All TARBELL products are available from computer store dealers everywhere.

Tarbell Floppy Disk Interface

- Plugs directly into your IMSAI or ALTAIR and handles up to 4 standard single drives in daisy chain.
- Operates at standard 250K per second on normal disk format capacity of 256K bytes.
- Works with modified CP/M Operating System and BASIC-E Compiler.
- Hardware includes 4 extra IC slots, built-in phantom bootstrap and onboard crystal clock. Uses WD 1771 LSI chip.
- Full 6-month warranty and extensive documentation.
- Kit $190 .... Assembled $265.

Tarbell Disk BASIC

- Runs on 8080, 8085 or Z80
- Searches a file quickly for a string.
- Up to 64 files open at once.
- Random Access.
- Assignment of I/O.
- Alphanumeric line labels allowed.
- Read and Write string or numeric data.
- Unlimited length of variable names and strings.
- Procedures with independent variables.
- Number system 10 digits BCD integer or floating point.
- Chain to another program.
- Cause programs to be appended onto programs already in memory.
- Cause interpreter to enter edit mode using 15 single character edit commands.

Occupies 24K of RAM. Tarbell BASIC on CP/M Disk ............. $48.
Source on paper or CP/M Disk ... $25. CP/M and BASIC-E on disk with manuals .......... $100.

Tarbell 32K RAM Memory

- 32K Static Memory
- S-100 Bus Connector
- 9 regulators provide excellent heat distribution.
- Extended addressing (bank switching.)
- Phantom line.
- Low power requirement.
- 20-Page operating manual.
- Full 1-year warranty.
- Assembled and tested full price only $625
- 16K version also available, assembled and tested only $390.

Tarbell Cassette Interface

- Plugs directly into your IMSAI or ALTAIR.
- Fastest transfer rate: 187 (standard) to 540 bytes/second.
- Extremely reliable—Phase encoded (self-clocking).
- 4 extra status lines, and 4 extra control lines.
- 37-page manual included.
- Device code selectable by DIP-switch.
- Capable of generating Kansas City tapes.
- No modification required on audio cassette recorder.
- Complete kit $120 ........ Assembled $175.
- Manual may be purchased separately ........ $8.
- Full 6-month warranty on kit and assembled units.

Tarbell Cassette BASIC

Includes most features of ALTAIR Extended BASIC, plus these added features:
- Assignment of I/O.
- Alphanumeric line labels.
- Unlimited length of variable names and strings.
- Number system 10 digits BCD integer or floating point.
- Procedures with independent variables.
- Read and Write string data.
- Multi-file capability.

Full price with complete documentation ........ $48.
Prepaid, COD, or cash only. California residents please add 6% sales tax.

ALTAIR is a trademark/tradename of Pertec Computer Corporation
CP/M is a trademark/tradename of Digital Research

TARBELL ELECTRONICS

950 DOVLEN PLACE • SUITE B
CARSON, CALIFORNIA 90746
(213)538-4251 • (213) 538-2254
it will occur. Under the old approach, this means varying factors in the environment and looking for behaviors that correlate with those variations. But if we try to describe behavior in terms of the output signals from the nervous system, all correlations disappear. Oh, maybe we have a knee jerk or a sneeze left over, but we have lost all the regularities that give us some reason to talk about behavior in the first place. We would never guess, from looking at Chip's neural signal outputs, that the result of them would be a straight path of a car that is being forced one way and another by a variable crosswind.

When you pause and reflect upon what has been covered so far, you will realize that we are already deep into control theory, even though we haven't discussed it by name yet. We have dealt with the subject as such because the discussion concerns a fundamental difficulty with the very concept of behavior, especially the concept that behavior is the final product of an organism's inner activities. As we see how this difficulty gets resolved, we will be forced into control theory no matter how we approach the solution. One reason biologists or psychologists have not developed control theory is that they have clung stubbornly to the idea that behavior is part of a causal chain that starts in the nervous system (or in stimuli that cause activity in the nervous system) and propagates outward from there according to physical laws of cause and effect. That is why people design robots in the same way, and why those robots have yet to behave in a way that is convincingly alive. In order to solve this problem instead of just brushing it aside, we have to admit that the causal chain in which people have believed for so long simply does not exist, and never has existed.

Figure 1 sums up the problem we are dealing with. At every stage of events following the outputs from Chip's nervous system disturbances come into play, adding to the effects that can be traced to the neural signals. As we go farther to the right of the figure, we might expect that any regularities in Chip's output signals would be lost (ie: that each successive variable would show more and more random variations).

Exactly the opposite is true. The farther to the right we go in figure 1, the less random variation occurs. The variable farthest to the right, the relationship of the car to its lane, can remain constant within a few inches for hour after hour. We find that this is the most stable variable in the chain, and that as we go backward up the chain toward Chip's nervous system, the random-looking variations get larger and larger. At the beginning of the chain the variations become totally unpredictable.

Consider figure 2; we added the effects of external events on a nervous system. According to the old picture still fundamental to most life sciences, external events act on the physical structure of the nervous system (along with internal events such as changes in body chemistry), and cause outputs to occur. Those outputs have consequences which show up at the end of the chain as behavioral patterns. To study the organization of behavior, you manipulate the external events, and look for regular behaviors that result (of course, you find them).

**Figure 1:** The cause and effect chain leading to behavior. The behavior called "driving in a straight line" is anything but simple. Some psychologists speak of behavior as simply being emitted by an organism, but this is clearly an inadequate concept. Between the nervous system and the stable pattern it appears to produce, disturbances come into play, having just as much effect on the final outcome as the nervous system has. Nevertheless, the most regularity appears at the end of this chain, and the least at the beginning.
Here's a quick point you should know about

The fastest floating point BASIC for any micro.

TSC BASIC for the 6800 is the fastest floating point BASIC for ANY 8 bit microprocessor. No longer will the 6800 take a back seat to the 6502, 8080, or Z80! And with the TSC name, you know it's top quality.

TSC BASIC is not only fast, but complete with over 50 commands and functions. Features include six digit floating point math, full transcendental functions, unlimited string length, if/then/else construct, logical operators, and two-dimensional arrays including string arrays. The disk versions for FLEX™ 1.0 and 2.0 support random access data files (the mini FLEX™ version does not).

A cassette version requires 10K while the disk versions require at least 12K. No source listings included. With KCS cassette - $39.95; mini FLEX™ - $49.95; FLEX™ 2.0 - $54.95; and FLEX™ 1.0 - $59.95. Soon to come are a business BASIC and 6809 BASIC.

Technical Systems Consultants, Inc.

All orders should include 3% for postage and handling (8% on foreign orders). Send 25¢ for a complete software catalog.

Box 2574
W. Lafayette, IN 47906
(317) 463-2502
But in figure 2 we also see those random disturbances. The only way to get away from them is to make sure that the environment remains absolutely stable (i.e.: that nothing happens which can interfere with behavior). The standard approach requires eliminating those disturbances, for the simple reason that if they are not eliminated, the experimental results disappear into the background noise. Thus by eliminating disturbances as completely as possible, under the guise of establishing standard (i.e: control) experimental conditions, some scientists have swept this basic problem under the rug. They have also done away with the principal tool we have for understanding how these systems really work. If there are no disturbances, then the idea of a cause-effect chain running from external events through the organism to behavior seems to hold up, more or less. As soon as natural disturbances are allowed to occur, we find that the overall connection from external event to final behavior remains as clear as ever; but, the model of what happens in between falls to pieces with a loud crash.

Closing the Loop

There seems to be nothing wrong with figure 2; nothing, that is, except that it cannot account for the regularities of behavior. There is something wrong; something has been left out. Let's focus on the final variable in the chain, the position of the car relative to the lane. What variable that could affect Chip's senses, do you suppose, would have the most to do with his manipulations of the steering wheel? The position of the car relative to the lane. This variable is both the consequence of Chip's actions, and the main source of sensory information that could cause him to act (see figure 3).

Psychologists have gone this way before. They have tried to make sense of this situation by supposing that the behavioral variable is somehow different from the stimulus variable. If the position of the car relative to its lane is the behavioral variable, then perhaps the onset of a change in the visual image of the road is the stimulus variable. That leads to the idea of a chain of stimuli and responses. The car drifts in its lane; that stimulates Chip's nervous system to make a response, which affects the physical position of the car in its lane, which causes a new change in the stimulus, and so on around and around.

There are several severe difficulties with this explanation. In the first place, there is no way to separate the visual image from the position of the car; these are just two ways of talking about one whole physical situation in which a certain collection of independent variables changes simultaneously. The alternation between stimulus and response is completely imaginary, as anyone who drives knows. If causes and effects really were sequential, and chased themselves around and around the loop, it is unlikely that Chip would keep the car on the road for more than ten seconds. In part 2 we'll do a proper simulation in BASIC, and you will see that when the system is designed to behave sequentially, the result is most likely to be violent oscillations.

There is no reason at all to make an artificial distinction between the position of the car on the road as a behavioral response and as the stimulus which causes the response. Only one physical situation
DOUBLE DENSITY HORIZON I KIT

double the storage at the same price!

Today's best buy. 180K bytes per disk. The chosen computer for two MicroWorld systems... Autoscribe — The Paperwork Manager - and Bookkeeper — The Office Accountant-. Single density still runs on your new Horizon, or you can copy and convert all North Star software and programs to double density.

- exclusive application software
- add'1 16K memory (kit), $349
- add’1 disk drive (kit), $349

$1349
(reg. $1599)

NEW!

Call for low assembled prices. Double density also available on North Star disk sub-system, $599 kit.

MICROPOLIS DISK DRIVE FOR TRS-80

$499
Introductory Price
(reg. $599)

HEATH DATA SYSTEMS PRINTER

$895

MICROWORLD Specials

Integral Data Printer $749
Add for Tractors $150
 Mime Terminal $742
 Hazeltine 1410 Terminal $765
 Hazeltine 1500 Terminal $1097
 Teletype Model 43 Printer $1019
Dataprocessor M-200 $2921
Vector Graphics MZ $3225
Exidy 16K Sorcerer $1035
Data General microNOVA $CALL
Queme Sprint 5 RO Printer (55cps) $2895
DEC LS 120 Printer $CALL
Centronics 779 Printer (incl. tractors) $1095
Micropolis 1042 Mod I Drive $CALL
TI 59 Calculator $219
Novation CAT Modem $199
TI 820 Terminal $2199
North Star Horizon Software $CALL
Dataproducts B-300 Printer $5346
IPS1 1620 Diablo RO $2705
Hitachi 9" Monitor $184
Cromemco System III $5299
Imsa VDP-80 $CALL

CALL TOLL-FREE 1-800-528-1418
exists, and there is no need to present it in two disguises. The position of the car on the road is both an effect of Chip's actions and the sensory situation which leads (with a little help from Chip) to those actions. There is a closed loop of cause and effect, and the position of the car is just one part of that loop.

Now we begin to draw a diagram of a proper control system. In figure 4, three physical quantities are shown, an output quantity, an input quantity, and a disturbing quantity.

The output quantity corresponds to an output of Chip's that is entirely due to himself (i.e., perhaps due to the neural signals reaching his muscles or to some variable farther down the chain of figure 2, revealed when disturbances are known or can be legitimately eliminated).

The input quantity is the variable that is stabilized by the variations in Chip's output. Thus we call the input quantity, here, the position of the car relative to its lane. Of course, by that we mean whatever it is about that position that can be a sensory input to Chip (i.e., probably a visual image of the hood of the car and the road beyond, framed in the windshield).

Between the output quantity and the input quantity is placed a feedback function. This function expresses the physical links that exist between Chip's output quantity and the input quantity. In the case of a moving car, if the output quantity were the angle of the steering wheel, which it might be if the angle is also a controlled quantity, then the effect of the wheel angle would be a continual change of car position, and the feedback function would have to include at least one time integration. The feedback function is simply a description of the physical processes which give each magnitude and direction of the output quantity a contribution to the state of the input quantity.

In figure 4 we also include disturbances as an integral part of the diagram of the system. The disturbing quantity in this case would be wind velocity and direction, and the disturbance function connecting it to the input quantity would express the way in which aerodynamic laws convert wind velocity into effects on the car's position in its lane.
The state of the input quantity, therefore, can be expressed in terms of all effects which contribute to it. We have shown only the output quantity and the disturbance due to wind. Many other disturbances—low tires, or tight wheel bearings, or gradation in the road—could also contribute to the state of the input quantity at the same time. All disturbances, however, can be reduced to a single one, since no matter what the cause of the disturbance, the only effect that matters is the effect on lateral position of the car.

Chip himself can be represented by a function, a function that converts the sensed position of the car into a steering wheel angle. This *system function* (system, being short for behaving system) will surely contain delays, nonlinearities, and even variations of its parameters. At first glance it may seem a terrible oversimplification to reduce a whole human being to a simple input/output box, but the situation isn't that bad. We are centering this diagram around the input quantity, not around Chip as a whole; therefore the "Chip box" does not wholly represent him, but only that part which reacts to changes in the input quantity by altering the output quantity. Furthermore, the Chip box (i.e., the system function) is not quite as simple as it seems even after being simplified a great deal.

The functions connecting the variables in this closed loop can be extremely complex, and even to approach this system analytically will obviously require some approximations. This is not the place to justify every simplification; sometimes complex mathematics are required to reach a simple conclusion. I'll drop some hints along the way about how the simplified model is generated and why it works, but if you really want to get into this, study a text on servomechanism design.

**Simulating Chip**

Let us conclude by building a working simulator of Chip driving the car. This is just a hint of what this 4-part series of articles will develop. Building the simulator requires building some special numbers into the program without any explanation at present. The point is to enjoy the simulation, and get used to the idea that everything in a control loop happens at the same time.

We will assume that the steering wheel angle to left or right of center is Chip’s output quantity, and that there are no disturbances that can interfere at this point. This output quantity will be called A.

Under the influence of A alone, the car would drift sideways at a rate proportional to A, for small deviations from the center of the lane. Designating the crosswind velocity as W, if W were the only influence acting, the car would drift sideways at a rate proportional to W (in this somewhat oversimplified universe). In the BASIC program we will assume that each iteration corresponds to a fixed amount of elapsed time, so the distance D that the car will drift during any one iteration is simply the sum of the two influences acting on it (line numbers correlate with listing 1):

\[ D = K_1 \cdot W + K_2 \cdot A \]

The position, I, of the car relative to its lane will change by an amount D on each iteration:

\[ I = I + D \]

Now I must introduce a detail: if we just had Chip respond proportionally to the deviation of car position, we would have to make his muscles so flabby that hardly any response would occur, unless we wanted to demonstrate self-immolating oscillations. We have to take care of two destabilizing factors. First, the feedback function is essentially...
MICROCHESS
The Industry's First Gold Cassette Over 50,000 Sold

MICROCHESS is the industry's best selling computer game. And no wonder—because MICROCHESS gives you more than just a chess playing program: A convenient, foolproof set of commands and error checks...complete instructions in a 5½" by 8½" booklet...a cassette that's guaranteed to load, with disk versions coming soon...and several levels of difficulty to challenge you not just once, but time after time. It's available through well over three hundred computer stores and many mail order sources...always originating from Personal Software. What's more, every Personal Software product is selected to give you these same benefits of easy availability, reliable cassettes, readable documentation, a carefully thought out user interface...and most important, continuing challenge and enjoyment, not just once but time after time. If you haven't already, order your own gold cassette: MICROCHESS, by Peter Jennings, for 8K PETs, 16K APPLEs, and 4K Level I and II TRS-80s $19.95

TIME TREK by Brad Templeton for 8K PETs and Joshua Lavinsky for 4K Level I and II TRS-80s adds a dramatic new dimension to the classic Star Trek type strategy game: REAL TIME ACTION! You'll need fast reflexes as well as sharp wits to win in this constantly changing game. Be prepared—the Klingons will fire at you as you move, and will move themselves at the same time, even from quadrant to quadrant—but with practice you can change course and speed, aim and fire in one smooth motion, as fast as you can press the keys. Steer under power around obstacles—evade enemy shots as they come towards you—lower your shields just long enough to fire your phasers, betting that you can get them back up in time! With nine levels of difficulty, this challenging game is easy to learn, yet takes most users months of play to master. ADD SOUND EFFECTS with a simple two-wire hookup to any audio amplifier; the TRS-80 also produces sound effects directly through the keyboard case, to accompany spectacular graphics explosions! You won't want to miss this memorable version of a favorite computer game... $14.95

BLOCKADE by Ken Anderson for 4K Level I and II TRS-80s is a real time action game for two players, with high speed graphics in machine language. Each player uses four keys to control the direction of a moving wall. Try to force your opponent into a collision without running into a wall yourself! A strategy game at lower speeds, BLOCKADE turns into a tense game of reflexes and coordination at faster rates. Play on a flat or spherical course at any of ten different speeds. You can hear SOUND EFFECTS through a nearby AM radio—expect some razzing if you lose! $14.95

WHERE TO GET IT: Look for the Personal Software™ display rack at your local computer store. If you can't find the product you want, you can order direct with your VISA/Master Charge card by dialing 1-800-325-6400 toll free (24 hours, 7 days; in Missouri, dial 1-800-342-6600). If you have questions, please call 617-783-0694. Or you can mail your order to one of the addresses below, as of the dates shown.

Until July 1: P.O. Box 136 Cambridge, Mass. 02138

After July 1: 582 Weddell Dr. Sunnyvale, Calif. 94086

<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>PET/TRS-80/APPLE</td>
<td>Personal Software brings you the finest!</td>
<td></td>
</tr>
<tr>
<td>MICROCHESS</td>
<td>The Industry's First Gold Cassette</td>
<td>$19.95</td>
</tr>
<tr>
<td>TIME TREK</td>
<td>A Tour De Force In Real Time Action Strategy Games</td>
<td>$14.95</td>
</tr>
<tr>
<td>BLOCKADE</td>
<td>by Ken Anderson for 4K Level I and II TRS-80s</td>
<td></td>
</tr>
<tr>
<td>GRAPHICS PACKAGE</td>
<td>by Den Fylstra for 8K PETs includes programs for the most common 'practical' graphics applications: PLOTTER graphs both functions and data to a resolution of 80 by 50 points, with automatic scaling and labeling of the axes; BARPLOT produces horizontal and vertical, segmented and labeled bar graphs; LETTER displays messages in large block letters, using any alphanumeric or special character on the PET keyboard; and DOODLER can be used to create arbitrary screen patterns and save them on cassette or in a BASIC program</td>
<td>$14.95</td>
</tr>
<tr>
<td>ELECTRIC PAINTBRUSH</td>
<td>by Ken Anderson for 4K Level I and II TRS-80s: Create dazzling real time graphics displays at speeds far beyond BASIC, by writing 'programs' consisting of simple graphics commands for a machine language interpreter. Commands let you draw lines, turn corners, change white to black, repeat previous steps, or call other programs. The ELECTRIC PAINTBRUSH manual shows you how to create a variety of fascinating artistic patterns including the one pictured. Show your friends some special effects they've never seen on a TV screen!</td>
<td>$14.95</td>
</tr>
</tbody>
</table>
an integrator, and so puts a lag into the control process. This alone would not cause a problem, but Chip also contains a transport lag; he cannot actually produce an output at the same instant that the input occurs, nor can our program since it is evaluating equations one at a time. The integration lag we take care of by adding to the position 1 (which Chip senses) the variable D, which is approximately the first derivative of the input quantity. He senses the input quantity with some emphasis on its rate of change, which is actually a realistic model of human perception. This part of the stabilizing of the control action is done in step 9:

\[ 9 \quad A_1 = K_3 \times (1 + 0.8 \times D) \]

We have computed a variable A1, the angle which the wheel would assume if Chip reacted instantly. But to handle the transport lag, we must slow his response, letting only a fraction K5 (between 0 and 1) of it occur during any one iteration. That is what step 10 does:

\[ 10 \quad A = A + K_5 \times (A_1 - A) \]

This slowing technique will be used in the larger simulator next time. To see how it works, set A1 to 10.00, K5 to 0.25, and A to 0, and then simply keep doing step 10 with pencil and paper. A will gradually approach the value of A1 from any starting point.

The program in listing 1 asks for a wind velocity, and then proceeds to do ten iterations of the control loop, printing wheel angle A and car position deviation 1 each time. A positive number means the wind is blowing, the wheel is cocked, or the car has moved to the right. If you want to follow the program for more than ten iterations, give it the same wind again. It always starts where it left off.

In part 2, we will begin exploring a model of the kind described in figure 4 and start the somewhat mind boggling task of retraining the intuition to think in closed loop terms instead of straight through cause and effect. There is a big difference. We'll see that, in general, control systems control what they sense, not what they do. We'll discover something called a reference signal, which functions in a control system exactly the way an inner purpose has always been supposed to function. In part 2, we'll see how perception figures into control. And we'll start working with a more extended BASIC simulator than the tiny one in listing 1. Parts of this simulator will be suitable for building into the computer part of a robot, should anyone want to carry matters that far.
DIABLO PROVES
LOOKS ARE EVERYTHING.

With Diablo's printers and terminals, you can always be sure that beauty will be in the eyes of the beholder. Because no one knows more about print wheel technology than the company that invented it in the first place.

Diablo's metal and plastic wheel printers have established industry standards for crisp, clear characters, proportional spacing, and uniform density.

So, when you're ready to choose a printer for your own computer, pick the one that produces "picture perfect" originals every time.

If you really want to look good, remember this. With Diablo, you'll always look your best.

Diablo Systems
The 1802 Op Codes

The RCA/Hughes 1802 is an 8 bit microprocessor with a small but growing following. Its ease of interface and low CMOS power requirements make it attractive for many small applications. The accompanying chart of op codes for the 1802 illustrates all of the 255 variations. I have used the RCA mnemonics.

The 1802 is organized around sixteen 16 bit registers. These can be used as program counters, index registers, subroutine pointers, and general data storage registers. The interrupt and direct memory access features of the 1802 also make use of specific registers for their operation. There is an 8 bit accumulator (D), and three 1 bit flags: DF for the carry flag, IE for the interrupt enable flag, and Q for the direct output flag. There are also four 4 bit registers: two to hold the current op code, one

```
Table 7: RCA/Hughes 7802 instruction set. The op codes and the number of bytes used by each are shown.
```

```
<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDL</td>
<td>LDN</td>
<td>LDO</td>
<td>LDR</td>
<td>LDR</td>
<td>LDR</td>
<td>LDR</td>
<td>LDR</td>
<td>LDR</td>
<td>LDR</td>
<td>LDR</td>
<td>LDR</td>
<td>LDR</td>
<td>LDR</td>
<td>LDR</td>
<td>LDR</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>INC</td>
<td>INC</td>
<td>INC</td>
<td>INC</td>
<td>INC</td>
<td>INC</td>
<td>INC</td>
<td>INC</td>
<td>INC</td>
<td>INC</td>
<td>INC</td>
<td>INC</td>
<td>INC</td>
<td>INC</td>
<td>INC</td>
<td>INC</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>DEC</td>
<td>DEC</td>
<td>DEC</td>
<td>DEC</td>
<td>DEC</td>
<td>DEC</td>
<td>DEC</td>
<td>DEC</td>
<td>DEC</td>
<td>DEC</td>
<td>DEC</td>
<td>DEC</td>
<td>DEC</td>
<td>DEC</td>
<td>DEC</td>
<td>DEC</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>STO</td>
<td>STO</td>
<td>STO</td>
<td>STO</td>
<td>STO</td>
<td>STO</td>
<td>STO</td>
<td>STO</td>
<td>STO</td>
<td>STO</td>
<td>STO</td>
<td>STO</td>
<td>STO</td>
<td>STO</td>
<td>STO</td>
<td>STO</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>LDA</td>
<td>LDA</td>
<td>LDA</td>
<td>LDA</td>
<td>LDA</td>
<td>LDA</td>
<td>LDA</td>
<td>LDA</td>
<td>LDA</td>
<td>LDA</td>
<td>LDA</td>
<td>LDA</td>
<td>LDA</td>
<td>LDA</td>
<td>LDA</td>
<td>LDA</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>STR</td>
<td>STR</td>
<td>STR</td>
<td>STR</td>
<td>STR</td>
<td>STR</td>
<td>STR</td>
<td>STR</td>
<td>STR</td>
<td>STR</td>
<td>STR</td>
<td>STR</td>
<td>STR</td>
<td>STR</td>
<td>STR</td>
<td>STR</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>IRX</td>
<td>IRX</td>
<td>IRX</td>
<td>IRX</td>
<td>IRX</td>
<td>IRX</td>
<td>IRX</td>
<td>IRX</td>
<td>IRX</td>
<td>IRX</td>
<td>IRX</td>
<td>IRX</td>
<td>IRX</td>
<td>IRX</td>
<td>IRX</td>
<td>IRX</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>RET</td>
<td>DIS</td>
<td>LDXA</td>
<td>STXD</td>
<td>AOC</td>
<td>SDB</td>
<td>SHRC</td>
<td>SHLC</td>
<td>SMB</td>
<td>SAV</td>
<td>MAR</td>
<td>RDO</td>
<td>ADI</td>
<td>SOB</td>
<td>SHL</td>
<td>RSH</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>GD0</td>
<td>GD0</td>
<td>GD0</td>
<td>GD0</td>
<td>GD0</td>
<td>GD0</td>
<td>GD0</td>
<td>GD0</td>
<td>GD0</td>
<td>GD0</td>
<td>GD0</td>
<td>GD0</td>
<td>GD0</td>
<td>GD0</td>
<td>GD0</td>
<td>GD0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>GHO</td>
<td>GHI</td>
<td>GHI</td>
<td>GHI</td>
<td>GHI</td>
<td>GHI</td>
<td>GHI</td>
<td>GHI</td>
<td>GHI</td>
<td>GHI</td>
<td>GHI</td>
<td>GHI</td>
<td>GHI</td>
<td>GHI</td>
<td>GHI</td>
<td>GHI</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>FLO</td>
<td>FLO</td>
<td>FLO</td>
<td>FLO</td>
<td>FLO</td>
<td>FLO</td>
<td>FLO</td>
<td>FLO</td>
<td>FLO</td>
<td>FLO</td>
<td>FLO</td>
<td>FLO</td>
<td>FLO</td>
<td>FLO</td>
<td>FLO</td>
<td>FLO</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>PHI</td>
<td>PHI</td>
<td>PHI</td>
<td>PHI</td>
<td>PHI</td>
<td>PHI</td>
<td>PHI</td>
<td>PHI</td>
<td>PHI</td>
<td>PHI</td>
<td>PHI</td>
<td>PHI</td>
<td>PHI</td>
<td>PHI</td>
<td>PHI</td>
<td>PHI</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>LBR</td>
<td>LBQ</td>
<td>LBQ</td>
<td>LBQ</td>
<td>LBQ</td>
<td>LBQ</td>
<td>LBQ</td>
<td>LBQ</td>
<td>LBQ</td>
<td>LBQ</td>
<td>LBQ</td>
<td>LBQ</td>
<td>LBQ</td>
<td>LBQ</td>
<td>LBQ</td>
<td>LBQ</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>SEP</td>
<td>SEP</td>
<td>SEP</td>
<td>SEP</td>
<td>SEP</td>
<td>SEP</td>
<td>SEP</td>
<td>SEP</td>
<td>SEP</td>
<td>SEP</td>
<td>SEP</td>
<td>SEP</td>
<td>SEP</td>
<td>SEP</td>
<td>SEP</td>
<td>SEP</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>EX0</td>
<td>EX0</td>
<td>EX0</td>
<td>EX0</td>
<td>EX0</td>
<td>EX0</td>
<td>EX0</td>
<td>EX0</td>
<td>EX0</td>
<td>EX0</td>
<td>EX0</td>
<td>EX0</td>
<td>EX0</td>
<td>EX0</td>
<td>EX0</td>
<td>EX0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>LDK</td>
<td>LMK</td>
<td>AND</td>
<td>XOR</td>
<td>ADD</td>
<td>SD</td>
<td>SHR</td>
<td>SM</td>
<td>LDI</td>
<td>OHI</td>
<td>ANI</td>
<td>XIN</td>
<td>ADI</td>
<td>SDI</td>
<td>SHI</td>
<td>SMH</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 1: RCA/Hughes 1802 instruction set. The op codes and the number of bytes used by each are shown.
to designate which of the R registers is the program counter, and one to designate which of the R registers is the index pointer. Lastly, there are four EF external pins that are sensed as conditional branch flags.

11 commands make up the bulk of the 1802 op codes. Each is 1 byte in length, with the first nybble designating the operation, and the last nybble acting as a 4 bit immediate operand. They account for 175 of the op codes (LDN does not operate on register 0) and allow data transfer to and from the R indexed memory, incrementing and decrementing the R registers, and setting the P and X registers. There are four major operations (hexadecimal 80 through BF) that move bytes of data between the accumulator and the two halves of the 16 bit registers.

The arithmetic and logical operations use the accumulator with either the immediate data or the indexed memory contents as the other operand.

There are three types of branches. The short branch uses the immediately following byte as the next address in the local 256 block of memory space. This is *not* a relative jump; the immediate data just replaces the low byte of the program counter. The long branch uses the two following bytes, high byte first, to construct the branching address. The skip instructions skip over following instructions if the tested condition is true. The short branch instructions include the external flags as possible testable conditions, allowing quick direct serial input.

There is also a set of I/O (input/output) instructions to transfer a byte to or from one of seven possible I/O ports. The external Q pin can be set or reset to give quick direct serial output.

The SAV, MARK, RET, and DIS instructions can be used to implement recoverable interrupt and nested subroutines by using a stack in memory.

The last instructions are NOP and IDL. The IDL instruction places the machine on hold until an interrupt or direct memory access request occurs.

The 1802 is a well-designed computer package, and CMOS is the technique in battery powered applications.
The History of Computing
The IBM 7070

IBM 7070s undergoing final checkout before shipment.

An IBM 7070 operator's console.

A typical IBM 7070 configuration. The engineering console (for repair diagnostic information) is in the table in the foreground.
The second computer generation is said to have begun with the advent of the transistor. An equally important advance was the realization that most programmers would soon be programming not in symbolic machine language but in machine independent high level languages. This led hardware designers to build instructions that simplified compiling of programs, such as editing, table lookup and string scanning instructions. Some of these instructions are found in the IBM 7070, announced in 1959.

The 7070, like the 650, was built around a 10 digit signed decimal word. Signs and digits were stored in a two-out-of-five code; five bits were used to represent a digit, of which exactly two were "on". The five bits were assigned values of 0,1,2,3 and 6, so a little fudging had to be followed in order to represent 0. Since 3 can be represented two ways, 0-3 or 1-2, the former was used as the value for 3 and the latter for 0. Alphabetic characters were represented by digit pairs, hence, only five letters could be stored in a word. To distinguish between alphabetic and numeric representation, three signs were allowed: +, -, and @, represented by the codes for 9, 6, and 3, respectively.

Two memory sizes, 5,000 and 9,990 words, were available. The larger size could have been 10,000 words, but addresses 9991-9999 referred to addressable registers, including three accumulators. The small memory size was seen as a drawback, but a remarkably powerful instruction set tended to offset this problem. The 7070 might have been the start of a new decimal based family of computers if IBM had added a memory paging feature to allow for expansion.

The instruction format used the sign and first two digits as an operation code. Two digits for an indexing address, two digits for field definition or instruction augmentation, and four digits for an address. Hence, 200 different instruction types and 99 index words were possible. In fact, 190 instructions were implemented, and memory locations 0001 through 0099 could be used as index “registers.” Field definition allowed arithmetic to be performed on parts of words. If field definition 58 was specified in an ADD instruction, the contents of digit positions 5 thru 8 of the addressed value would be added to the specified accumulator.

I/O (input/output) units did not look much different from first generation equipment, but in fact embodied several significant improvements. Magnetic tape units could read and write in low (200 bits per inch) or high density (556 bits per inch). Data channels allowed overlap of data transfer and processing, and a priority I/O scheme allowed for simultaneous peripheral operation on line—spooling, as it is still called. The idea behind spooling is that punched cards may be read and lines printed during times when the machine is simultaneously doing something else. The main program gets and puts records on a faster medium, such as a disk, and is therefore not forced to wait for the relatively slow card reader or printer.

File handling capability on the 7070 was very sophisticated due to a feature called block transmission. A record could be read into several noncontiguous blocks of memory under control of RDWs (record definition words). The programmer specified in a tape read instruction the unit number of the tape to be read and the address of the first of a sequence of one or more record definition words. Each definition contained the starting and ending address of a block (set of consecutive words) into which data was to be read. Each record definition word in the sequence had a positive sign except the last one, which was negative. If the physical record ended before all definitions were exhausted, the remaining were ignored. If the last record definition word was exhausted before the end of the record was reached, the remaining data were not transferred into memory. When a record was written, record definition words were similarly used to gather data from various parts of memory without actually transferring them into one contiguous memory block.

Variable length records could also be handled easily through use of a tape read per record mark control instruction. A record mark was a special character having the keypunch code 0-2-8, which was written as a not equal sign (≠). When the tape was read under record mark control, the normal sequence of data transmission to storage via record definition words was followed until a record mark was read. This caused the 7070 to cease transmission of data to the block specified by the current definition and to move on to the next.

For example, suppose a tape record contained:

```
ABCDEFGHI ≠ JKLM ≠ NOPQR
```

and a tape read per record mark control
Up Your Output.

TEMPOS

MULTI-TASKING!

The TEMPOS Operating System is quickly becoming the standard in Multi-User, Multi-Tasking operating systems for 080 and 280 microcomputers. Multi-Tasking means that, even with only one user at one terminal, more than one job can be running on the system simultaneously! If you have ever had to go get a cup of coffee while you wait for your computer to print listings, you know the advantages of a system that will handle one job while you are working on another. TEMPOS is a true time sharing system, and the maximum number of jobs is limited only by your memory.

MULTI-USER!

Want to share your computer with another user? With TEMPOS all it takes is another terminal... up to seven interactive terminals are allowed! And with Re-Entrant programs, each user does not need a complete copy in memory. We include three Re-Entrant programs (the OPUS/THREE High-Level Language, the TEXTED Text Editor, and FILES, a disc file directory/ manipulator) or write your own! In addition, we include an assembler, a linking loader, over a half-dozen other utility programs and over 60 system subroutines, callble by the programmer.

PROVEN!

With TEMPOS, you get a package that has been tested in our facilities for over two years, and in the field at over 50 different installations. We have used this system ourselves for everything from writing high level languages to developing applications to text editing to games. TEMPOS is undoubtedly the most flexible software tool on the market... and you can have it for much less than you think!

COMPATIBLE!

TEMPOS is available for many different systems; pre-written drivers may include yours. Or, using our interactive System Generation Routine, you can add your own. Call or write now for our free catalog and the name of a dealer near you. The TEMPOS Operating System is available for $787.00, the manual set (price may be credited toward the purchase of the TEMPOS package) for $21.50 (prices include shipping within the U.S.).

ADMINISTRATIVE SYSTEMS INC.

1642 S. Parker Road, Suite 300, Denver, Colorado 80231
(303) 755-9694

A major problem arose because of the special nature of alphabetic data. In first generation computers, conventions had been established regarding coding of alphabetic characters on tape, and these conventions were carried on into the 7070. Some means of differentiating between alphabetic and numeric data had to be established, however, since the old-fashioned "overpunched" numeric sign used in unit-record equipment and early computers could not always be distinguished from alphabetic characters. This problem was resolved on the 7070 by assuming that a tape was alphabetic until a delta character was read, whereupon the delta was not transferred into memory, but served instead to change the mode of data transfer to numeric. The next delta flipped the mode back to alphabetic, and so on. A delta on the seven track BCD (binary coded decimal) tape (in which the tracks were labeled CBA8421) consisted of the CB8421 bits. Thus the three words:

+012343210
-5678998765
@7461796368

would be written on tape as A01234-432105678998765.S.MARCH. When read into a 7070, a perfect translation took place back into the three words shown above. However, when read into any other computer, the delta characters transferred into memory, giving IBM 1401 programmers considerable annoyance. Nevertheless, it is safe to say that the 7070 represented a very large step between first generation and modern computers. Most apparent among the second generation refinements was the recognition that computers did not have to be classified as commercial or scientific machines but in fact could be used to solve problems in both of the disciplines. On the one hand, the record definition word concept made sorting extremely fast, while hardware implemented floating point instructions were available for calculation.
INFO 2000 DISK SYSTEMS: A LOT LESS THAN YOU EXPECT.

Less Cost
The DISCOMEM Controller board costs us less to manufacture. So your complete INFO 2000 Disk System costs you less — at least $400 less than comparable disk systems.

Less Hardware
Only three S-100 boards are needed to create a complete, high-performance disk-based microcomputer system—the DISCOMEM Controller Board, a 32K memory board, and any 8080, 8085 or Z80 CPU board. You don't need extra interface or EPROM boards since DISCOMEM contains 2 serial ports, 3 parallel ports and provision for 7K of EPROM and 1K of RAM.

Less Time
The INFO 2000 Disk System is incredibly fast! Using the PerSci Drives with voice coil positioning, disk seek times are up to 8 times faster than with other drives. A full disk-to-disk copy and verification takes well under a minute. Formatting and verifying a new diskette takes less than half a minute. Reloading CP/M from diskette takes a fraction of a second.

Less Space
The system is remarkably compact, requiring only 1/2 to 1/3 the space taken by other 2-drive disk systems.

It all adds up to more capability for your money.

The complete INFO 2000 Disk System comes completely assembled and tested. It includes dual diskette drives, the DISCOMEM Controller, power supply, cabinet, cables and the CP/M disk operating system—everything you need for immediate plug-in-and-go operation with your microcomputer. This means less time, hassle, hardware, space, errors and less money than for comparable equipment. Now, isn't that a lot less than you'd expected in a dual disk system?

INFO 2000 DISK SYSTEMS are also available for Digital Group and Heath H8 microcomputers. Dealer inquiries welcomed.

INFO 2000 CORPORATION
20620 South Leopwood Avenue
Camarillo, California 90406
(213) 532-1702

Circle 173 on inquiry card.

1 CP/M is a registered trademark of Digital Research.
Artificial Intelligence and Entropy

Although this article is written with a sense of science fiction creativity and speculation, the concepts involved are based on sound ideas that recently won for Ilya Prigogine the 1977 Nobel prize (see reference 1). No longer can it be said that the laws of thermodynamics prohibit the creation of artificial intelligence.

Computer intelligence has long been a hazy dream in many enthusiasts' eyes, but so often that gleam has been glazed over by a rational response from the scientific community: "You can get out of any computer only what you put in. The computer, after all, has to be told what to do. It can't think."

These valid scientific arguments are based, essentially, on the laws of thermodynamics, especially the second law, concerning entropy. The second law says in effect that for all (isolated) systems at or near equilibrium, any process will have a tendency to increase the system's entropy.

Shannon has developed the idea that entropy is related to the inverse of information (see reference 2); so as entropy goes up, information goes down. The second law of thermodynamics seems to demand that this decrease in information shall always happen for mechanical or electrical machines.

The conclusion that machines will never be capable of thinking seems irrefutable.

But man is a biological machine, and yet he thinks. How can these two seemingly contradictory ideas be reconciled with the second law? One of the greatest scientific puzzles of the last century was that the idea of a thinking biological machine cannot be brought into accord with the laws of equilibrium thermodynamics! The paradox stands.

The brilliance of I Prigogine lay in his recognition that another regime far from local thermodynamic equilibrium may exist for complex interacting systems. Exactly what this new regime is all about took many years of study to formulate and understand, but in the last two years the verification of this new thermodynamic concept has been achieved by a small but convincing number of chemical experiments (see reference 3).

Simply, the new thermodynamic regime is a regime far from equilibrium where semi-steady state modes of collective interactions can self-organize in complex systems. In this collective mode of self-organization, far from thermodynamic equilibrium, the entropy of the system drops dramatically; the information content rises. The increasing entropy dictum of the second law is no longer valid because the system is not in equilibrium.

The key features of systems that can support such entropy-decreasing modes are that:

1. They are not isolated systems: they draw energy and material from their surroundings; that is, they feed.
2. They are complex systems of many interacting parts, and the interactions must be nonlinear.

These conditions seem to be necessary but not sufficient. A complex system that has these properties need not self-organize into an entropy decreasing mode, but if these conditions are met, the low entropy modes are now scientifically recognized possibilities.

Theoretical models of complex chemical systems have indicated that the minimum number of subparts that will form a collective mode far from equilibrium is measured in the thousands. This result is striking; it could have been that it would take statistically large mole numbers ($10^{23}$) of parts to form self-organized systems, but no, it appears that thousands, or a few tens of thousands, of subsystems interacting nonlinearly can, for certain ranges of parameters, flip into self-organized modes of decreasing entropy.

For the first time, thermodynamics (albeit of the nonequilibrium variety) can be used to substantiate entropy decreasing modes, biological systems, and thinking machines! Using these ideas as a basis, it is conceivable that a collection of subsystem computers linked together nonlinearly could, for certain ranges of coupling parameters, self-organize into a collective mode of operation in which the entropy of the complex system decreases.

The gleam in the young experimenter's eye need not be glazed over and extinguished by a thermodynamic "it's impossible" argument. The loophole in the law has been discovered.
A few years ago such a project would have been economically impossible, but now with the advent of cheap small volume microprocessors it is conceivable that, say, ten thousand computer subsystems could be assembled and linked together in one complex. Moreover, following the theoretical advances pioneered by I. Prigogine, such a complex might be arranged to operate in a collective mode far from equilibrium in which the entropy content drops dramatically, the information content skyrockets, and the idea of artificial intelligence need no longer be squashed by thermodynamic dictum. It indeed may be possible to create a thinking machine.

REFERENCES

Appendix: Collective Mode Systems of Low Entropy

After I submitted the above article to BYTE, editor Carl Helmers asked if I could provide a tutorial example explaining the ideas of a collective mode system with low entropy. Perhaps the most striking example of such a system is given by the laser (see reference 4).

The typical laser consists of an optical cavity, a set of atoms such as He-Ne—connected to the outside world by means of a power supply. Energy flows continually into (and out of) the system so it cannot be considered to be isolated. If the system gain parameter is below a critical value, the gas atoms may be excited by the energy source and subsequently release their excess excitation energy through the emission of photons. The photons all have random phase, i.e., the emission of photons by the various atoms in the gas is random, and not coherent. The system has a high entropy content associated with the disorder and the random emission of photons. The system does reach a steady state, not a collective mode state, and not a state of equilibrium, because it continually receives energy across its boundary.

If the gain parameter of the system is slowly increased to above the critical value, a dramatic transition takes place—far from equilibrium. The system lases, i.e., the gas atoms no longer emit the photons in a random manner, but instead they de-excite in a coherent collective mode. The emission of one photon from one atom stimulates the emission of another photon from another atom, and so on. The photons are emitted with the same phase; disorder has been removed, and the system entropy drops dramatically.

Figure 1: The He-Ne discharge glows in a disordered random fashion. The emission of photons is random, disordered and associated with the notion of high entropy.

Figure 2. For the system "gain" above the critical value lasing action takes place in the He-Ne gas. The radiation is phase locked into a collective mode associated with low entropy.
The notions of disorder and randomness are concepts associated with the notion of entropy. The decrease of the laser's entropy is due to lack of disorder in the lasing state.

These ideas are described in figures 1 and 2. Figure 1 represents a laser being supplied with energy from the power source, but with the gain of the cavity below the critical value. The photon emission is random and the system has high entropy.

On the other hand in figure 2 the gain factor of the system is above the critical value and the system has flipped into a low entropy collective mode emitting highly ordered radiation. The atoms radiate collectively.

The almost incredible feature of many complex systems interacting nonlinearly is that they may self-organize into these low entropy modes. In particular, biological systems appear to be of this type. Numerous examples of collective mode systems appear in the physical world, but most of them occur at low temperature; superconductors and superfluids are examples. The self-organization into collective modes far from equilibrium at modest to high temperatures is yet another idea.
INTRODUCING THE .4 MEGABYTE DUAL DRIVE MINIFLOPPY FOR 8K PETS!

NOW WITH 400K (.4 MEGABYTES) OF DISK STORAGE

CUSTOMER ORDERS ARE NOW BEING SHIPPED WITHIN TEN DAYS!!!

DKH641 IS A PRODUCT OF COMPUTHINK.

PET COMPUTER

NEECO NOW OFFERS A FULL ONE YEAR WARRANTY ON ALL PETS! — AN ADDITIONAL 9 MONTHS!

THE ABOVE PRICES INCLUDE THE INSTALLATION AND TESTING OF INTERNAL MEMORY BOARDS.

עמי נמרוד

INTRODUCTION MEMORY EXPANSION FOR PET!

EXPANDAPE T™ INTERNAL MEMORY EXPANSION UNIT FOR 8K PETS

* MOUNTS EASILY INSIDE YOUR PET
* EASY TO INSTALL (15 MINUTES)
* NO DEGRADATION OF PET SYSTEM
* USES LOW POWER DYNAMIC RAMS
* 90 DAY PART & LABOR, 1 YEAR RAMS
* 50 DAY MONEY BACK GUARANTEE
* MOUNTING SLOTS FOR 4 BOARDS
* CALL/WRITE FOR ADDITIONAL INFO

DEALER INQUIRIES INVITED

OPTIONAL PLUG-IN BOARDS
4K EPROM DAUGHTER BOARD USING 2716 EPROMS .... $50
32K UNIT ALLOWS 8K OF ASSEMBLY LANGUAGE SUBROUTINES ACCESSED VIA THE USR COMMAND

EXPANDAPE T IS A PRODUCT OF COMPUTHINK.

FULLSIZED TYPEWRITER KEYBOARD FOR PET!

NOW AVAILABLE! $139.95

NPK-101 IS A PRODUCT OF NEW ENGLAND ELECTRONICS.

OUR NEW JUNE PET CATALOG IS NOW AVAILABLE. CALL OR WRITE FOR OUR *FREE* PET PRODUCTS CATALOG.

DOMESTIC & OVERSEAS DEALER INQUIRIES INVITED ON *MEMORY* KEYBOARD * FLOPPY*.

NEW ENGLAND ELECTRONICS CO., INC.
679 HIGHLAND AVE., NEEDHAM, MASS. 02194
MON. - FRI. 9:30 - 5:30, EST.

(617) 449-1760

MASTERCHARGE OR VISA ACCEPTED

TELEX NUMBER 951021, NEECO

Circle 281 on inquiry card.
BASIC Text Editor

Like many an individual who uses computers at work and for personal purposes, I have a tendency to write. At work, this tendency is expressed in the usual ways as memos, project oriented documentation and more general papers. In personal life, this tendency is expressed by the existence of this article and several others which preceded it.

After some considerable chicken scratch ing it became apparent that my method for collecting ideas and creating a final manuscript was not optimum. The problem became clearly defined when one day I looked up from my note pad only to see my IMSAI arrogantly sleeping while I worked.

The literary approach I had been using was reasonably conventional. First in the procedure was the generation of an outline which contained ideas organized by section. Then a handwritten rough draft was composed in which these thoughts were structured within each section and expanded upon. The draft was then reviewed and changes made until legibility was threatened. If the writing had been for "work" the next step would have been to have the draft retyped. However, as writing for microcomputer journals is a private pursuit, a paid typist is used sparingly.

The next step was therefore to go back through the draft and reedit, being very careful with errors and is, and then to give it to the typist for final preparation. The typist's job was to take the grubby and somewhat illegible pile of paper and transform it into a nicely typed manuscript suitable for submission. However, the last step was invariably one of carefully applying correction fluid, scissors and tape in the proper proportions to assemble a truly final version. Usually the alterations were due to my own errors, though my excellent typist often adds a few variations as part of her own editing contribution. As a result, I have never sent an original to an editor, always a copy which hid the horrors of the manuscript's creation. After all, what editor wants flakes of dried correction fluid sprinkled on his or her clothes and desk?

A few further considerations convinced me that it was time to make a change. First, I cannot stand reading my own handwriting. Second, I can type much faster than I can write. Third, it was a convenient time to design an editing system. The reason for the latter was that I had a video display, IMSAI and North Star disk combination at home and a very nice Diablo printer, Altair 8800B and North Star disk setup available at work. Thus there was basic compatibility between the two systems via the floppy diskette. I had taken care to assure that the two systems were software compatible, particularly with respect to IO.

The general idea was to use my personal system to compose and edit versions of a manuscript and then to bring the finished form, on diskette, to work to be printed out on the Diablo. In practice it turned out to be more convenient to have listings of the various versions to work from. This made the iterations much easier. There is no replacement for hard copy when writing either a program or an article.

One of the goals established for the eventual editor software was that it should not be unique to my particular hardware configuration. Rather it was to be translatable to other systems with a minimum of change. For this reason BASIC was chosen as the implementation language, though machine language would have led to a much better utilization of memory as well as higher speed. The particular BASIC used was North Star, Version 6, Release 3. This interpreter has string manipulation functions which are very convenient for developing editing routines. These functions can also be translated into counterparts a la Microsoft BASIC. This will be discussed more later.

Text editors naturally require significant computer storage capabilities. The one shown in listing 1 is no exception. For those who have disk based systems other than North Star, the conversion of this program for use with another system would be through changes in the disk access subroutines which are clearly defined on the listing. For those who do not have disk hardware, but rather cassette IO, storage and retrieval can also be accomplished through the disk access subroutines after the appropriate modifications are made.

The program also has the ability to automatically save and retrieve the text from active memory. This is presently not in effect in the version shown in listing 1, but can be brought to life by removing statements 2000 and 2100. This feature is useful if the computer is a little unstable and has a tendency to crash; at least the latest text version might be saved in a protected memory region if the program did not get as far as saving the text on diskette or tape. The
THE LEADER IN
MICROCOMPUTER EDUCATION
PRESENTS

BEST-SELLING BOOKS
Used by Universities and Industry worldwide (ten languages)

C200 - AN INTRODUCTION TO
PERSONAL AND BUSINESS COMPUTING
Rodnay Zaks, 250 pp
A comprehensive introduction to small computers, their peripherals, and what to select. $6.95

C201 - MICROPROCESSORS: FROM
CHIPS TO SYSTEMS
Rodnay Zaks, 416 pp
The basic text on all aspects of microprocessors and the assembly of a system. $9.95

C202 - PROGRAMMING THE 6502
Rodnay Zaks, 250 pp
A complete introductory programming text for the 6502. $10.95

D302 - 6502 APPLICATIONS BOOK
Rodnay Zaks, 200 pp
Connecting a 6502 board to the outside world from home alarm to music and industrial control. $12.95

C207 - MICROPROCESSOR
INTERFACING TECHNIQUES
A. Lesaka & R. Zaks, 416 pp
How to interface a microprocessor to external devices, from keyboard to ADC to floppy disk, including standard busses. $11.95

X1 - MICROPROCESSOR LEXICON, 125pp
All the definitions of the microprocessor word in a convenient pocketbook format. $2.95

AVAILABLE AT BOOKSTORES, COMPUTER STORES, AND ELECTRONIC SHOPS EVERYWHERE!

SELF-STUDY COURSES ON CASSETTES
"The time-efficient way to learn"™
Self-study courses include two to eight audio-cassettes and a special book. They offer the fastest way to learn the topic covered (from ½ to two days). Highly effective.

1-INTRODUCTORY - SHORT (2.5 hrs ea)
S1-INTRODUCTION TO MICROPROCESSORS $29.95
S2-PROGRAMMING MICROPROCESSORS $29.95
S3-DESIGNING A MICROPROCESSOR SYSTEM $29.95
S10B-INTRODUCTION TO PERSONAL AND BUSINESS COMPUTING $21.90

2-INTRODUCTORY - COMPREHENSIVE (10 to 12 hrs ea)
S81-MICROPROCESSORS $59.95
S82-MICROCOMPUTER PROGRAMMING $59.95

3 - SPECIALIZED (4.5 to 6 hrs ea)
S83-MILITARY MICROPROCESSOR SYSTEMS $49.95
S85-BIT-SLICE $49.95
S86-INDUSTRIAL MICROPROCESSOR SYSTEMS $49.95
S87-MICROPROCESSOR INTERFACING $49.95

TO ORDER
By Phone: 415 848-8233, Visa, M.C., American Express
By Mail: Include payment. Shipping: add $1.50 per book (UPS) or 65¢ (FedEx) - allow 4 weeks. Double for cassettes and overseas. Tax: in California add tax.
FREE DETAILED CATALOGUE

NAME ____________________  POSITION ____________________
COMPANY ____________________
ADDRESS ____________________
CITY ____________________ STATE/ZIP ____________________
☐C200 ☐C201 ☐C202 ☐C207 ☐D302 ☐S10B ☐S83 ☐S85 ☐S86 ☐S87
☐charge my ☐Visa ☐M.C. ☐Amer Express
Number ____________________ Exp. date ____________________
Signature ____________________ ☐Send Catalogue

SYBEX
Dept B6
2020 Milvia Street
Berkeley, CA 94704
Tel 415 848-8233 Telex 336 311
See You At NCC—Booth 31

Circle 356 on inquiry card.
Listing 1: This BASIC program is the complete listing of the text editor.

10 REM EDITOR, VERSION 6, AS OF 1500 HOURS, 1/31/78
20 REM WRITTEN BY F.R. RUCKDESCHEL
30 REM 775 JOHN GLYNN BLVD
40 REM WEBSTER, NEW YORK 14580
50 REM NEW PARAGRAPH CHARACTER: &
60 PRINT "ENTER MAXIMUM LINE LENGTH",
70 INPUT M1
80 PRINT "ENTER LETTER LENGTH",
90 INPUT M2
100 DIM AS(M2),GS(M1),E(300),E(300)
110 PRINT "INPUT BEGINNING STORAGE LOCATION (DECIMAL): ",
120 INPUT Y9
130 REM TEST TO CHECK IF LETTER IS NEW
140 PRINT "NEW LETTER (N) OR RESTART (R): ",
150 INPUT G$1
160 IF G$1(1,1)="N" THEN GOTO 190
170 GOSUB 3010
180 GOTO 380
190 A$=""
200 G$=""
210 L=0
220 B$=""
230 PRINT "GET LETTER FROM FILE? (Y/N): ",
240 INPUT H$
250 IF H$(1,1)="Y" THEN GOTO 300
260 PRINT "INPUT NAME OF LETTER: ",
270 INPUT Z$
280 GOSUB 1530
290 PRINT "INPUT NAME OF LETTER: ",
300 REM START OF NEW LETTER
310 L=1
320 PRINT $1,L,
330 INPUT G$
340 IF G$="" THEN GOTO 630
350 A$=A$+G$
360 PRINT "INPUT NAME OF LETTER: ",
370 INPUT M1
380 A$=""
390 GOTO 380
400 PRINT "ENTER LINE NUMBER TO BE EDITED",
410 INPUT L1
420 REM L=0 IS ESCAPE EDIT
430 IF L=0 THEN GOTO 630
440 REM ADDITION AT FRONT OF LETTER?
450 IF L=2 THEN GOTO 1680
460 REM ADDITION TO END OF LETTER?
470 IF L=0 THEN GOTO 1790
480 L=2
490 PRINT $2,L2,
500 REM INSERTION? F CHANGE IS DEFAULT
510 IF L=0 THEN GOTO 300
520 PRINT $1,L,
530 PRINT Z$+""
540 G$=""
550 INPUT G$
560 L(0)=1
570 IF G$(1,1)="<" THEN B$=B$+G$
580 IF G$(1,1)=">" THEN GOTO 550
590 E(0)=300
600 REM NEW PARAGRAPH CHARACTER
610 GOTO 630
620 REM *********************
630 REM ENTER EDIT MODE
640 PRINT "EDIT SUBROUTINE"
650 PRINT "ENTER LINE NUMBER TO BE EDITED",
660 INPUT L
670 REM ENTER SUBROUTINE
680 REM RESTART (R): ",
690 INPUT H$
700 PRINT "WANT LETTER NUMBERED? (Y/N): ",
710 INPUT H$
720 IF H$(1,1)="N" THEN H=1
730 IF H=1 THEN JS+1
740 IF H=0 THEN GOTO 710
750 FOR K=1 TO 7
760 PRINT L1"\K GOTO 970
770 NEXT K
780 PRINT "LINE NUMBER RANGE: (LOW, HIGH)",
790 INPUT M8,M9
800 GOTO 990
810 PRINT "WANT JUSTIFIED TEXT? (Y/N): ",
820 INPUT J9$1
830 IF J9$="Y" THEN J9=1
840 FOR K=1 TO 5
850 PRINT L1"K
860 NEXT K
870 T=0
880 IF T>LEN(A$) THEN GOTO 300
890 S=S+W
900 REM NEW PARAGRAPH CHARACTER
910 F=0
920 IF S=LEN(A$) THEN S=LEN(A$)
930 IF J9=0 THEN GOTO 1030
940 REM TEST FOR PARAGRAPH CHARACTER

The object of the editor program is to generate a text oriented file which can be corrected and expanded with a reasonable level of ease. As mentioned earlier, the file may be stored on diskette, tape, or in active memory. The file can be recalled and printed out in two general formats, justified and unjustified. In the justification mode, by definition, lines are ended between words. The chosen line length may be any size as long as it is longer than the longest word in the text and shorter than the maximum line length allowed by the software. In the unjustified format, printing fills the entire line, regardless of whether or not a word is broken.

In either justification format the program will list selected line number groups using only even numbers. This allows the user to insert lines, when in the edit mode, by giving them odd numbers. Inserted lines can be any number of characters long within the constraints of memory or dimension. The program rennumbers and reformats after each editing exercise.

Upon listing, it is the choice of the user to have the lines numbered or not. If the decision is not to number, the entire text will be printed. Otherwise a line number range can be chosen. In either case, the program goes through the entire text, reformats and assigns line numbers. In the justification mode defined above this may consume a significant length of time as tests for the gaps between words and new paragraph identifiers must be made. In the un-
for memory, the word is “CHOICE”

No matter what system you choose — S-100 based, Radio Shack-80, H8, Digital Group, or even the Intel/National single board computer system — we have the memory you want. You may choose from a variety of configurations and densities, as a variety of price levels.

We also give you the choice of buying your memory in unkit form (sockets, bypass caps pre-soldered in place), assembled and tested; or qualified under our CSC (Certified System Component) high-reliability program (200 hour burn-in, immediate replacement in event of failure within one year of invoice date, and more).

But there are some areas where we don't give you a choice. You can't choose between 2 and 4 MHz versions of our high density memories, because we only make the 4 MHz type. And you can't choose between low and high power versions — all our memories are designed for very low power operation. An example: our 32K bank select board's guaranteed maximum current spec is 3.5A, which is considerably lower than most other typical current specs.

We even give you a choice of non-memory products that offer exceptional value and performance, such as our I/O board, motherboard, and active terminator.

How do you get ahold of a CompuKit® product? Well, there's a choice there too. Our products are available from many fine computer stores, or directly from us.

<table>
<thead>
<tr>
<th>Name</th>
<th>Storage</th>
<th>Buss</th>
<th>Design</th>
<th>Speed</th>
<th>Configuration</th>
<th>Unkit</th>
<th>Assm</th>
<th>CSC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Econoram X</td>
<td>32K X 8</td>
<td>S-100</td>
<td>static</td>
<td>4 MHz</td>
<td>2 ind. banks*</td>
<td>$649</td>
<td>$649</td>
<td>N/A</td>
</tr>
<tr>
<td>Econoram X</td>
<td>32K X 8</td>
<td>S-100</td>
<td>static</td>
<td>4 MHz</td>
<td>2 ind. banks*</td>
<td>$479</td>
<td>$539</td>
<td>$649</td>
</tr>
<tr>
<td>Econoram X</td>
<td>32K X 8</td>
<td>S-100</td>
<td>static</td>
<td>4 MHz</td>
<td>2 ind. banks**</td>
<td>$629</td>
<td>$699</td>
<td>$849</td>
</tr>
</tbody>
</table>

*addressable on 8K boundaries  **addressable on 16K boundaries

Econoram is a trade mark of Godbout Electronics.

BANK SELECT MEMORIES (for Alpha Micro Systems, Marinchip, etc.)

Econoram XII-16 16K X 8 S-100 static 4 MHz 2 ind. banks* $369 $419 $519
Econoram XII-24 24K X 8 S-100 static 4 MHz 2 ind. banks* $479 $539 $649
Econoram XII-32 32K X 8 S-100 static 4 MHz 2 ind. banks** $629 $699 $849

Also available: 16K Memory Expansion Chip Set $109 (3/$320)

FOR Radio Shack-80, Apple, Sorcerer machines, 250 ns chips for 4 MHz operation, DIP shunts. 1 year limited warranty. With easy-to-follow instructions.

ACTIVE TERMINATOR KIT $34.50

Our much imitated design plugs into any S-100 motherboard to reduce noise, ringing, overshoot, and other bus-related problems.

DUAL CHANNEL/DUAL FUNCTION S-100 I/O BOARD $189 unkit, $249 assm

This one does things the others can only dream about. Two independently addressable serial ports with full RS232C current loop (20 mA) and TTL signals on both ports, crystal controlled Baud rates to 19.2 KHz, hardware UARTS, compatible with 2 or 4 MHz systems, low power consumption, and a whole lot more — we'll be glad to give you more info, just write.

2102 MEMORY SPECIAL 10/$9.90

That's only .99c each for very low power, static 1K RAMs suitable for use with any 2 MHz system. Price only good on orders of 10 or more. 16 pin top-lobe sockets also available at the special price of $125.00.

1791 MOS LSI DUAL DENSITY DISC CONTROLLER CHIP $59

Just in! Prime Western Digital parts, plus pinout and data.

HEATH H8 BARE BOARD MEMORY SPECIAL — $35!

Don't need the full 12K of our standard H8 memory? We now offer the board, mounting bracket, edge connector, and schematic for only $35. Populate it with a few support chips and readily available low cost 2102s to build your memory up to a full 12K whenever your budget permits.

11 SLOT MOTHERBOARD UNKIT

With 11 edge connectors pre-soldered in place for easy assembly, as well as integral active terminator circuitry. Dimensions: 8.5" X 11" $90

18 SLOT MOTHERBOARD UNKIT

Same as above, but 18 slot version with 18 edge connectors. Dimensions: 8.5" X 16.7" $124

FREE FLYER: We'll be glad to tell you more than the space of this ad allows. Just send your name and address, we'll take care of the rest. If you're in a hurry, enclose 41c in stamps and we'll send it out first class.

CompuKit® from Godbout Electronics

Box 2355, Oakland Airport, CA 94614

Circle 150 on inquiry card.
In addition, changing the first character in the text is a little cumbersome; it is suggested that the very first character be a blank to mitigate this problem.

When any of the above failures occur there is a good chance that recently edited work may be lost. For example, when a program fails, most BASICs enter the direct command mode. If the program is rerun, most likely the string variables will be cleared. The temporary save and retrieval subroutines were included to reduce the impact of such errors. If the error occurs during the edit mode, the last form of the text (before the edit mode was entered) may be retrieved by rerunning and answering the initialization appropriately (restart: R). If the failure occurs during a disk or a tape load, unless a large crash occurs, the most recent text version may be recovered upon restart.

Additional Notes

There are several statements employed in North Star BASIC which must be modified if the editor program is to be used with another interpreter. The following is a list of the types of changes required if this program is to be translated into a BASIC similar to that written by Microsoft and distributed by MITS:

- **FILL<></>,<>** same as **POKE<></>,<>**
- **EXAM(<>)** same as **PEEK(<>)**

% Denotes a printing format (for example, nFm which is similar to the FORTRAN real format nFm). This can be simulated using the INT function along with some multiplication and division. In the more advanced versions of BASIC there is usually an equivalent format statement.

_ Denotes a continued print statement without a carriage return and line feed. In MITS BASIC one would use a semicolon.

A$(M,N) With respect to the editing functions as implemented by the program, this is the most important difference between the North Star and Microsoft interpreters. For the task at hand the North Star form is preferred because of ease of use. In North Star BASIC A$(M,N) represents a substring of A$ which runs from character position M to character position N, thus having length N−M+1. To accomplish this in Microsoft BASIC one would use MID$(A$,M, N−M+1). Although a little more cumbersome, the Microsoft string function would suffice if it were not for the important variance that North Star BASIC allows arbitrarily long string lengths whereas Microsoft limits the string length to 255 characters. However, this limitation may be overcome by string subscripts. Note that string dimensions and subscripts are permitted in Microsoft BASIC, but not in North Star. Having to resort to subscripts is certainly an inconvenience and is a small pain to program. North Star BASIC certainly has an advantage in that respect.

The most difficult editing function to perform is the alteration of a text segment as the set of characters to be changed may extend over more than one text line. Generally it is best to attack the last line of the modification first. The corrections should then proceed toward the lower line number. The reason for doing this is that the text is reassembled upon each editing pass. If a change is made in a given line, all the lines above that point are altered, whereas all the lines below that point maintain their structure if the same line width format is chosen.

Inserting text is usually easy. As a redundant word of caution, remember to place a blank in the last character position in the file. Also, as there is some awkwardness in changing the very first character in the file, having a blank there is also helpful.

Conclusion

The limited capability editor program presented in the previous sections has the advantages of being easy to use as well as being somewhat portable. It was really meant to operate with the North Star Disk System, but can be translated for use on other BASIC oriented machines. Its utility is exemplified by the present article which served as a test case. In this application the article was broken up into files of 12 blocks (12 by 256 characters) or less to ease the strain on active memory. Thus, in effect, there is no limit to the document length which can be handled. Incidentally, 12 blocks corresponds to approximately half a typeset magazine page.

The true power of this program is apparent when large portions of the text creation and editing are done on a video display system (it is easy to get into the swing of rapidly typing additions and changes). However, occasional hard copy listings are invaluable for leisurely reviewing. A near ideal combination would seem to be a video display for editing and a fast hard copy terminal for printing. The denser and faster the video display the better.

Copies of the software shown on listing 1 are available from the author on diskettes in North Star format for $9.95 each (New York State residents add sales tax).
PROUDLY ANNOUNCES THE NEWEST PET MICROCOMPUTERS BY COMMODORE!

The PET™ is now a truly sophisticated Business System with the announcement of these Peripherals.

The PET™ is now a truly sophisticated Business System with the announcement of these Peripherals.

The PET™ is now a truly sophisticated Business System with the announcement of these Peripherals.

NEECO OFFERS COMPLETE SOFTWARE (COMMERCIAL & CONSUMER)

1. The 16K/32K (large keyboard) units do not include a cassette drive. Order C2N Cassette.
2. 2040 Floppy Drive requires a 16K or 32K unit 8K RAM Retrofit available July.
3. UNIT INTERFACES VIA THE USER PORT. FOR THE FIRST TIME A BRAND NEW IBM SELECTRIC IS AVAILABLE FOR YOUR PET! FULL CASSETTE OR DISK WORD PROCESSING PACKAGES. CALL FOR MORE INFO. PET—IBM ......... $1995
4. BUSINESS SOFTWARE BUSINESS PACKAGES AVAILABLE ON THE 2040 DUAL FLOPPY.
5. BUSINESS PAYROLL—COMPLETE MAILING LIST—STATISTICAL PACKAGE—GENERAL LEDGER—(UP TO 1,024 A/R's, 512 A/P's, 512 GEN LED ACCTS, POSTING, DISBURSEMENT, AGEING, B/S, P/R, AND MANY OTHER FUNCTIONS) COMPLETE WORD PROCESSING PACKAGES.

NEW ENGLAND ELECTRONICS CO., INC.
679 HIGHLAND AVE., NEEDHAM, MASS. 02194
MON. - FRI. 9:30 - 5:30, EST.

(617) 449-1760
MASTERCHARGE OR VISA ACCEPTED
TELEX NUMBER 951021, NEECO

Circle 282 on inquiry card.
Bubble Memories

A Short Tutorial

In the first quarter of 1977 Texas Instruments announced the availability of a 92,000 bit magnetic bubble memory, making bubble memories a commercial reality ten years after the effect was discovered at Bell Laboratories. The bubble memory provides nonvolatile, medium speed data storage at a price close to that of the floppy disk, but without either moving parts or the problems of reliability that moving parts entail. Future memories will provide storage densities of up to one million bits per chip and faster data rates, as the technology matures.

Bubble memories are shift registers that move magnetic domains representing binary data using rotating magnetic fields. The bubble memory integrated circuit is made of a magnetically reactive material such as garnet and has implanted in it a bubble generator for writing data, bubble detectors for reading data, bubble annihilators for erasing data and replicators to provide nondestructive readout. Bubbles move in loops made of small bars of permalloy. As the magnetic field driving circuit rotates, the permalloy bars change their magnetic bias, attracting or repelling the bubbles, as shown in figure 1. This creates a shift register. The Texas Instruments TBM 0101 memory contains 157 minor loops of 641 bubble positions for data storage, and a major loop of 640 bubble positions for reading and writing data. This configuration is shown in figure 2.

In operation, data is written into the major loop at the bubble generator. The bits so written are shifted along the major loop until they are adjacent to the minor loops where they are to be stored. The bubble transfer line is then activated and the bubbles are shunted onto the minor loops. Of the 157 minor loops on the device, 144 are guaranteed to be good, so the user must avoid writing into any of the 13 minor loops declared bad at the factory. Each memory device will be shipped with a map of the bad loops written into the device at the factory. This map should be written into programmable read only memory to control access of the minor loops. The controller integrated circuit offered by Texas Instruments will have an input to cause it to ignore bubbles and may be driven by the read only memory. To read data, the minor loops are rotated until the desired 144 bubbles are adjacent to the major loop. The transfer line is activated and the bubbles are shunted out of the minor loops and onto the major loop. The bubbles are then shifted along the major loop until they reach the combination replicator and annihilator.

If a replicate pulse is applied to the circuit, the bubble is duplicated. While one copy goes on to the detectors and eventual

---

**Figure 1:** Movement of a magnetic bubble through a permalloy pattern in response to a rotating magnetic field.
destruction, the other bubble continues around the major loop until it is shunted back onto its minor loop, thus providing nondestructive readout. The bubble that is passed on to the detectors activates dual Hall effect devices that vary their electrical resistance with varying magnetic fields. Two of these detectors are supplied in order to cancel noise through the use of a detector bridge connected to a differential amplifier. The detectors have a nominal resistance of 1100 ohms and are matched to within ±10 ohms. A single bubble passing under the two detectors produces a 7 mV signal with two positive and two negative peaks. Care must be taken when laying out circuit boards to avoid long detector signal lines and cross-coupling of control signal noise.

The rotating magnetic field for shifting the bubbles is produced by driving the coils built into the circuit with signals that are 90° out of phase at a maximum frequency of 100 kHz. This technique is shown in figure 3. For standby low power operation, the coil drive may be turned off with no loss of data.

Data in the memory is organized in the form of 18 byte pages and 641 pages per integrated circuit for a total of 11,538 bytes. Using the TMS 9916 controller, any byte within a page may be randomly accessed, although the pages are serially accessed. Each minor loop contributes a bit to the formation of a page, so that the 144 bits of a page are distributed over 144 minor loops.

Prior to removing power from the memory system, the user must be sure that page zero is rotated back into the page zero position. If this is not done, the next time power is applied it may not be possible to locate page zero for proper addressing. This is because there are no physical indices to mark the beginning of the medium. If the TMS 9916 controller is used, power failure detection circuitry will initiate data positioning automatically. This process requires 12.8 ms, so the system's power supplies should remain in regulation for at least this long.

Considering the high price of the magnetic bubble medium, it is unlikely that it will be used in a removable form as is the case with the floppy disk. Instead, they will probably be built into a cabinet (or even a mainframe) and used as a drum would be. An 11 K byte drum may seem small, but remember that single circuits with 3 to 10 times the capacity of the TBM 0101 are on their way.

Figure 2: Logical layout of the Texas Instruments TBM 0101 bubble memory. The 157 minor loops are used for data storage. Each loop contains 641 bit positions.

Figure 3: This simple circuit is an example of how the bubble memory field may be driven.
Stacks in Microprocessors

T Radhakrishnan
Dept of Computer Science
Concordia University
Montreal CANADA

M V Bhat
Pratt & Whitney Aircraft, Canada
Engineering Computing
Longuenil Quebec CANADA

Introduction

The stack or the “last in first out” (LIFO) data structure has become an essential tool in computer systems. There are two major operations associated with this data structure:

PUSH: places a new data item on top of the existing ones in the stack.

POP: removes the topmost element of the stack for succeeding operations.

A spring loaded plate holder in a cafeteria is a good example of a “stack,” since addition and removal of items occur at the same end in a last in first out sequence (see figure 1).

When the capacity of a stack is “n” items, then n+1 consecutive PUSH operations will cause the stack to overflow. Similarly, popping an empty stack creates an underflow. Even though stack underflow may not occur intentionally, programmers should account for this condition. Stack overflow is more probable when the stack capacity is not large enough to accommodate all the occurring conditions simultaneously.

Stack size is one of the major design parameters in processor architecture. For instance, the earlier Intel 8008 processor had a built-in 7 level subroutine control stack which was later increased to a more general stack pointer which could range throughout memory in the 8080.

In the software realization of stacks, a programmable memory location is used along with an address pointer, called the “stack pointer” or SP. The stack pointer points to the memory location that holds the top element of the stack; the pointer is updated (incremented or decremented) after every push or pop operation (see figure 2). In this case the programmer must set aside a portion of the main memory to accommodate the stack. Consequently, the stack capacity is determined by the free space in the main memory and is more flexible. In figure 2 the occupied portion of the stack grows from low to high memory addresses. Hence, the PUSH operation increments the stack pointer and the POP operation decrements it. It is not difficult to introduce the stack overflow and underflow conditions in the above simulation.

In another realization of stacks, a set of n registers constitutes a stack. Every POP operation takes the data item from the topmost register; the data in each stack location is then shifted upward. The PUSH operation shifts the stack contents down one place.
ONE PACKAGE DOES IT ALL
Includes these Application Programs...
Sales Activity, Inventory, Payables, Receivables, Check/Expense Register,
Library Functions, Mailing Labels, Appointments, Client/Patient Records

RANDOM, MULTI-KEY RECORD RETRIEVAL under CP/M, CDOS, IMDOS, ADOS...

SELECTOR III ALLOWS INSTANT RECALL OF ANY RECORD USING ANY INFORMATION ITEM IN THE RECORD. That statement deserves re-reading, because that ability makes SELECTOR III the most powerful Date Base Management System in microcomputers today!

With SELECTOR III you can...
• define a record format, assign retrieval keys, and begin entering data in minutes.
• create sorted pointers to records matching your specific or range of requirements.
• automatically generate reports with control-break summaries and unlimited variety.
• bring an application online in hours instead of months.

SELECTOR III comes complete with eight application programs that perform the tasks listed at top of page. And, since it's distributed in source code form, you can easily add subroutines to do specific computations or file updates.

SELECTOR III runs under CBASIC Vers. 1 or 2, and is priced at $295. SELECTOR III-C2 is dedicated to Vers. 2 only, runs about twice as fast, and costs $345.

Both systems are available in a variety of CP/M, diskette size and density formats including IBM 8"; North Star; Micropolis; TRS-80; Processor Tech Helios II; Altair; iCOM; Dynabyte; Imsai; and others.

Available from computer stores nationwide:
LIFEBOAT Associates
2248 Broadway, Suite 34
New York, N.Y. 10024 • (212) 580-0082
Or order direct from
MICRO-AP
9807 Davona Drive, San Ramon, CA 94583
(415) 828-6697
The stack is a storage place in a computer designed to hold pieces of data in a serial order. "PUSHing" an element onto the stack causes the existing elements in the stack to be moved downward, in much the same manner as a spring loaded plate holder found in restaurants. "POPing" an element from the stack removes the most recent addition to the stack for use. Because of these two features, the stack operation is often referred to as "last in first out," or "LIFO."

![Figure 2: A software simulation of the pushdown stack. Operation of the stack is identical to the hardware stack (see figure 1), except that there is no dedicated hardware involved. Instead, a program creates a stack pointer in memory which points to the current location of the top of the stack.](image)

**Table 1: Stack features of some common microprocessors.** The stack is a storage place in a computer designed to hold pieces of data in serial order. “PUSHing” an element onto the stack causes the existing elements in the stack to be moved downward, in much the same manner as a spring loaded plate holder found in restaurants. “POPing” an element from the stack removes the most recent addition to the stack for use. Because of these two features, the stack operation is often referred to as “last in first out,” or “LIFO.”

<table>
<thead>
<tr>
<th>Processor</th>
<th>Hardware Stack or Stack Pointer</th>
<th>Stack Oriented Instructions</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 8080</td>
<td>16 bit stack pointer</td>
<td>a) Push register pair into stack</td>
<td>Any of the 16 registers can be used as a SP</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b) Pop register pair from stack</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>c) Push/Pop processor status word</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>d) Exchange stack top with register pair (H.L)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>e) Load SP from register pair (H.L)</td>
<td></td>
</tr>
<tr>
<td>2. Z-80</td>
<td>16 bit stack pointer</td>
<td>a) All the instructions of Intel 8080</td>
<td>Stack overflow Underflow Interrupts are provided</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b) Push/Pop the (A or B) accumulator</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>c) Load SP from memory</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>d) Store SP into memory</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>e) Transfer index register contents to SP</td>
<td></td>
</tr>
<tr>
<td>3. M6800</td>
<td>16 bit stack pointer</td>
<td>a) Push/Pop the (A or B) accumulator</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>b) Load SP from memory</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>c) Store SP into memory</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>d) Transfer index register contents to SP</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>e) Increment/Decrement SP</td>
<td>Any of the 16 registers can be used as a SP</td>
</tr>
<tr>
<td>4. RCA 1802</td>
<td>16 bit stack pointer</td>
<td>a) Increment/Decrement the selected register (SP)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>b) Push/Pop the working (D) register</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>c) Load the D register into left or right half of SP</td>
<td></td>
</tr>
<tr>
<td>5. PACE</td>
<td>Hardware stack 8 16 bit words</td>
<td>a) Push/Pop program counter</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>b) Push/Pop the specified register</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>c) Exchange the contents of the register with SP</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>d) Push/Pop the flag register</td>
<td></td>
</tr>
<tr>
<td>6. IMP-8C</td>
<td>Hardware stack 16 8 bit words</td>
<td>a) Push/Pop the selected accumulator into stack</td>
<td>No overflow Underflow Interrupts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b) Exchange the stack top with the selected accumulator</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>c) Push/Pop the status flags into the stack</td>
<td></td>
</tr>
</tbody>
</table>

Most modern processors provide one or more registers to hold stack pointers. For example, there is one stack pointer register in the Intel 8080 and there can be as many as 16 stack pointers in the RCA 1802 processor (see table 1). The pop and push instructions update the SP registers automatically. The architecture and the stack oriented instructions differ widely among the various processors, and table 1 gives details of some of the common ones.

**Typical Applications of Stacks**

Suppose a routine A calls another routine B at some point a in A. Similarly, let B call C at point b. The addresses a+1 and b+1 are the return addresses where execution control will return from the called routine. It is evident from figure 3 that the return addresses are used in the reverse order of their sequence of occurrence. The labels c1, c2, c3 in figure 3 stand for the first, second and third calling of routines, and r1, r2, r3 stand for the first, second and third returns from the called routines. This last in first out (LIFO) nature of the use of return addresses in multilevel calling is commonly implemented with stacks. Simple extensions have been devised to pass the parameters along with these return addresses using the stack structure (see reference 1).

The calls shown in figure 3 could also be considered as calls to service routines due to asynchronous interrupt signals. In the latter case, the return addresses are not predetermined address points, but are instead the contents of the program counter. However, the last in first out nature of the return addresses remains valid. The call due to an interrupt creates a new process, and hence the status of the current process (process status word, flags, etc) has to be additionally...
BATTERY SUPPORTED
CALENDAR CLOCKS

PDP-11*
TCU-100 • $495
- Provides month, day, hour, minute and second.
- Can interrupt on date/time, or periodic intervals.

TCU-150 • $430
- Provides year, month, day, hour, minute and second.
- Automatic leap year.
- Patches for RSX-11M, RT-11 FB/SJ VO2, VO3 and UNIX.

LSI-11/2*
TCU-50D • $295
- Provides month, day, hour, minute and second.
- Dual size board.
- Patches for RT-11 SJ/FB VO2, VO3B.

Lockheed SUE
TCU-200 • $550
- Provides year, month, day, hour, minute, second and milli-second.
- Interval interrupts between 1/1024 seconds and 64 seconds.

Computer Automation (Naked Mini)
TCU-310 • $385
- Provides year, month, day, hour, minute and second.

Multi-Bus**
TCU-410 • $325
- Provides year, month, day, hour, minute and second.
- SBC/BLC compatible.

HP 2100
TCU-2100 • $395
- Correct time restored after power failure.
- Compatible with the HP TBG card.

Serial Clock (RS 232 or 20 mA)
SLC-1 • $575
- Connects between any terminal and host computer.
- Provides date, time and more!

All Digital Pathways TCUs have on board NICAD batteries to maintain time and date during power down. Timing is provided by a crystal controlled oscillator. Prices are U.S. domestic single piece. Quantity discounts available.

For more information on these products, contact:
Digital Pathways Inc.
4151 Middlefield Road
Palo Alto, CA 94306
Phone: (415) 493-5544
saved. Some processors, like the IMP-8C, have instructions to push and pop status flags onto stacks. In other processors, this is done automatically when an interrupt occurs. Stacks in microprocessors, starting from the early Intel designs, have traditionally been used primarily for subroutine control and interrupt handling.

Another use of stacks, though one not much used in the hardware of processors, is in the compiling arithmetic expressions. Consider the following arithmetic expression:

\[ A+B \times C-D/E \]

In this form, the "operator" is between the two operands. This is known as infix notation. The form in which the operator follows the operands is called postfix or reverse Polish after the Polish logician J. Lukasiewicz, who investigated the properties of this notation. The postfix equivalent of the above expression, which does not require any parentheses, is as follows:

\[ AB+CXDE/- \]

Algorithms exist which use the stacks to convert arithmetic expressions from infix to postfix notation (see reference 2). Figure 4 shows a sample code for the above postfix expression; it is meant for a computer with stacks, and is used to evaluate arithmetic expressions. Operations such as ADD and SUB take the top two elements of the stack, perform the operation, and then push the result back onto the stack. Such a system is called a stack computer. Using this postfix notation, it is not hard to generate code for machines with single accumulators or for machines with multiple registers.

Stack Machines

Among the architectures with two stacks, two broad categories are evident. The first kind of machine provides stack features along with conventional architecture. This stack feature might be implemented through a hardware realized stack, a stack pointer register with a set of associated hardware instructions, or a complete software simulation using a memory location as the stack and its pointer. Some combinations of these three approaches are also present in some recent processor architectures. Most processors have some sort of stack facility and instructions to manipulate data with stacks or stack pointers.

The second kind of machine with stack facility can be called a stack machine. Its architecture is completely centered on stacks. The Burroughs B5500 and B6700, HP3000 and ICL.2900 are examples of this category. In these machines, the three basic functions of process management, memory management, and data management of jobs are all stack oriented. Most of these archi-

---

### Figure 3: Diagrammatic representation of multilevel, or "nested," subroutines. The return address of each subroutine call must be remembered so that the program can return to the right place after the subroutine is completed. The "last in first out" nature of nested subroutines is such that the stack is a logical way to keep track of the return addresses.

### Figure 4: Op code designed for use with Polish postfix notation on stack oriented computers. Polish notation is a method for rewriting expressions unambiguously by systematically segregating operators and operands. For instance, the expression used in this example appears as \((A+B)\times C-D/E\) in normal, or "infix" notation; the Polish postfix equivalent is \(AB+CXDE/-\). The latter can be directly used by a stack oriented computer, which automatically performs stack operations. (For example, a stack ADD instruction takes the top two elements of the stack, adds them together, and pushes them back onto the stack. The MULT, DIV and SUB operators work in the same manner.) The algorithm for evaluating the expression then reduces to examining each element in the Polish notation string from left to right, pushing it onto the stack if it is an operand and performing the operation if it is an operator.
Both our UNCommon Dynamic and our UNCommon Static RAMS have the following features and specifications:

- They are all GUARANTEED to be compatible with the following S-100 systems: CROMEMCO, IMSAI, ITHACA AUDIO, MITS, NORTH STAR, PROCESSOR TECHNOLOGY, TDL, TEL, VECTOR GRAPHICS, and other S-100 systems.

Both of Our UNCommon Dynamic RAM Series, the DMB-6400 and the DM-6400, feature:

- 64K bytes of dynamic RAM with on board transparent refresh.
- S-100 interface compatible, with crystal controlled timing INDEPENDENT of bus or processor timing.
- No wait states with 8080 or Z-80 to 4MHz, Up to 5MHz with 1 wait state.
- Memory selectable or deselectable in 4K byte increments.
- Low power, 8 watts maximum, in 64K byte configuration.

Our UNCommon Static RAM Series, the SMB-3200, features:

- Memory Bank select capabilities: Either two (2) 16K byte banks of memory, or one (1) 32K byte bank per board.
- 32K bytes of low power static RAM.
- No wait states with 8080, 8085, or Z-80 processors up to 5MHz.
- Addressable in 4K byte increments at 4K boundaries. Deselectable in 4K byte increments.

Announcing the Model DMB-6400 Series of UNCommon Dynamic RAMS. This Series incorporates the features which are standard in the DM-6400 Series and adds the following capabilities:

- MEMORY BANK SELECT which is compatible with CROMEMCO, NORTH STAR, and other systems using output port bank select.
- 250 ports selectable (including CROMEMCO 4OH and NORTH STAR COH).
- D25 ports of memory per output port.
- Each 16K bytes of addressable memory space may be individually set to start at 0000, 4000, 8000, or C000 and can be set for any of the 8 banks on one selected output port. The bank memory size can be incremented from 16K bytes to 64K bytes in 16K increments, allowing 512K byte bank sizes.
- Total memory addressing to over 100 Megabytes by using different I/O ports for memory control.

All of our UNCommon Dynamic and Static Series RAMS feature the following:

- Inputs are RC filtered and buffered with 1LS TTL load. Compatible with terminated or un terminated busses.
- Outputs are all tri-state.
- Disc compatible, DMA compatible.
- Phantom memory selectable on pin 67.
- DIP switch selectable addressing.
- Reliability -- all boards fully tested and burned-in.
- FULL DOCUMENTATION -- Schematics, layout, parts list, theory of operation, timing diagrams, and option selection.
- Industrial quality design, components and construction. Glass epoxy boards. Fused, double solder masks. Gold plated connector contacts. All IC’s socket mounted.
- Guaranteed performance on parts and labor for one year.

MEASUREMENT systems & controls incorporated
867 North Main Street
Orange, California 92668
Telephone: (714) 633-4460

For the above products see your local dealer or order directly.

ORDERS -- BA, VISA, MASTER CHARGE, money orders, or personal checks. Please allow 14 days for checks to clear bank. California residents please add 6% sales tax to your order. All orders shipped postpaid. All orders in U.S. funds. Please add 10% on all orders outside the U.S.A. and Canada.
Computer systems and architectures can be appraised from three points of view: the languages available to users (application and system programmers), the operating system, and the hardware. These three areas are highly interrelated, and it is difficult to separate their capabilities. A few stack machine architectures are commercially available with facilities for multiprocessing and timesharing. The architecture of the Burroughs systems is such that the system software can be effectively written in a high level language. Stack machines have good and bad points. Their advantages are noticeable in block structured programming, which is becoming popular. As Doran points out (see reference 1), stack machines have proven to be successful. The increasing cost of software and the flexibility available through microprogramming indicates a trend towards stack machines or, at least, toward a greater use of stack features in computer architectures.

Conclusions

Developments in software and programming techniques during the past decade have proven the advantages of stack data structures. Microprocessors of recent origin provide adequate facilities to support this data structure. The provision of stack pointers is a compromise between the expensive and inflexible hardware stacks at one end and the inexpensive and flexible software simulation at the other end. Most microprocessors have stack pointers and a set of associated machine instructions.

Stack machines have certain advantages in higher level block structured programming and the implementation of operating systems. At present, programming with microprocessors is done mostly in machine or assembly language level. Large in-house software systems for microprocessors are not yet a reality. As a result, stack machine architectures are still in the realm of large machines.

Acknowledgement

We gratefully acknowledge the help of K Venkatesh, research assistant, Computer Science Department of Concordia University, in the preparation of this manuscript.

REFERENCES

Basic Time introduces the $15,995* Complete System

*Quantity 1 Price

Complete System Includes:

★ 10 Million Character Hard Disk Storage
★ Disk Operating System & Extended Basic
★ Powerful 16-Bit Central Processing Unit
★ Video Display Terminal
★ 150 CPS Line Printer and Printer Stand
★ Desk Enclosure

Basic Time

1215 E. El Segundo Boulevard
El Segundo, California 90245
213/322-4435
Designing a Command Language

Nearly every system, whether it is composed of ten lines of code or ten thousand lines of code, will perform three distinct functions. It will receive input from the user, it will process this input and it will output the results. Of these three functions, the one which undoubtedly receives the least attention from the system designer is the communication from the user of the system to the system itself.

Hours and hours may be spent perfecting a processing algorithm and computing field lengths so that the resulting output can be instantly understood, yet due to the lack of consideration put into the input stage of the system, the user may be forced to plow through a series of questions and answers directed to him by the system. This is a situation which would try the patience of even the most tolerant person. Sometimes a situation even worse than this series of questions may be caused by the designer who is very familiar with the system. In an effort to save time and memory space, the designer may decide to reduce or even entirely omit any prompting by the program. This leaves the decision of what information must be entered to the intuition of the user, or to a system manual which will probably not be around when it is needed.

A good solution to the problem would be a well designed command language which allows for both the experienced user who knows exactly what data the program needs at every instant and for the first time user who requires some help from the system now and then, but who will soon become familiar with the system and probably prefer to avoid the repetitious prompting.

Consider the following example which, although hypothetical and not necessarily typical of chess playing programs in general, illustrates problems which do exist in many systems. A superb chess playing program has been designed after months of hard work. Along with this program, a graphics output system has been devised to display the present formation of the board after each move is made. When the user sits down to test his skill against that of the machine, he becomes a partner to the following dialogue:

(C: COMPUTER; P: PLAYER)
C: DO YOU WISH TO MOVE(1), CAPTURE(2), OR CASTLE(3)? ENTER 1, 2, OR 3.
P: 1
C: ENTER NUMBER (1-8) OF ROW THAT PIECE IS ON.
P: 2
C: ENTER LETTER (A-Z) OF COLUMN THAT PIECE IS ON.
P: D
C: ENTER NUMBER (1-8) OF ROW TO WHICH YOU ARE MOVING.
P: ...

No matter how well the machine plays chess, it is doubtful whether it will be used by any particular person for more than a few games. Despite the thought that went into the rest of the program, no creative thought was put into the command language for the system.
Now, consider the following conversation between the computer and the player.

C: ENTER YOUR FIRST MOVE.
P: MOVE FROM D2 TO D4
C: I MOVE FROM H5 TO E2. CHECK.
P: CAPTURE E2
C: FROM WHERE?
P: H2
C: ...

This method not only cuts down on the unnecessary chatter which was encountered in the first case, but gives the player credit for possessing some knowledge of what is happening in the game. By taking time to design an easy to use command language, the designer can produce a game which will not only play well but which will also be enjoyable to use.

The problem encountered when designing a program which handles a set of commands such as these is that often no organized approach is taken to assure that the allowable commands are processed correctly. Each input string may be scanned and re-scanned for the information which is needed by the program. This type of haphazard approach will very likely produce unreadable code which is hard to debug and which may contain hidden errors and ambiguities. To avoid these problems, the theory of finite state machines (FSMs) may be used to produce a recognizer program which can parse the input commands and produce a structured command which can be interpreted by the system.

Finite State Machines

Since the aim of this article is to show how to use finite state machines to aid in programming a command language, not to thoroughly cover finite state machine theory, I will give a rather informal description of the machines. The representation used here has appeared in various places, and was chosen mainly because of its simplicity for this application.

Consider the finite state machine shown in figure 1. Each circle represents a state of the finite state machine. In this example there are seven states: S, 1, 2, 3, F1, F2 and F3. The names chosen for the states are arbitrary. The directed lines between the states are called state transition paths. The state transition path, labeled with an H, located between state S and state 1, is named S-1(H). The parenthetical symbol will be omitted when there is no ambiguity, such as the path 1-3. The states which are circled twice are final states. The final states in figure 1 are F1, F2 and F3. The states which are pointed to by arrows which lead from no other state are called initial states. The only initial state in figure 1 is S.

This finite state machine can be used to recognize several different strings, a string in this case being merely a sequence of letters. For a particular string to be recognized, an ordered path must exist between an initial state and a final state such that every symbol in the string being recognized exists (in its original order) along the path starting at the initial state. Using this finite state machine the string HOG is recognized in the following manner. Starting at initial state S, the first symbol in the string, H, leads to state 1 along path S-1(H). The second symbol, the letter O, selects path 1-3 leading to state 3. Finally, the symbol G leads to the final state F2 via the path 3-F2. Since this path exists from the initial state S to the final state F2, the string has
Figure 3: A lexical finite state machine for recognizing the entities that will be accepted by the game: <TO>, <TAKE>, <MOVE>, <CAP>, <FROM>, <END>, <POS>.

Figure 2 is an example of a finite state machine which will recognize any string which begins and ends with an A and which has zero or more Bs between the two As, such as the strings: AA, ABA, ABBA, etc.

Sample Problem

Now that the basics of finite state machines have been explained, a simple command language will be defined and implemented using them as a design tool. Using this example, a similar procedure can be followed to produce a recognizing program for nearly any command language which might be chosen.

Assume that there is a game which is played on a chess board. The columns of the board are labeled with the letters A thru H and the rows of the board are labeled with the numbers 1 thru 8. The three possible moves which may be made by any player consist of moving a piece from one square to another, MOVE, moving a piece to another square and capturing the piece on that square, CAP, or removing one of his own pieces from the board, TAKE. Some examples of commands which are to be accepted by the program are:

```
MOVE FROM A1 TO C3
CAP FROM 4H TO H1
TAKE FROM E5
```

It can be seen that the commands are made up of six basic entities which must be recognizable. Three of these entities are the commands MOVE, CAP and TAKE. TO and FROM are keywords which must be identified in order to interpret a command. The final type is a position which may consist of a letter followed by a number or a number followed by a letter and which will exist one or more times in each command.
Command Recognizers

When a command is entered to be interpreted by the computer, it consists merely of a sequence of symbols (letters, numbers and spaces) which have no syntactic meaning of their own. The meaning only starts to become clear when the symbols are grouped together to form tokens. The tokens which exist in this game are the six entities described above. These tokens will be referred to as <MOVE>, <CAP>, <TAKE>, <TO>, <FROM>, <POS>. A finite state machine which will recognize each of these tokens is shown in figure 3. Blanks are shown on this diagram and in the following diagrams as small squares. Note that one new token has been added to the six types listed above. This new token is <END> which is recog-

Figure 4: A syntactic finite state machine for accepting valid commands.

keeping you in touch with technology...

The Understanding Series™ from Texas Instruments.

Five self-paced, easy-to-understand books for the reader who wants to learn about electronics technology, but can't devote years to the study.

Understanding Microprocessors. 250 pages. Available June 1979. For the newcomer to microprocessors. What they are, what they do, how they work.


Understanding Digital Electronics. 265 pages. The world of today's digital devices made easy.

Basic Electricity and DC Circuits. 1026 pages. Learn all about DC Circuits—simply, easily.

Mail check or money order to Texas Instruments, P.O. Box 3640, M/SB4, Dallas, Texas 75285. Orders in Continental U.S. shipped prepaid. Foreign orders: Prepaid funds in U.S. dollars only. Include shipping costs.

Name ____________________________
Address ____________________________
City State ZIP _______________________

Add applicable sales tax (except AK, DE, HI, MT, NH, OR)

SPECIAL OFFER: Purchase any two books and save $ .50 Purchase all five and save $2.00

Limited time offer Prices effective January, 1979 Subject to change without notice.

© 1979 Texas Instruments Incorporated

Circle 366 on inquiry card.
Figure 5: Two example COMMAND arrays. COMMAND array A results after processing the command MOVE TO C1 FROM H6. COMMAND array B is the result of processing TAKE FROM A7.

after processing the command MOVE TO C1 FROM H6. COMMAND array B is the result of processing TAKE FROM A7.

nized when an end of line (col) delimiter is found.

Most of this finite state machine is self-explanatory. Note, however, the two states L15 and L23 which are entered after matching an initial C or F, respectively. These states represent a point in the matching process where the token being recognized may be either a command (<CAP> or <FROM>) or a position (<POS>). When the next symbol in the input stream is examined, the recognition of the token as a position (paths L15-L20 and L23-L20) or as a command (paths L15-L16 and L23-L24) can be made.

The finite state machine which has just been described performs the process known as lexical analysis, the process of grouping together input symbols to determine the tokens which have been input. The next process which must be performed is the process of syntactic analysis, checking the order of the tokens which have been formed to see whether they form a valid command. For example, the two "commands":

\[\text{MOVE FROM A1 TO C3} \]
\[\text{A1 C3 FROM TO MOVE} \]

are both composed of valid tokens for the example language but only the first command is syntactically correct. To determine the syntactic correctness of a command another finite state machine must be designed. This machine, rather than having paths labeled with symbols from a character set, will have labels which are valid tokens of the language being processed. Figure 4 shows a finite state machine which will accept the valid commands of the language.

Semantic Routines

At this point two finite state machines have been produced which can be used to recognize valid commands for the game. Before these machines are used to help produce code to process actual commands, the results of processing each command must be defined. After a decision has been made regarding these results, semantic routines, routines to carry out the processing of the various commands, should be associated with each state transition path of the finite state machines. In our system, each command will be converted to a set of codes and placed in an array called COMMAND which will have five elements. COMMAND(1) will be set to a code describing the command operation (1=MOVE, 2=CAP, 3=TAKE), COMMAND(2) and COMMAND(3) will hold, respectively, the column and the row position associated with the FROM keyword. COMMAND(4) and COMMAND(5) will hold the column and row position associated with the TO keyword. Figure 5 shows the expected results of processing following two commands:

\[\text{MOVE TO C1 FROM H6} \]
\[\text{TAKK FROM A7} \]

For the finite state machine that is shown in figure 4, table 1 shows the semantics which will produce the desired results. Routines for paths such as S1-S2(<MOVE>) set the first element of the COMMAND array to indicate which command was recognized. Path S2-S3 is an implicit recognition of the word FROM and has no semantics associated with it since nothing must be done until the path S3-S4 is traversed. When this action occurs, the row and
ADAPTIVE INFORMATION PROCESSING, AN INTRODUCTORY SURVEY by Jeffrey R Sampson.
- Even the most complex of today's computers is dwarfed by the capabilities of its designer's brain. Imitation of the capabilities and adaptive nature of biological information processing systems has long been a goal of computer designers. Jeffrey R Sampson presents an introductory survey of this field. From the fundamentals of information and information processing entities, he examines the richness of biological information processing and goes on to cover the application of computers to artificial intelligence. His is a view which unifies the diverse aspects of the subject of artificial intelligence, emphasizing adaptive behavior. 214 pp. $14.80 hardcover.

COMPUTER MODELS OF THOUGHT AND LANGUAGE edited by Roger C Schank & Kenneth Mark Colby.
- Part of the current work in AI involves the modeling of human mental processes in computer programs. Here is a collection of articles, which deal with natural language models, models of belief systems, and models of memory and cognition. Required reading for AI enthusiasts. 450 pp. $24.95 hardcover.

HOW TO BUILD A COMPUTER-CONTROLLED ROBOT by Tod Loofbourrow.
- This book combines the dream of robotics—to create an intelligence other than human—with the reality, by providing both hands-on experience with robotics and an application of a microprocessor. It details the step-by-step directions for building a robot, named "Mike," controlled by a KIM-1 microprocessor, with the complete control programs clearly written out. 132 pp. $7.95.

ROBOTS ON YOUR DOORSTEP by Nels Winkless and Iban Browning.
- "This book will amaze you, frighten you, nauseate you, excite you...it will probably make you think about things you have never contemplated before," states the introduction to this clever and well-written account of robots: past, present, and future. Intelligence, artificial intelligence, brain structure and simulation, and characteristics of robots are only a few of the areas explored. 179 pp. $6.95.

THE THINKING COMPUTER: MIND INSIDE MATTER by Bertram Raphael.
- With a minimum of technical jargon, this book discusses the capabilities of modern digital computers and how they are being used in contemporary AI research. It discusses the progress of AI, the goals, and the variety of current approaches to making the computer more intelligent. $9.50.

COMPUTER POWER AND HUMAN REASON by Joseph Weizenbaum.
- If you're presently a programmer by trade or skill, you'll see a philosophy of computer use and abuse propounded. If you're a novice, the tutorial and explanatory chapters of this book serve as an excellent and eminently readable background source. This includes an outstanding, low level explanation of what an algorithm is, and how computers execute effective algorithms. $8.50.

For your convenience in ordering, please use this page plus the order form on page 200. You may photocopy this page.

DIAL YOUR CHARGE CARD ORDERS TOLL FREE
(800) 258-5477. Mon - Fri 9 - 5 PM

*Artificial Intelligence Quotient
column are stored in the COMMAND array to indicate the FROM position. When a final state is reached, an entire command has been parsed and the COMMAND array contains all of the necessary information to fully describe the command.

The lexical finite state machine shown in figure 3 will be used by the syntactic finite state machine just described to obtain tokens from the input stream when they are needed. The output from the lexical finite state machine will be a 2 element array named TOKEN which will contain the following codes. If the token is <POS>, then the first element of TOKEN will be the row number and the second element

Listing 1: Routine constructed for the lexical finite state machine.

LEX IS A SUBROUTINE WHICH EXAMINES INPUT CHARACTERS UNTIL IT FINDS A VALID TOKEN OR AN INPUT ERROR. SUBROUTINE RCHAR READS THE NEXT CHARACTER FROM THE INPUT BUFFER INTO CHAR. '#' IS THE END-OF-BUFFER CHARACTER.

LEX SETS TOKEN (THE TWO ELEMENT ARRAY) TO THE FOLLOWING CODES:

<table>
<thead>
<tr>
<th>TOKEN(1)</th>
<th>TOKEN(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>'MOVE'</td>
<td>0</td>
</tr>
<tr>
<td>'CAP'</td>
<td>0</td>
</tr>
<tr>
<td>'TAKE'</td>
<td>0</td>
</tr>
<tr>
<td>'TO'</td>
<td>0</td>
</tr>
<tr>
<td>'FROM'</td>
<td>0</td>
</tr>
<tr>
<td>'ERROR'</td>
<td>0</td>
</tr>
<tr>
<td>'&lt;POS&gt;'</td>
<td>ROW: 1-8</td>
</tr>
<tr>
<td></td>
<td>COL: A-Z</td>
</tr>
</tbody>
</table>

LEX: SUBROUTINE;

LEX: SUBROUTINE;

TOKEN(1) = 0

STATE 1 - BEGINNING STATE

CALL RCHAR();

IF CHAR = ' ' THEN GO TO L1;
IF CHAR = 'T' THEN GO TO L3;
IF CHAR = 'M' THEN GO TO L10;
IF CHAR = 'C' THEN GO TO L15;
IF CHAR = '#' THEN DO;
TOK = 'T' THEN DO;
TOK = 'C' THEN DO;
TOK = ' ' THEN DO;
RETURN;

IF CHAR = 'A' | 'B' | 'D' | 'E' | 'G' | 'H' THEN DO;
TOK = CHAR;
GO TO L19;

IF CHAR = '1' | '2' | '3' | '4' | '5' | '6' | '7' | '8' THEN DO;
TOK = CHAR;
GO TO L22;

GO TO LEXERR;

STATE 3 - HAVE FOUND 'T'

CALL RCHAR();

IF CHAR = 'O' THEN GO TO L4;
IF CHAR = 'A' THEN GO TO L6;
GO TO LEXERR;

STATE 4 - HAVE FOUND '<TO'>

CALL RCHAR();

IF CHAR = '#' THEN DO;
TOK = 4;
RETURN;

GO TO LEXERR;

STATE 6 - HAVE FOUND 'TA'

CALL RCHAR();

IF CHAR = 'K' THEN GO TO L7;
GO TO LEXERR;

STATE 7 - HAVE FOUND 'TAK'

CALL RCHAR();

IF CHAR = 'E' THEN GO TO L8;
GO TO LEXERR;

STATE 8 - HAVE FOUND '<TAK>'

CALL RCHAR();

IF CHAR = 'T' THEN DO;
TOK(2) = 3;
RETURN;

GO TO LEXERR;

STATE 9 - HAVE FOUND 'TAK'

CALL RCHAR();

IF CHAR = 'A' THEN GO TO L16;
GO TO LEXERR;

STATE 15 - HAVE FOUND '<C>'

CALL RCHAR();

IF CHAR = '1' | '2' | '3' | '4' | '5' | '6' | '7' | '8' THEN DO;
TOK = 'C';
GO TO L20;

IF CHAR = 'A' THEN GO TO L16;
GO TO LEXERR;

STATE 19 - HAVE FOUND COLUMN LETTER (A-Z)

CALL RCHAR();

IF CHAR = '1' | '2' | '3' | '4' | '5' | '6' | '7' | '8' THEN DO;
TOK = CHAR;
GO TO L20;

GO TO LEXERR;

STATE 20 - HAVE FOUND '<POS>'

IF CHAR = ' ' THEN RETURN;

STATE 22 - HAVE FOUND ROW NUMBER (1-8)

IF CHAR = 'A' | 'B' | 'C' | 'D' | 'E' | 'F' | 'G' | 'H' THEN DO;
TOK = CHAR;
GO TO L20;

GO TO LEXERR;

STATE 23 - HAVE FOUND '<F>'

IF CHAR = '1' | '2' | '3' | '4' | '5' | '6' | '7' | '8' THEN DO;
TOK = 'F';
GO TO L20;

IF CHAR = 'R' THEN GO TO L24;
GO TO LEXERR;

STATE 24 THRU 26 ARE SIMILAR TO OTHER STATES WHICH RECOGNIZE KEYWORDS AND ARE NOT SHOWN.

LEXERR - AN ERROR HAS BEEN ENCOUNTERED IN THE INPUT STRING.

LEXERR: TOKEN(1) = 0;
TOK(2) = 7;
RETURN;
END LEX;
Microcomputer UPDATES

Keeping up with the blizzard of new microelectronic components is a formidable task facing any engineer. First there are innumerable part announcements; next comes unreadable literature, hastily compiled by the vendor who places more emphasis on selling you than telling you. And what about availability? Will a part be available within three months of its announcement, or three years?

Osborne & Associates' publications offer a solution to these problems. You can bypass the vendor announcements, ambitious claims and incomprehensible literature.

An Introduction to Microcomputers:
Volume 2 — Some Real Products
Volume 3 — Some Real Support Devices
contain complete, objective part descriptions of virtually every microprocessor and support device on the market today.

Volume 2 and Volume 3 of contain descriptions of products through June 1978. To remain current, each book has a yearly update series to which you can subscribe. The first is the 1978-1979 Update Series.

The updates provide descriptions of the newest products throughout the year. Each update series is bi-monthly; you receive six updates per year per book, or 12 updates if you subscribe to both series. Volume 2 and Volume 3 sold loose-leaf to allow easy insertion of update material.

Among the newest part descriptions appearing in the first year's update series:

- Z8, Z8000
- A/D and D/A converters
- Floppy Disk Controllers
- Am9511
- Sy6551, R6531
- 6801, 6809
- COPs, PPS4
- TM990 Bus
- Heath H18 Bus
- RS449-422-423
- S2651, S2652
- MC6854

An Introduction to Microcomputers:
Volume 2 — Some Real Microprocessors
Volume 2 — Some Real Memory Chipsets
Volume 2 — Handbooks of 1977 updates
Volume 3 — More Handbooks of 1977 updates

SPECIAL DISCOUNT: Combined purchase price of both Volume 2 and Volume 3 update subscriptions: $49.00. Specific, Volume 2 and 3 updates: $40.00

An Introduction to Microcomputers:
Volume 1 — Some Real Support Devices
Volume 1 — More Support Devices
Volume 1 — More Support Devices
Volume 1 — Handbooks of 1977 updates
Volume 1 — More Handbooks of 1977 updates

BASIC Software

- Complete source listings with remarks
- 76 tested, working programs
- Standard BASIC
- Math, statistics personal finance and general interest programs

Some Common BASIC Programs, by Lon Poole and Mary Borchers. Designed for people who can use a variety of practical BASIC programs. 76 programs are published in the book, which includes program descriptions, sample runs, and source listings with remarks. The documentation is complete so that a minimum of programming knowledge is required in order to use the programs. 200 pp., softbound. (#06-3, $8.50.)

For PET Users

the PET® Cassette

If you use a Commodore PET, you have probably realized that many BASIC programs require modification in order to run optimally on the PET. We have done the reprogramming necessary for Some Common BASIC Programs® programs to conform to the PET's BASIC syntax, calculation accuracy and video display, and now offer these listings for purchase on our PET Cassette.

If you don't already own a Some Common BASIC Programs book, we urge you to purchase one for program documentation and user instructions. (#25-X, PET Cassette, $10.00.)

GUARANTEE

We warrant each PET Cassette to be free from defects in material and manufacture.

CirCUIT 292 on inquiry card.

osborne & associates, inc.
630 bancroft way, dept. 121
berkeley, ca 94710
(415) 548-2805
twx 910-366-7277

NAME

ADDRESS

CITY STATE ZIP

PHONE

SHIPPING (shipping for large orders to be arranged)
Vol. 2 and Vol. 3 update subscriptions:
- $4.00 foreign air mail shipping per update subscription
- No charge in U.S. - 4th class mail ONLY

Books & Binders:
- All foreign orders $4.00 per book for air mail
- $0.45 per item 4th class in the U.S. (allow 3 weeks)
- $0.75 per item UPS in the U.S. (allow 10 days)
- $1.50 per item special rush shipment by air in the U.S

Cassettes:
- $1.50 each foreign air mail
- No additional charge in the U.S

UPDATES:

No tax on update subscriptions
California residents tax
S.F. BART residents add 6-1/2% sales tax

Payment in advance must be enclosed for purchases of up to $70.00. Invoicing U.S.

<table>
<thead>
<tr>
<th>Book/Cassette</th>
<th>Price</th>
<th>Quantity</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Subtotal

Shipping

TOTAL AMOUNT ENCLOSED

Please send the following information

1. Becoming an O&A dealer
2. List of foreign distributors
3. School discounts
4. Current catalog

S1032
Listing 2: Routine constructed for the syntactical finite state machine.

```
* SYN IS A SUBROUTINE WHICH EXAMINES INPUT
* TOKENS TO DETERMINE IF A COMMAND IS OR IS
* NOT VALID. SYN USES SUBROUTINE LEX TO
* OBTAIN THE TOKENS FROM THE INPUT STREAM.
* A FIVE ELEMENT ARRAY NAMED COMMAND IS
* SET USING THE FOLLOWING CODES:
* COMMAND(1) : 0=ERROR, 1=MOVE, 2=CAP, 3=TAKE.
* COMMAND(2) : COLUMN (A-H) OF "FROM".
* COMMAND(3) : ROW (1-8) OF "FROM".
* COMMAND(4) : COLUMN (A-H) OF "TO".
* COMMAND(5) : ROW (1-8) OF "TO".
*
*
SYN: SUBROUTINE;
*
STATE 1 - BEGINNING STATE
S1: CALL LEX( ) ;
  IF TOKEN(1)=O & TOKEN(2)=1 THEN DO;
    COMMAND(1) = 1;
    GO TO S2 ;
  END;
  IF TOKEN(1)=0 & TOKEN(2)=2 THEN DO;
    COMMAND(1) = 2 ;
    GO TO S2 ;
  END;
  IF TOKEN(1)=0 & TOKEN(2)=3 THEN DO;
    COMMAND(1) = 3 ;
    GO TO S3 ;
  END;
  GO TO SYNERR ;
*
STATE 2 - <MOVE> OR <CAP> FOUND
S2: CALL LEX( ) ;
  IF TOKEN(1)=0 & TOKEN(2)=5 THEN GO TO S3 ;
  IF TOKEN(1)=0 & TOKEN(2)=4 THEN GO TO S4 ;
  GO TO SYNERR ;
*
STATE 3 - <MOVE><FROM> FOUND
S3: CALL LEX( ) ;
  IF TOKEN(1)>0 THEN DO;
    COMMAND(2) = TOKEN(2) ;
    COMMAND(3) = TOKEN(1) ;
    GO TO S4 ;
  END ;
  GO TO SYNERR ;
*
STATE 4 - <MOVE><FROM><POS> FOUND
S4: CALL LEX( ) ;
  IF TOKEN(1)=0 & TOKEN(2)=4 THEN GO TO S5 ;
  GO TO SYNERR ;
*
STATE 5 - <MOVE><FROM><POS><TO> FOUND
S5: CALL LEX( ) ;
  IF TOKEN(1)>0 THEN DO;
    COMMAND(4) = TOKEN(2) ;
    COMMAND(5) = TOKEN(1) ;
    GO TO S6 ;
  END ;
  GO TO SYNERR ;
*
STATE 6 - ENTIRE COMMAND FOUND
S6: CALL LEX( ) ;
  IF TOKEN(1)=0 & TOKEN(2)=6 THEN RETURN ;
  GO TO SYNERR ;
*
STATES 8 THRU 13 ARE VERY SIMILAR TO STATES
2 THRU 6 AND ARE NOT SHOWN.
*
SYNERR - INVALID COMMAND SYNTAX.
SYNERR: COMMAND(1) = 0;
RETURN;
END SYN;
```

Implementation

The first step in implementing the command language is the conversion of the lexical finite state machine into a subroutine which locates the next token in the input stream and places the necessary codes into TOKEN as described above. If at any time, an error is detected while attempting to recognize a new token from the input stream, then TOKEN(1) is set to zero, TOKEN(2) is set to 7 and this routine returns to its calling routine.

A program named LEX, written in a BASIC-like language, which accomplishes these results is shown in listing 1. Prior to the invocation of this routine, the input command must be obtained from the user and stored in a buffer followed by a blank and the end of line character. A routine RCHAR is assumed to exist, which reads the next character from the input buffer and places it into the variable CHAR. Because of the way that the program has been designed, the flow of the program is easy to understand and modifications are easy to make if necessary, especially if the corresponding finite state machine diagram is available. The program is divided into sections which correspond to the states in the finite state machine. Each section determines which state transition pointer should be followed from the character which is being scanned. It then performs the semantics associated with this state transition pointer and moves along the path by means of the appropriate GO-TO statement. If during the processing of any state, the input character being examined does not correspond with any valid state transition pointer, the routine sets TOKEN to the error code described above and returns to its caller.

Listing 2 shows the routine constructed from the syntactic finite state machine. The
5 reasons why you should not buy
the electric pencil II™

Check the appropriate box(es):

☐ You love typing the same copy 20 thousand times a day.
☐ Your secretary can type 250 words per minute.
☐ You’re dying to spend $15,000 on a word processing system, just for the tax investment credit.
☐ All your capital assets are tied up in a 10-year supply of correction fluid.
☐ You never commit a single thought to paper.

If you have checked one or more boxes, you do not need The Electric Pencil. On the other hand, you may want to join the thousands of people who haven’t checked a single box.

The Electric Pencil II is a Character Oriented Word Processing System. This means that text is entered as a string of continuous characters and is manipulated as such. This allows the user enormous freedom and ease in the movement and handling of text. Since line endings are never delineated, any number of characters, words, lines or paragraphs may be inserted or deleted anywhere in the text. The entirety of the text shifts and opens up or closes as needed in full view of the user.

Features

• CP/M, IMDOS and HELIOS compatible
• Supports four disk drives
• Dynamic print formatting
• DIABLO and NEC printer packages
• Multi-column formatting in one pass
• Print value chaining
• Page-at-a-time scrolling
• Bidirectional multispeed scrolling controls
• Subsystem with print value scoreboard
• Automatic word and record number tally
• Cassette backup for additional storage
• Full margin control
• End-of-page control
• Non-printing text commenting
• Line and paragraph indentation
• Centering
• Underlining
• Bold face

Upgrading policy

Any version of The Electric Pencil may be upgraded at any time by simply returning the original disk or cassette and the price difference between versions, plus $15 to Michael Shroyer Software. Only the originally purchased cassette or diskette will be accepted for upgrading under this policy.

Have we got a version for you?

The Electric Pencil II operates with any 8080/8085 based microcomputer that supports a CP/M disk system and uses an IMSAI VIO, Processor Tech. VDM-1, Polymorphic VTI, Solid State Music VS-1B or Vectors Graphic video interface. REX versions also available. Specify when using CP/M that has been modified for Micropolis or North Star disk systems as follows: for North Star add suffix A to version number; for Micropolis add suffix B, e.g., SS-IIA, DV-1IB.

Attention: TRS-80 Users!

The Electric Pencil II is designed to work with both Level I (16K system) and Level II models of the TRS-80, and with virtually any printer you choose. Two versions, one for use with cassette, and one for use with disk, are available on cassette. The TRS-80 disk version is easily transferred to disk and is fully interactive with the READ, WRITE, DIR, and KILL routines of TRS-DOS 2.1.

Wide screen video

Versions are available for Imma VIO video users with the huge 80x24 character screen. These versions put almost twice as many characters on the screen!!!

Demand a demo from your dealer!

MICHAEL SHROYER SOFTWARE, INC.
1253 Vista Superba Drive
Glendale, CA. 91205
(213) 956-1593

Have you got a version for you?

The Electric Pencil II operates with any 8080/8085 based microcomputer that supports a CP/M disk system and uses an IMSAI VIO, Processor Tech. VDM-1, Polymorphic VTI, Solid State Music VS-1B or Vector Graphic video interface. REX versions also available. Specify when using CP/M that has been modified for Micropolis or North Star disk systems as follows: for North Star add suffix A to version number; for Micropolis add suffix B, e.g., SS-IIA, DV-1IB.

Attention: TRS-80 Users!

The Electric Pencil II is designed to work with both Level I (16K system) and Level II models of the TRS-80, and with virtually any printer you choose. Two versions, one for use with cassette, and one for use with disk, are available on cassette. The TRS-80 disk version is easily transferred to disk and is fully interactive with the READ, WRITE, DIR, and KILL routines of TRS-DOS 2.1.

Wide screen video

Versions are available for Imma VIO video users with the huge 80x24 character screen. These versions put almost twice as many characters on the screen!!!

Demand a demo from your dealer!

MICHAEL SHROYER SOFTWARE, INC.
1253 Vista Superba Drive
Glendale, CA. 91205
(213) 956-1593

Have you got a version for you?

The Electric Pencil II operates with any 8080/8085 based microcomputer that supports a CP/M disk system and uses an IMSAI VIO, Processor Tech. VDM-1, Polymorphic VTI, Solid State Music VS-1B or Vector Graphic video interface. REX versions also available. Specify when using CP/M that has been modified for Micropolis or North Star disk systems as follows: for North Star add suffix A to version number; for Micropolis add suffix B, e.g., SS-IIA, DV-1IB.

Attention: TRS-80 Users!

The Electric Pencil II is designed to work with both Level I (16K system) and Level II models of the TRS-80, and with virtually any printer you choose. Two versions, one for use with cassette, and one for use with disk, are available on cassette. The TRS-80 disk version is easily transferred to disk and is fully interactive with the READ, WRITE, DIR, and KILL routines of TRS-DOS 2.1.

Wide screen video

Versions are available for Imma VIO video users with the huge 80x24 character screen. These versions put almost twice as many characters on the screen!!!

Demand a demo from your dealer!

MICHAEL SHROYER SOFTWARE, INC.
1253 Vista Superba Drive
Glendale, CA. 91205
(213) 956-1593

Have you got a version for you?

The Electric Pencil II operates with any 8080/8085 based microcomputer that supports a CP/M disk system and uses an IMSAI VIO, Processor Tech. VDM-1, Polymorphic VTI, Solid State Music VS-1B or Vector Graphic video interface. REX versions also available. Specify when using CP/M that has been modified for Micropolis or North Star disk systems as follows: for North Star add suffix A to version number; for Micropolis add suffix B, e.g., SS-IIA, DV-1IB.

Attention: TRS-80 Users!

The Electric Pencil II is designed to work with both Level I (16K system) and Level II models of the TRS-80, and with virtually any printer you choose. Two versions, one for use with cassette, and one for use with disk, are available on cassette. The TRS-80 disk version is easily transferred to disk and is fully interactive with the READ, WRITE, DIR, and KILL routines of TRS-DOS 2.1.

Wide screen video

Versions are available for Imma VIO video users with the huge 80x24 character screen. These versions put almost twice as many characters on the screen!!!

Demand a demo from your dealer!

MICHAEL SHROYER SOFTWARE, INC.
1253 Vista Superba Drive
Glendale, CA. 91205
(213) 956-1593

Have you got a version for you?

The Electric Pencil II operates with any 8080/8085 based microcomputer that supports a CP/M disk system and uses an IMSAI VIO, Processor Tech. VDM-1, Polymorphic VTI, Solid State Music VS-1B or Vector Graphic video interface. REX versions also available. Specify when using CP/M that has been modified for Micropolis or North Star disk systems as follows: for North Star add suffix A to version number; for Micropolis add suffix B, e.g., SS-IIA, DV-1IB.

Attention: TRS-80 Users!

The Electric Pencil II is designed to work with both Level I (16K system) and Level II models of the TRS-80, and with virtually any printer you choose. Two versions, one for use with cassette, and one for use with disk, are available on cassette. The TRS-80 disk version is easily transferred to disk and is fully interactive with the READ, WRITE, DIR, and KILL routines of TRS-DOS 2.1.

Wide screen video

Versions are available for Imma VIO video users with the huge 80x24 character screen. These versions put almost twice as many characters on the screen!!!

Demand a demo from your dealer!

MICHAEL SHROYER SOFTWARE, INC.
1253 Vista Superba Drive
Glendale, CA. 91205
(213) 956-1593

Have you got a version for you?

The Electric Pencil II operates with any 8080/8085 based microcomputer that supports a CP/M disk system and uses an IMSAI VIO, Processor Tech. VDM-1, Polymorphic VTI, Solid State Music VS-1B or Vector Graphic video interface. REX versions also available. Specify when using CP/M that has been modified for Micropolis or North Star disk systems as follows: for North Star add suffix A to version number; for Micropolis add suffix B, e.g., SS-IIA, DV-1IB.

Attention: TRS-80 Users!

The Electric Pencil II is designed to work with both Level I (16K system) and Level II models of the TRS-80, and with virtually any printer you choose. Two versions, one for use with cassette, and one for use with disk, are available on cassette. The TRS-80 disk version is easily transferred to disk and is fully interactive with the READ, WRITE, DIR, and KILL routines of TRS-DOS 2.1.

Wide screen video

Versions are available for Imma VIO video users with the huge 80x24 character screen. These versions put almost twice as many characters on the screen!!!

Demand a demo from your dealer!

MICHAEL SHROYER SOFTWARE, INC.
1253 Vista Superba Drive
Glendale, CA. 91205
(213) 956-1593

Have you got a version for you?

The Electric Pencil II operates with any 8080/8085 based microcomputer that supports a CP/M disk system and uses an IMSAI VIO, Processor Tech. VDM-1, Polymorphic VTI, Solid State Music VS-1B or Vector Graphic video interface. REX versions also available. Specify when using CP/M that has been modified for Micropolis or North Star disk systems as follows: for North Star add suffix A to version number; for Micropolis add suffix B, e.g., SS-IIA, DV-1IB.

Attention: TRS-80 Users!

The Electric Pencil II is designed to work with both Level I (16K system) and Level II models of the TRS-80, and with virtually any printer you choose. Two versions, one for use with cassette, and one for use with disk, are available on cassette. The TRS-80 disk version is easily transferred to disk and is fully interactive with the READ, WRITE, DIR, and KILL routines of TRS-DOS 2.1.

Wide screen video

Versions are available for Imma VIO video users with the huge 80x24 character screen. These versions put almost twice as many characters on the screen!!!

Demand a demo from your dealer!
structure of this program is almost identical to the structure of the previous routine. This time each section of the program examines the next token which has been obtained by a call to LEX, performs the appropriate semantics for the path to be traversed, and then moves to the next defined state. Again, if either an invalid token is encountered or if the routine LEX returns an error code, this routine returns to its caller after leaving an error code of zero in COMMAND.

Due to the way these routines were constructed, a single error code is returned if any error occurs in a command. But, because the exact location in the state diagram is known whenever an error occurs, more descriptive error messages can be generated, or fix up action may be performed. If the command:

MOVE TO A8

is entered, then the syntactic routine would encounter the <END> token while processing state 58. Based on the present form of the program, the error message printed would most likely be "INVALID COMMAND SYNTAX - ENTER NEW COMMAND" since no attempt is made to analyze the syntax error.

However, instead of merely returning the zero error code to its caller, the syntactic routine could return a unique code to indicate that the FROM section of the command is missing. The calling routine could then prompt the user for the coordinates of the piece which is to be moved. Depending on the extent to which this error checking is carried out, a very elaborate and easy to use command system can be created.

Other Representations

The finite state machine diagrams in figures 3 and 4 have been chosen to illustrate the techniques of using finite state machines for designing command languages and do not represent the only way to implement this sample command language. An alternate finite state machine which performs lexical analysis for the example game is shown in figure 6. In this finite state machine all of the commands and keywords (MOVE, CAP, TAKE, TO and FROM) map into the single token <KEYWORD>. Semantic routines associated with the paths L1-L6, L1-L7, L6-L7 and L7-L7 would be used to save the symbols which have already been matched. Then when path L7-L8 is traversed, the semantics associated with this path would include a table lookup routine to identify the command or keyword and correctly fill in the TOKEN array.

To illustrate this technique, observe how the finite state machine in figure 6 would recognize the capture command. Starting with state L1, the C would cause the traversal of path L1-L6 and would be saved to later help identify the token being parsed. The A and the P would similarly cause the program to move along the paths L6-L7 and L7-L7, respectively, and again these letters would be saved by the semantics associated with these paths. Finally, the ending blank would cause the traversal of path L7-L8. At this time, the semantics associated with path L7-L8 would examine the letters which had been saved, identify the parsed word as either a valid token or an invalid word, and correctly fill in the TOKEN array with the code for the token of the error code.

Figure 6: An alternate solution for the lexical analysis of the game program.
Certain advantages exist for both the method used in the finite state machine in figure 3 and for this method but as the number of keywords increases, this method becomes much more efficient in terms of memory used.

Conclusion

The purpose of this article has been to show how finite state machine theory can be used to design retentive systems, and to show that such systems are not the most efficient routines which could be used to improve the performance of character by character scanning and comparison. Of course, both of the routines may be written in any language desired, but because of the memory space limitations of most small computers, assembler language would probably be an asset. As memory size increases, however, the advantages of assembler tend to decrease. Whichever language is chosen, the finite state machine method of designing a command language should produce a system which runs correctly after less programming effort, which can be more readily understood and changed as necessary, and which can provide a series of error and prompting messages that help to make the system easier and more enjoyable to use.

REFERENCES

For examples of the use of finite state machines to identify tokens of a programming language I refer the reader to the following:


More information on finite state machines and their theory can be found in many other books, including:

Approximation Makes a Magnitude of Difference

Bob Leedom
14069 Stavens Valley Ct
Glenwood MD 21738

I enjoyed Richard Lord's article presenting an assembly language FFT (fast Fourier transform) program for the 6800 (February 1979 BYTE, page 108). Adaptation to my 6502 (KIM) system should be fairly straightforward.

However, the author notes that obtaining the magnitude of each resulting vector is almost as time-consuming as the FFT process itself, since this would involve taking the square root of the sum of the squares of each REAL/IMAG pair. Strictly speaking, he is correct, but with very little trouble a quite reasonable approximation to the correct magnitude can be found. The following algorithm is often used for this purpose in the processing of speech and radar data, and may be implemented easily in either hardware or software.

To find the magnitude of a vector, given the orthogonal components (eg: REAL and IMAG):

- take the absolute values of REAL and IMAG;
- compare the two absolute values, place the larger in L and the smaller in S - if they're equal, it doesn't matter which goes where;
- multiply S by a constant (K), add the result to L.

What is K? That depends on how much accuracy you're willing to sacrifice for computation speed. To appreciate this, you should understand that the error in the magnitude computation will be a function of the phase angle between the two components. In his article, Mr Lord simply added L to S, thus letting K = 1. This approximation gives an error of from 0 to 41 percent:

\[ \text{MAGN} = L + S. \]

Table 1 shows several values of K, along with the corresponding spread of the peak errors. However, just looking at the peak errors can be deceiving; what you really
want to do is minimize some measure of the average error. Since the error function "folds" at 45 degrees of phase angle between L and S, I wrote a short program to compute the error at 1 degree intervals from 0 to 45 degrees. The root mean square of these errors is given in table 1 as a sort of quality factor for a given value of K.

As you can see, the computation of the magnitude can be improved from 3 to 8 times, simply by choosing the appropriate value of K. The error reduction as a function of K is shown graphically in figure 1; this is the accuracy part of the tradeoff.

The other side of the coin is speed of implementation. Given the absolute values of REAL and IMAG, and the fact that some fraction of one will be added to the other, it takes no extra time to perform the algorithm with K=1. However, with K=.414214, you must multiply (after finding the smaller of the two absolute values). The range of in-between speeds is given in table 2.

The accuracy/speed tradeoff should be evaluated for each user's application, either by analysis or by trying possible values of K. However, if you don't have the time or energy for this, remember that an immediate reduction of the root mean square error to less than ten percent may be obtained by a compare and a shift (ie, K = .5).
Concerning User's Manuals

In my opinion, many engineers are incompetent when it comes to transmitting information to anyone not already trained in their particular specialty. (I, myself, am wondering if I'm getting this message across.) Engineers, who generally are not human oriented, excuse the obscurity of their communications by charging that the other person (not one of their compatriots, obviously) is not too bright. Unfortunately, there is just enough truth in this assumption to convince most engineers that there is no need to undertake the drudgery of learning how to be lucid — nothing is so easy as adjusting facts to fit opinions.

It is clearly apparent that if engineers are no more obscure in discourse than other people, then I don't have much of a point. So, before plunging into the real subject of this article, let's examine this question with respect to one particular feature involved in the process of transmitting information to others — namely, indices. Information that is not accessible, or that is accessible only with excessive difficulty, is not of much practical value.

In connection with another project, I made a statistical study of the indices of the nonfiction books available in a large public library. I found that the average amount of space devoted to indexing was approximately 1.8% of the total number of pages in a book. Indices varied in size from 0 to more than 7% of the book pages. While it is evidently true that index length is no measure of index quality, it is equally apparent that a short index is limited in the amount of information that it can transmit.

Engineering books, despite the complexity of their subject matter, have less indexing (at an average of 1.3%) than nonfiction books in general. On the other hand, science books, properly reflecting the complexity of their subject matter, have more indexing (at an average of 2.4%) than nonfiction books in general.

Unfortunately, many instruction manuals for computers have been written by engineers. It may well be that the obscurity of computer manuals has a substantial effect on personal computer sales. It is even conceivable that literally thousands of intelligent, educated people, those who might benefit from the possession of a personal computer, are "turned off" when they see
MetaFloppy™ goes beyond.

The Micropolis MetaFloppy™ gives you more than four times the capacity of anyone else's 5¼-inch floppy. Because it uses 77 tracks instead of the usual 35.

The field-proven MetaFloppy, with thousands of units delivered, comes in a complete family of models. And, like our MacroFloppy™ family of disk drives, MetaFloppy is designed for the S-100/8080/2-80 bus.

For maximum capacity, choose our new MetaFloppy 1054 system. Which actually provides you with more than a million bytes of reliable on-line storage. For less money than you’d believe possible.


If that’s more storage than you need right now, try our MetaFloppy 1053, with 650,000 bytes on-line. Or our MetaFloppy 1043, with 315,000 bytes on-line. Either way, you can expand to over a million bytes on-line in easy stages, when you need to. Or want to.

In other words, if your application keeps growing, we’ve got you covered. With MetaFloppy.

The system that goes beyond the floppy.

For a descriptive brochure, in the U.S. call or write Micropolis Corporation. 7959 Deening Avenue, Canoga Park, California 91304. Phone (213) 703-1121.

Or better yet, see your local dealer.

MICROPOLIS™

More bytes in store for you.

---

Some of the instruction manuals published by computer manufacturers. If the reader is skeptical on this point, let him compare the average personal computer user’s manual with a really good manual, such as the one supplied with Hewlett-Packard’s HP-67 calculator.

Suppose that in a given year 10,000 people are turned away from personal computers by the paucity of lucid manuals. (I’m safe here because no one really knows how many potential buyers don’t buy.) And suppose that the average user investment in personal computers is (optimistically) $4000. This means that the personal computer industry, with at least a few manufacturers and retail sellers on the ragged edge of solvency, may be needlessly driving no less than $40,000,000 per year into other hands.

If all computer manufacturers were to test their manuals by having several intelligent, educated people try to operate the corresponding computer with nothing but the manuals for a guide, the results might be illuminating, or even startling to the manufacturers. Then, instead of assuming that these test users are clumsy, it might be helpful to revise the manuals until they are lucid, not invincibly obscure.

I believe that the manufacturers will discover, if they actually make such a test, that the choice of a specific word is highly significant in the transmission of information. It makes a heap of difference whether one says, “Woman and child” or “Woman with child.” It also makes a difference whether an engineer writes, “... has a directory entry” or “... requires a directory entry.”

But most significant of all, many engineers seem to think that the reader needs little or nothing in the way of orientation. This, unfortunately, is not true. The reader of a manual needs to be led by the hand all the way, good writing typically provides such assistance. What often happens in practice is that the reader is given the brush-off, with the declaration that the manual assumes that the reader is acquainted with the subject. This is a luxury that the personal computer industry cannot afford.

Of course, it is perfectly reasonable to assume that the expectant owner of a personal computer should do a little studying of BASIC, for instance. The user definitely won’t be harmed if he or she gets some idea of the general organization of a computer. But there is grave doubt that such training will aid the user noticeably in learning how, for example, to manage the disk file of some particular computer.
25 START-AT-HOME COMPUTER BUSINESSES

In "Low Capital, Startup Computer Businesses"

CONSULTING • PROGRAMMING • MICRO COMPUTER OPPORTUNITIES • SOFTWARE PACKAGES • FREELANCE WRITING • SEMINARS • TAPE/DISC CLEANING • FIELD SERVICE • SYSTEMS HOUSES • LEASING • SUPPLIES • PUBLISHING • HARDWARE DISTRIBUTORS • SALES AGENCIES • USED COMPUTERS • FINDER'S FEES • SCRAP COMPONENTS • AND MORE . . .

Plus — ideas on moonlighting, going full-time, image building, revenue building, bidding, contracts, marketing, professionalism, and more. No career tool like it. Order now — if not completely satisfied, return within 30 days for full immediate refund.

$8 x 11 ringbound • 156 pp. • $20.00

Phone Orders 901-761-9060

DATASEARCH

4954 William Arnold Road, Dept. B, Memphis, TN 38117

Rush my copy of "Low Capital Startup Computer Businesses" at $20.

NAME/COMPANY

ADDRESS

CITY/STATE/ZIP

☐ Check Enclosed ☐ VISA ☐ Master Charge

# Exp. Date

Furthermore, such learning will be of no value at all in helping the hopeful beginning reader in remembering the casual comment, appearing many pages earlier, which mentions that control C is necessary whenever "2A00 hex" is transposed with M5700 in the . . . oh well, what does it matter? The point is that the novice computer owner needs guidance. Among other things, this means examples, examples, and more examples. Since the personal computer industry has not been overwhelmed by standardization, even the experienced computer user needs lucid, particular instructions when adapting to a new system.

One way to improve the situation is to have manuals written by those few engineers who have demonstrated a knack for putting ideas across. And since behavioral phenomena are complex, it is even better to engage the talents and specialized training of a psychologist. It is obvious to a psychologist that students need orientation and examples in order to develop skill in a reasonable time.

Unfortunately, it's one thing to observe a need and quite another to get action. I don't imagine for a moment that it is possible to get any action out of people without some kind of motivation. However, it should be noted that motivation techniques, like everything else, have changed remarkably over the years. In the 16th century, for instance, it was fairly common practice when a king was offended by some luckless peasant (or even by a nobleman) to have the offender bodly pulled apart by teams of Clydesdale horses (the kind that pull beer wagons). This sort of example was supposed to ensure a certain amount of respect for His Majesty. It was motivation that everyone could understand. Sadly, we're so civilized now that we can't use any of the old-time, sure-cure methods of motivation.

If engineers knew that the penalty for failure to be lucid was to be pulled apart by teams of draft horses, it might have a salutary effect on the writings of engineers. (If some computer engineers now think that I should be pulled apart by teams of draft horses, it clearly indicates that my writings are lucid. The readers get the message. Therefore I should not be pulled apart. Q.E.D.)

If a user's manual confuses intelligent people, it is not only unsatisfactory to the user, but damages the fortunes of manufacturers and retail dealers also, because poor documentation inhibits sales. Why should the manufacturers pay for full page color advertisements featuring their products, only to throw the benefits away by offering obscurely written manuals? There must be a better way.
David Lamkins’ article about printed circuit layout techniques “Designing With Double Sided Printed Circuit Boards” (March 1979 BYTE, page 94) described some techniques that shouldn’t be used in good printed circuit board designs. The main problem is the strategy of designing the power and ground runs as the last step. Don’t do it.

The power and ground runs should be designed first in the printed circuit board layout, and not last. Here is why:

• Power runs should be as wide as possible. It is difficult to make them very wide if you have to make them fit between signal runs, pins, etc.
• It will be almost impossible to add decoupling capacitors to power runs that snake through signal runs. Remember, you will need one decoupling capacitor per 7400 series integrated circuit in a good design.

Although the use of one colored pencil per side of the double-sided printed circuit board is noted, designers should try to keep the runs on one side oriented in a right-left fashion and those on the other side oriented in an up-down fashion. If this course is followed, problems such as those in Lamkins’ figure 4 are avoided. Use of this technique also simplifies problems such as those shown in Lamkins’ figure 3 design.

The article also mentions the use of a dedicated through-hole. This is a new one to me. I always thought that the holes on a printed circuit board were dedicated to something. If they weren’t dedicated, there wouldn’t be any need for them. What is a through-hole? I thought that holes went through something. Who knows, maybe some computerist will come up with a nested-hole; a small hole inside a bigger one.

Best wishes.

Statistical Computations
Recomputed

J G Bliss
2141 Cumberland Av S
Saskatoon, Saskatchewan
CANADA S7J 1Z2

Alan B Forsythe, in his article “Elements of Statistical Computation,” (January 1979 BYTE, page 182) states:

Several books of BASIC programs include the calculation of the standard deviation. Those I checked give the wrong answer for this set of data.

This is probably a result of the formula used in the article:

\[ s = \sqrt{\frac{1}{N-1} \sum (X-\bar{X})^2} . \]

The usual formula for standard deviation is:

\[ \sigma = \sqrt{\frac{1}{N} \sum (X-\bar{X})^2} . \]

The version given in the article is used when calculating standard deviation from a sample. (See for example Handbook of Sampling for Accounting and Auditing, 2nd edition, by Herbert Arkin, McGraw-Hill.)
Circle 142 on inquiry card.

T.D.Q.
TAPE DATA QUERY
PET-8 K
SOL-IIA
TRS-80-LEVEL II

*FILE MANAGEMENT SYSTEM
—Utilizes dual audio cassette recorders
*INTERACTIVE QUERY LANGUAGE
—English-like commands
*POWERFUL INFO RETRIEVAL CAPABILITY
*COMPUTERIZED BUSINESS & PERSONAL RECORDS
—Customize your own file structures
—Create & maintain data files
—No programming experience required

IMPLEMENTED IN BASIC
T.D.Q. CASSETTE WITH MANUAL & REF. CARD $50.00

THE FOLLOWING PRE-DEFINED T.D.Q. FILE STRUCTURES
ARE AVAILABLE TO SOLVE YOUR DATA PROCESSING NEEDS:

INVENTORY CONTROL $35.00
ACCOUNTS RECEIVABLE $35.00
ACCOUNTS PAYABLE $35.00
ORDER PROCESSING $35.00
CUSTOMER DIRECTORY $25.00
APPOINTMENT SCHEDULING $25.00

EACH WITH CASSETTE AND MANUAL.
SEND SELF-ADDRESSED STAMPED ENVELOPE FOR
COMPLETE SOFTWARE CATALOGUE.
SEND CHECK OR MONEY ORDER TO:

H. GELLER COMPUTER SYSTEMS
DEPT. B, P.O. BOX 350
NEW YORK, NY 10040

NEW YORK RESIDENTS ADD APPLICABLE SALES TAX.

ED SMITH'S SOFTWARE WORKS
ANNOUNCES R.R.M.A.G.
AN M6800 SYSTEM RELOCIATABLE RECURSIVE
MACROASSEMBLER & LINKING LOADER

ATTENTION ALL PROGRAMMERS: If you have
been looking for an assembler with real macro capabilities, then
we are the one for you.

Character replacement is the crux of macro expansion.
It allows unlimited character replacement in any field of a macro
model statement. A set of macro directional supports both global
and local set symbols. Set symbols can be based on either arithmetic
expressions or character expressions. Macro model statements can
determine attributes of set symbols or macro arguments.

We used Michael Wimble's flowcharts (see
"An APL Interpreter for Microcomputers," August, September, October 1977 BYTE) as
generalized guidelines for our APL interpreter,
rather than coding directly from them. We used most of his ideas on function implement-
tation, table storage, input scanning, and statement parsing. There were a few minor
errors in logic, but for the most part the flowcharts were clear and easy to work with.

We used Michael Wimble's flowcharts (see
"An APL Interpreter for Microcomputers," August, September, October 1977 BYTE) as
generalized guidelines for our APL interpreter, rather than coding directly from them. We used most of his ideas on function implementation, table storage, input scanning, and statement parsing. There were a few minor errors in logic, but for the most part the flowcharts were clear and easy to work with. We expanded the interpreter to include functions to which Wimble made reference but did not flowchart — inner product, outer product, catenate, and index-of. We made the interpreter extremely portable by having the character set machine (as well as keyboard) independent. We accomplished this by having the program read in the installation's character set from a file at the start-up of the program.
THE TRS-80
ASSEMBLY LANGUAGE
DEVELOPMENT SYSTEM.
(A STEAL AT TWICE THE PRICE)

A short time ago, Microsoft introduced TRS-80 FORTRAN—a complete ANSI-standard FORTRAN with macro assembler, linking loader, and text editor, all for only $350. The response has been overwhelming.

Many TRS-80 users even told us, "The assembly language development software alone is worth that price." We think they're right, of course, but we've made it an even better deal.

ANNOUNCING:
THE TRS-80
ASSEMBLY LANGUAGE
DEVELOPMENT SYSTEM
FOR $175.

For half the price of the TRS-80 FORTRAN Package, you can buy the TRS-80 ASSEMBLY LANGUAGE DEVELOPMENT SYSTEM, including:

EDIT-80 A fast, random access text editor that's easy to use and loaded with features. Lets you insert, replace, print or delete lines; edit individual lines; renumber lines in a file; and find or substitute text.

MACRO-80 The best Z80 assembler anywhere. MACRO-80 supports a complete Intel-standard macro facility plus many other "big computer" assembler features: comment blocks, octal or hex listings, 8080 mode, titles and subtitles, variable input radix (base 2 to base 16), and a complete set of listing controls.

LINK-80 Loads your relocatable assembly language modules for execution and automatically resolves external references between modules.

CREF-80 Gives you a complete dictionary of program symbols, showing where each is defined and referenced.

The Microsoft TRS-80 FORTRAN Package is still available for $350. Or, for HALF PRICE, get the TRS-80 ASSEMBLY LANGUAGE DEVELOPMENT SYSTEM.

Either way, it's a steal.

TO: Microsoft, 10800 N.E. 8th, Suite 819, Bellevue, WA 98004
☐ Send me the works! TRS-80 FORTRAN Package for $350.
☐ Send me half the works! TRS-80 Assembly Language Development System for $175.

☐ Check enclosed  ☐ Master Charge  ☐ VISA

CARD NUMBER EXP DATE

CARDHOLDER'S SIGNATURE

NAME

ADDRESS

CITY STATE ZIP

Dealer Inquiries Invited
Tables

Rather than using Wimble's method of storing tables in arrays (variable table, value table, function table, token table), we took advantage of one of Pascal's data structures, the linked list. This offers two big advantages to the design of the interpreter:

- Array sizes do not have to be declared elsewhere in the program. There is no way of telling which tables will grow very large and which ones will stay small; this is dependent on the calculations being performed with the interpreter and will vary from one terminal session to another. With linked lists, storage allocation is dynamic and can be used for each table as needed (storage is taken from a common pool of storage reserved for linked lists).
- It is a simple procedure to de-allocate storage (using the standard function "dispose" in Pascal) so that it can be re-used by the program as needed. This helps to keep the size of the running program to a minimum.

Values

We store all values as real numbers. We decided to do this based on the fact that although APL's data structures are weak (e.g., reals and integers can be stored in the same array), Pascal's data structures are very strongly typed. Numbers are checked to be whole numbers (nonfractional) for certain operations such as index generation (monadic iota) and reshaping (dyadic rho). Numbers are checked to be Boolean for such operations as logical negation (tilde), ANDs, and ORs.

The Nybbles Library is an inexpensive means for BYTE readers to share some interesting but specialized forms of software. These programs are written by readers with small computers and printer facilities, and are therefore designed for particular systems. The algorithms and programming techniques in these programs can be directly used by readers with similar equipment, or can serve as an inspiration for improvisation on computers of different characteristics.

Potential authors of such programs should send us a self-addressed stamped envelope, with a request for a copy of our "Guidelines for Nybbles Authors." Payment for Nybbles items is based on sales and length of the item. Rates are set at the time of acceptance.

Nybbles Library programs are sent in listing form, printed on 8.5 by 11 inch paper on both sides. The Nybbles Library programs are 3 hole punched for collection in loose leaf binders, and come in an attractive folder which serves as a cover.

This month "An APL Interpreter in Pascal" (document #109) has been added to the Nybbles Library. Use the coupon below to order your personal copy, at $10.00 postpaid in USA or $12.00 for overseas orders.

Please send _______ copies of BYTE Nybble #_______ at $_________ postpaid.

Please remit in US funds only.

_________ Check Enclosed

Bill my BAC # __________________________ Exp Date __________

Bill my MC # __________________________ Exp Date __________

Name ________________________________

Street ________________________________

City __________________ State ________ Zip Code __________

BYTE Nybbles Library, 70 Main St, Peterborough NH 03458

You may photocopy this page if you wish to keep your BYTE intact.
BUSINESS

Appointment Log by M. Kelleher Perfect for the professional. Accepts name and address, meeting start and business, bookkeeping, sales, and inventory, derives elapsed time. For Level II, 16K $9.95


Mail List I by Michael Kelleher is the economy model of disk-based mailing list programs. Uses a single drive and handles up to 1,000 names with minimum memory allocations. 16K, D $19.95

Mail List II by BIZ-80 Complete mail list system for dual disk. Enter, update, merge, sort, and print mailing labels. D, 32K $99.95

Small Business Bookkeeping by Roger W. Robitaille, Sr. Authentic bookkeeping system can handle up to 1,000 accounts receivable, accounts payable and general ledger systems, plus sales and payroll. Complete documentation and software on diskette, $200.00

BIZ-80 The Business Software People®

Just about everything you need.... within 1 year, participants receive programming for inventory, accounts receivable, accounts payable, and sales and payroll. Complete documentation and software on diskette, $200.00

ST 80 - SMART TERMINAL

Lance Micklus

Turns your TRS-80 into a computer terminal. Features include CONTROL key, REPEAT key, ESC key, RUN key and a functioning BREAK key. Lets you list incoming data on line printer. Reprogram RS-232-C switches from keyboard, making baud rate changes simple. Level II, 16K $49.94

Text-80 by Frank Rowlett Fully-documented text processing system for disk. Create, edit, move, delete, insert, change, print words or lines. D, 32K $59.95

KVP Extender by Lance Micklus Corrections keyboard bounce, upper case lock. permits use as a terminal, screen printing. On tape (24.95) or disk ($29.95)

8080-Z80 Conversion by Roger W. Robitaille, Sr. 230 stock items can be contained using the full 6 data areas and 2 pieces of alpha information. Level I or II, 16K $25.00

Inventory System II by BIZ-80 Proper inventory management is the backbone of a profitable business. Yet it is very difficult to keep current on product inventory, shrinkage, shrinkage-stocked items, profit-lossable items versus losers, without an efficient and prompt method of surveying your inventory levels at a given time. This program can help you to achieve optimal management — it can handle up to 1,000 items on one disk; each additional disk can handle another 1,000 items. With Documentation, $150.00

Inventory $ by Roger W. Robitaille, Sr. 240 stock items can be contained using the full 6 data areas and 2 pieces of alpha information. Level I or II, 16K $25.00

Inventory II.2. Disk based program allows for creation, maintenance and review of over 2,000 items per cleam diskette. Operates under Disk BASIC. 21 with minimum memory allocation. D, $59.95

Inventory II.2. Disk based program allows for creation, maintenance and review of over 2,000 items per clean diskette. Operates under Disk BASIC. 21 with minimum memory allocation. D, $59.95

ST 80 - SMART TERMINAL

Lance Micklus

Turns your TRS-80 into a computer terminal. Features include CONTROL key, REPEAT key, ESC key, RUN key and a functioning BREAK key. Lets you list incoming data on line printer. Reprogram RS-232-C switches from keyboard, making baud rate changes simple. Level II, 16K $49.94

Text-80 by Frank Rowlett Fully-documented text processing system for disk. Create, edit, move, delete, insert, change, print words or lines. D, 32K $59.95

KVP Extender by Lance Micklus Corrections keyboard bounce, upper case lock. permits use as a terminal, screen printing. On tape (24.95) or disk ($29.95)

8080-Z80 Conversion by Roger W. Robitaille, Sr. 230 stock items can be contained using the full 6 data areas and 2 pieces of alpha information. Level I or II, 16K $25.00

Inventory System II by BIZ-80 Proper inventory management is the backbone of a profitable business. Yet it is very difficult to keep current on product inventory, shrinkage, shrinkage-stocked items, profit-lossable items versus losers, without an efficient and prompt method of surveying your inventory levels at a given time. This program can help you to achieve optimal management — it can handle up to 1,000 items on one disk; each additional disk can handle another 1,000 items. With Documentation, $150.00

Inventory $ by Roger W. Robitaille, Sr. 240 stock items can be contained using the full 6 data areas and 2 pieces of alpha information. Level I or II, 16K $25.00

Inventory II.2. Disk based program allows for creation, maintenance and review of over 2,000 items per clean diskette. Operates under Disk BASIC. 21 with minimum memory allocation. D, $59.95

Inventory II.2. Disk based program allows for creation, maintenance and review of over 2,000 items per clean diskette. Operates under Disk BASIC. 21 with minimum memory allocation. D, $59.95

ST 80 - SMART TERMINAL

Lance Micklus

Turns your TRS-80 into a computer terminal. Features include CONTROL key, REPEAT key, ESC key, RUN key and a functioning BREAK key. Lets you list incoming data on line printer. Reprogram RS-232-C switches from keyboard, making baud rate changes simple. Level II, 16K $49.94

Text-80 by Frank Rowlett Fully-documented text processing system for disk. Create, edit, move, delete, insert, change, print words or lines. D, 32K $59.95

KVP Extender by Lance Micklus Corrections keyboard bounce, upper case lock. permits use as a terminal, screen printing. On tape (24.95) or disk ($29.95)

8080-Z80 Conversion by Roger W. Robitaille, Sr. 230 stock items can be contained using the full 6 data areas and 2 pieces of alpha information. Level I or II, 16K $25.00

Inventory System II by BIZ-80 Proper inventory management is the backbone of a profitable business. Yet it is very difficult to keep current on product inventory, shrinkage, shrinkage-stocked items, profit-lossable items versus losers, without an efficient and prompt method of surveying your inventory levels at a given time. This program can help you to achieve optimal management — it can handle up to 1,000 items on one disk; each additional disk can handle another 1,000 items. With Documentation, $150.00

Inventory $ by Roger W. Robitaille, Sr. 240 stock items can be contained using the full 6 data areas and 2 pieces of alpha information. Level I or II, 16K $25.00

Inventory II.2. Disk based program allows for creation, maintenance and review of over 2,000 items per clean diskette. Operates under Disk BASIC. 21 with minimum memory allocation. D, $59.95

Inventory II.2. Disk based program allows for creation, maintenance and review of over 2,000 items per clean diskette. Operates under Disk BASIC. 21 with minimum memory allocation. D, $59.95
The BASIC Handbook: An Encyclopedia of the BASIC Computer Language  
by David A Lien  
360 pages, paperback  
$14.95  

The title of this book really should read *A Dictionary of the BASIC Computer Language*. It is laid out in a self-indexing format as an alphabetic listing of BASIC keywords (such as PRINT, GOTO, and INT) accompanied by a detailed explanation of the effect that the keyword has when used in a program. Operator symbols are also dealt with.

The description given for each keyword includes the following: introductory and descriptive remarks, a test program with a sample run to show how the machine should respond, helpful hints, variations in usage between different brands of computers or different implementations of the BASIC language, and cross-references to related keywords. Also included is a section called "If Your Computer Doesn't Have It." This section is of great value to readers who may have BASIC interpreters that lack certain features.

In many cases this section gives a subroutine which performs a function. These subroutines are similar in design to those which are found in the Radio Shack User's Manual for Level I TRS-80 Microcomputer System. In some cases a slightly modified algorithm is used for better accuracy. These subroutines are written in a form which transports well between different systems. (The similarity to subroutines in the TRS-80 manual, and a slight emphasis on TRS-80 BASIC, is not surprising. Dr Lien is the author of the TRS-80 Users Manual.)

The BASIC Handbook is good within its limits. It will be a help to the beginning programmer, especially one trying to convert a BASIC program from one microcomputer system to another. When this novice programmer encounters a word with which he or she is not familiar in a program, the chances are that it is in this book, along with supplementary information.

A problem arises, however: not all features and differences between BASIC systems occur in the keywords. For example, the BASIC compiler offered by North Star Computers has several characteristics which differ from other BASIC systems. These include reversed use of commas and semicolons, and accessing of single characters from a string by subscript notation. The book could address the punctuation symbol usage, but it does not. The format does not provide a good section to discuss the subscript notation for strings or other differences of a similar nature.

The book in this edition is incomplete. Certain keywords do not appear. Notable by their absence are the string usage statements CHANGE and LINPUT; the special forms RESTORE$ and RESTORE#; the matrix arithmetic operations (MAT C = A + B); the matrix initialization keywords (MAT C = ZER or CON or IDN); the matrix manipulation statements (MAT C = TRN(A) or INV(A), etc.); and most of the various statements for handling data files on mass storage devices.

Part of the reason for the above mentioned omissions is that most of the information presented in this book concerns microcomputer BASIC systems. In particular, the various Microsoft (MITS, Apple, Radio Shack, Commodore, Ohio Scientific) interpreters are well covered. Implementations of BASIC on minicomputers and large mainframes are somewhat neglected, however. They appear in the list on the inside back cover, but most of the more unusual features, those which are most likely to cause trouble, have not been included in this book.

The result of all this is that a person who wishes to convert a BASIC program from a large computer system to a small computer system will need to determine if the more specialized features of the "large" BASIC have been used. If they have, the programmer will need to consult the user's manual for the BASIC language as it works on the large source computer. Dr Lien recognizes this, as he states in the introduction, "The BASIC Handbook is not a substitute for the manufacturer's manual which accompanies each computer. It is a supplement."
I SMELL A WUMPUS!!!

...SHOOT or MOVE?

ISBN 0-931718-03-1
$6.00

Buy this book at your favorite computer bookstore or order direct from BYTE BOOKS.
Send 60¢ per book for postage & handling.

It's Jack Emmerichs' new book, 'Superwumpus', an exciting adaptation of the 'Wumpus' game for computer programmers. The cave system of the Wumpus is a dodecahedron, and you're the lost hunter who has to capture the Wumpus to lead you out. You'll have to hurry before your supplies are depleted, or before you're caught in a bat migration, a rock slide, or some other catastrophe.
Superwumpus is outstanding in the realm of computer games as being both challenging and enjoyable.
Superwumpus is programmed in both 6800 assembly language and Basic, and comes complete with source listings and bar codes.
Watch out for Superwumpus—it's addictively fun!

70 Main Street, Peterborough, New Hampshire 03458
FREE SOFTWARE!

PRACTICAL MICROCOMPUTER PROGRAMMING: THE Z80
by W.J. Weller

Here from W.J. Weller and Northern Technology Books is the third in the Practical Microcomputer Programming series. It is a comprehensive text covering assembly language programming for Z80 based microcomputers. The first 16 chapters cover Z80 programming comprehensively, from binary operations to interrupt handling. Included are chapters on moving data, logical and arithmetic operations, use of the stack, communications with the terminal, floating point arithmetic and graphic output. All programming techniques are illustrated with formal tested examples. An important feature of the book is that it uses the universal standard 8080 mnemonics. This is of great help to users who are upgrading their machines and software to utilize the Z80 processor.

The last part of the book is software; an editor/ assembler which will run on any 8080 or Z80 machine and a debugging monitor.

Hardcover $29.95

FINALLY....

FREE:

AN EDITOR/ASSEMBLER SYSTEM
FOR 8080/8085 BASED COMPUTERS
by W.J. Weller and W.T. Powers

This 148 page book contains complete information for initializing and using a powerful editor/ assembler and debugging monitor system, and the full SOURCE text of both. The assembler fully supports all Intel instruction mnemonics as well as the entire language used in Practical Microcomputer Programming™: The Intel 8080. The editor/assembler is resident in less than 8K RAM and will run on any 8080, 8085 or Z80 based computer with peripherals which transfer on a character basis or can be made to do so by buffering. The user supplies his or her own I/O drivers. The text editor is extremely simple to use and does not require irrelevant line numbers. Also included is a program to convert Processor Technology™ format tapes to a format usable by the editor/assembler.

This system is not the usual "quickie" software, riddled with errors and limitations, but a professionally created, thoroughly tested and debugged system. At $14.95 it is the best software bargain you are ever likely to see.

AND BY THE WAY... paper tape object copies of all this software are sent FREE to book purchasers when the coupon at the back of the book is returned to Northern Technology Books. 8 ½" x 11". $14.95

- 8080/8085 editor/assembler object code on diskette for North Star disc systems. Only $14.00
- 8080/8085 editor/assembler and debug source code for North Star disc systems. Only $14.00
- Or both for $26.00!

PRACTICAL MICROCOMPUTER PROGRAMMING:
THE INTEL 8080
by W.J. Weller, A.V. Shatzel and H.Y. Nice

Here is a comprehensive source of programming information for the present or prospective user of the 8080 microcomputer, including moving data, binary arithmetic operations, multiplication and division, use of the stack pointer, subroutines, arrays and tables, conversions, decimal arithmetic, various I/O options, real time clocks and interrupt driven processes, and debugging techniques. This 306-page hardcover book is well worth its $21.95 price and should be in every 8080 or Z80 user's library.

PRACTICAL MICROCOMPUTER PROGRAMMING: THE M6800
by W.J. Weller

This second volume of the Practical Microcomputer Programming series addresses the problems of applications programming at assembly level for the M6800. In 16 chapters and more than 100 formal examples, the fundamental techniques of assembly level programming are applied to the solution of specific problems with the 6800. Nowhere theoretical, it is a thorough and detailed methods text for the beginning and intermediate application programmer using the 6800. $21.95 hardcover.

*A trademark of Tandy Corporation
Dr Lien treats the END statement in a way I dislike. He describes it only as a means of terminating program execution; whereas many computers use END as a means of indicating the end of the program text, and some systems use END as a marker for the physical end of file when a program is stored on a disk. Programmers treating END only as an execution terminator scatter ENDS throughout the program. If an unsuspecting user types in such a program on a system using END for end of file and saves it on a disk, he may lose the result of hours of work. I prefer the use of the STOP statement for terminating program execution other than at the end of the program.

I hope that BASIC experts will communicate with Dr Lien, to provide him with exact information concerning the more exotic features of the language. Then, perhaps, the second edition of this essentially helpful book can be more helpfully essential. All things considered, the book is a useful purchase, especially for the beginner, but I urge that it be improved. An improved version could truly require the appellation "encyclopedia."

Richard S Shuford
Editor

Structured Programming and Problem-Solving with Pascal
365 pages paperback
$10.95

Good habits appear to be in vogue for 1979. In programming, the good habits that we are suddenly hearing about are documentation, top-down design and bottom-up coding techniques, and the Pascal language. Richard B Kieburz's book demonstrates the necessity of a firm grounding in the design and implementation of programs in order to cope with the complexity of today's programming problems.

The book is divided as follows: 45 percent Pascal, 45 percent structured design and programming techniques, and 10 percent theory (introductory material on computers that qualifies the book for use as a college textbook).

Pascal is largely defined and taught by the context of its use in solving problems such as determining the intersection of two line segments, writing a word processing program, and running a rabbit population simulation. Although there is an index of

---

**Expand your TRS-80. Save $100.**

Meet the Vista V80 Mini Disk System. The perfect way to upgrade your TRS-80® system. Inexpensively. (Our $395.00 price is about $100.00 less than the manufacturer's equivalent.) Here's how it can help you.

- **23% more storage capacity.** Useable storage capacity is increased from 55,000 to 65,000 bytes on drive one.
- **8 times faster.** While electronically equal to the TRS-80 Mini-Disk system, track-to-track access is 5ms versus 40ms for the TRS-80.
- **Better warranty.** The V80 carries a 120 day warranty—longer than any comparable unit warranty available.

The Vista V80 Mini Disk System comes complete with Mini floppy disk drive, power supply, regulator board and case. And it's ready to run—simply take it out of the box, plug it in and you're ready to go.

**Vista**

1320 East St. Andrews Place, Suite I
Santa Ana, California 92705
(714) 558-8813

At Vista, we mean business.
'TINY' PASCAL
for
TRS-80® & NORTH STAR®
Now you too can have Pascal! The Chung/Yuen 'Tiny' Pascal has been specially designed for TRS-80 & North Star owners. The full power & elegance of 'Tiny' Pascal is at your command. Programs written in 'Tiny' Pascal run at least 4 times faster than the same program in BASIC! 'Tiny' Pascal is also a great way to learn Pascal Programming, & fun too.
The minimum system requirements are: Level II, 16K for TRS-80, & 24K for North Star (specify single or double density).

SOURCE TOO!
But most important, you also get source to 'Tiny' Pascal written in Pascal with each purchase! You can even compile the compiler! (Requires 36K for North Star systems, & 32K, Level II for TRS-80). You can customize your own version, or just use it the way it is.
'Tiny' Pascal is a subset of Standard Pascal & includes:
- RECURSIVE PROCEDURE/FUNCTION, IF-THEN-ELSE, REPEAT/UNTIL, 'PEEK & POKE', WHILE, CASE, & MORE!
Also you can save & load programs.
You get all this & more, plus a user's manual for $40.00.

available from:
SUPERSOFT
P.O. Box 1628
Champaign, IL 61820
(217) 344-7596

All orders pre-paid, Illinois residents add 5% sales tax

At last a
DICTIONARY
for
TRS—80
6000 words in 12K!
A selection of 6,000 words (no definitions) up to 9 letters long, with an average length of over 5 letters. Indexed by first, second and last letter. Answers the vital question — what word has a first letter of U, a third of G and a last of T? Great for Scrabble or crossword or your own word games. Each word has a two byte code; handy for text compression too. Requires 16K Level II.

$14.95 U.S. ($17 CDN)

HEXAGON SYSTEMS
P.O.Box 397, Station A
Vancouver, B.C. V6C 2N2 Canada

Pascal terms pointing back to the text, many of these terms are not defined in sufficient detail to help debug a Pascal program. The book is readily understandable to anyone unacquainted with the language, but it should not be used as the sole reference book on Pascal as it describes a generalized Pascal that manipulates both character and numeric variables. Specifically, it does not mention some of the more advanced UCSD (University of California at San Diego) extensions to Pascal.
The concept that is the cornerstone for both the theory and implementation of structured techniques in this book is known as "design by stepwise refinement." This automatically implies two techniques that I find best for problems of any complexity: top-down design and bottom-up coding. Top-down design (breaking a problem into manageable subproblems) produces a modular program that can be easily modified. Bottom-up coding (writing the code for every subproblem before writing the code that uses them) avoids the problem of having to rewrite the high level routines to add something that you found you needed at a later date. Kieburtz uses a relatively new flow-chart-like notation that depicts the fundamental structured programming constructs (do-while, repeat-until, sequence, if-then-else, and case) in a way that is both graphic and intuitively understandable. For example, the body of a do-while clause is a rectangle bordered on the left and top by an L-shaped piece that describes the while condition for repeating the block.
The book also introduces several of the better known algorithms and ideas in computer science: the linear interpolation and binary search methods of extracting roots, Gaussian elimination to solve simultaneous equations, backtracking trial and error methods (to solve the eight queens problem), and several simulation examples. The final chapter, "How Does the Computer Work?," deals with binary numbers, machine language, and computer architecture. It is obviously there to catch a larger slice of the textbook market.
All in all, this book is reasonably priced and well worth the money. It is a good introduction to Pascal (but only that), and it exposes the reader to good programming habits on all levels. I wish that I had been exposed to this kind of book when I was learning to program.

Gregg Williams
1605 Eastmoreland #3
Memphis TN 38104•
Revolution in Miniature
by Ernest Braun and Stuart MacDonald
Cambridge University Press, 1978
231 pages hardcover
$16.95

The invention of the transistor was not a fortuitous accident of pure research. It had been sought for years before its actual invention. A working (though impractical) solid state amplifier had been demonstrated as early as 1933, and in 1939 Dr William Shockley tried to put a "grid" in a copper oxide rectifier. It didn't work. When developments in physics finally permitted its invention, the transistor principle was identified within weeks by Bell Laboratories, Purdue University, and a French team, all working independently.

These are some of the fascinating, amusing, and always factual incidents related in Revolution in Miniature. The book traces the history of solid-state electronics from the coherer (the first solid-state electronic device) to large scale integration. One of the authors is a historian, the other is a physicist, and I can't think of a better combination for this endeavor. The flair that these two British authors exhibit with their command of the English language provides a force of expression seldom seen in a technical book.

As the publisher states, "Semiconductor electronics... effect on life in the second half of the twentieth century can hardly be overestimated." Solid-state technology has made possible things that were never before envisioned, yet in the beginning the transistor was seen, even by its developers, as a mere substitute for the triode tube (or "valve," as described herein). The later, more successful transistor types were often electrically inferior to the fragile, lab assembled models and were adopted only in the interests of cheap, uniform mass-production. Early integrated circuits contained a lot of hand labor, and digital electronics as we know it today resulted from attempts to minimize the passive components needed in earlier analog circuitry.

The book is heavily footnoted and the bibliography is impressive. Aside from entertainment value, the historical data is worth having for reference. You will find answers to such questions as: who developed which manufacturing techniques; which key people spun a new company off from an established one; why Silicon Valley is what it is; and which bar is the scene of employee and information swapping. It's a lot like reading someone's diary.
ANNOUNCES MICROCOMPUTER SOFTWARE FOR APPLE II, NORTH STAR, & OHIO SCIENTIFIC USERS

APPLE II
*FILE MANAGEMENT SYSTEM (32 K) .................. $60.00
It's used to create, add, change or delete data records on disk. Includes label printing & mailing list.  

*WORD PROCESSOR (32 K) .................. $60.00
Disk based word processor includes upper & lower case plus complete printer control and more.  

*STEP by STEP (16 K) .......................... $39.95
(add $10.00 for disk version)
Computer Basic course in 20 lessons, 10 quizzes & final test.  

NORTH STAR

*INVENTORY ........................................ $25.00

*MEDICAL BILLING .............................. $25.00

*PAYROLL ......................................... $25.00

*COMPLETE BUSINESS PACKAGE

OHIO SCIENTIFIC (All Series)

*GAMES**SMALL BUSINESS PACKAGES

*EDUCATIONAL SOFTWARE

We have the most sophisticated library of software for these microcomputers in stock. Send $1.00 for software catalog or call our toll free number (800) 327-8455.
Please specify disk or tape version.

Trans-Data Corp.
161 Almeria Avenue, Suite 100-E
Coral Gables, Florida 33134

---

TRI-S-00 means business! ! !
...with CP/M, CBASIC2, & applications software.

CP/M ("the software bus") & CBASIC2 (the standard for business software) bring new power and versatility to the TRS-80 for practical use.

- CP/M Operating System (w/ Editor, Assembler, Debugger, Utilities & 6 manual set) ........ $150
- CBASIC2 Compiler (w/manual) .................. $95
- DESPOOL Print Spooler (w/manual) .............. $75
- Osborne & Assoc. PAYROLL W/COST ACCTING ........................................ $250
- Osborne & Assoc. ACCTS. RECEIVABLE & ACCTS. PAYABLE .................................. $250
- Osborne & Assoc. GENERAL LEDGER ................ $250
  * CBASIC2 source programs; add $15 (each) for applicable O & A book
- APH - Self-administered Automated Patient History .............................................. $175

Write/call for additional software available & FREE "CP/M Primer".
CA residents add 6% tax. Visa, M/C, M/O, Check OK.

---

How to Program Microcomputers is an introduction to machine language programming for the 8080, the 6800, and the 6502 microprocessors. The only other book I have seen that attempted to teach programming for a group of microcomputers did so by presenting all problems in a superset of the PL/M language. This book takes a different approach, and uses the assembler mnemonics for each of the processors discussed.

The book begins with an introduction to microcomputers: what they are, how they operate; and an introduction to alternative processor architectures. The structures of the 8080, the 6800, and the 6502 are described, then alternatives for addressing, memory access, stack manipulation, I/O (input/output) operation and interrupt processing are introduced. Each topic is illustrated with features from the applicable microprocessor.

The next part of the book deals with programming techniques. Data movement, arithmetic operations, multiple precision arithmetic, branching, indexing, subroutines, stack operations, table operations, list processing, bit manipulation, decimal and floating point arithmetic, and I/O are discussed, as well as how to put all of these elements together. As before, examples are given for each processor.
The last part of the book provides standard algorithms for each machine. Twenty different building blocks (most of which belong in any good monitor) are given for each processor. Appendices summarize the instruction sets.

There are three groups of people who might be interested in this book. The first group is composed of anyone becoming acquainted with microcomputer technology who wants an overview of the main processors in present hobbyist use. The second group is composed of people who already have a machine and who want good standard routines. The third group (in which I am included) consists of those hobbyists who have a machine and who would like to see how other processors operate. While I would certainly never trade my Z-80 for any of the processors illustrated in the book, it is good to know how the rest of the world operates.

John A Lehman
716 Hutchins #2
Ann Arbor MI 48103

---

You can use the versatile new BETS1 to plug the more than 150 S-100 bus expansion boards directly into your PET*

On a single PC card, BETS1 has both interface circuits and a 4-slot S-100 motherboard. With BETS1, you can instantly use the better than 150 boards developed for the S-100 bus. For expanding your PET's memory and I/O, BETS1 gives you the interface. The single board has both the complete interface circuits required and a 4-slot S-100 motherboard, plus an 80-pin PET I connector. BETS1 connects to any S-100 type power supply and plugs directly into the memory expansion connector on the side of your PET's case. And that's it. You need no additional cables, interfaces or backplanes. You don't have to modify your PET in any way, and BETS1 doesn't interfere with PET's I/F or parallel ports. And when you want to move your system, BETS1 instantly detaches from your PET.

BETS1 is compatible with virtually all of the S-100 boards on the market, including memory and I/O boards. BETS1 has an on-board controller that allows the use of the high-density, low-power "I-expandatrm" dynamic memory board from S.D. Sales. This means you can expand your PET to its full 32K limit on a single S-100 card! Plus, you won't reduce PET's speed when you use either dynamic or static RAM expansion with BETS1. Additionally, BETS1 has four on-board sockets and decoding circuits for up to 8K of 2716 or 2764 PROM expansion (to make use of future PET software available on PROM). BETS1 jumpers will address the PROMs anywhere within your PET's ROM area, too.

The BETS1 Interface/Motherboard Kit includes all components, a 100-pin connector, and complete assembly and operating instructions for $119.

The Assembled BETS1 board has four 100-pin connectors, complete operating instructions and a full 6-month Warranty for just $165.

MAIL ORDERS ARE NORMALLY SHIPPED WITHIN 48 HOURS. VISA AND MASTERCHARGE ORDERS ARE BOTH ACCEPTED.

FORETHOUGHT PRODUCTS
87070 Drakhtar Road #K
Eugene, Oregon 97402
Phone (503) 485-8575.

*PET is a Commodore product

If you need Business Reports with fancy frills you have the wrong company. We don't put these in our Software or our Ads. Both cost *** You *** Money.

But if you need solid, Down-To-Earth Software for your North Star, Imsai, or other low cost Data Processing System written in Microsoft Basic or CBasic including GL, AR, AP, Inventory, Payroll, Mailing List and Fixed Asset Accounting then you *** Do *** have the right company.

GIVE US A TRY — WE KNOW YOU'LL BE GLAD YOU DID

John J. J. Hughes
102 Avenida Dela Estrella
Suite 208
San Clemente, CA 92672
(714) 492-7633

FORETHOUGHT PRODUCTS
87070 Drakhtar Road #K
Eugene, Oregon 97402
Phone (503) 485-8575.
BASIC Factorials

Here’s another function to add to your BASIC, a factorial calculator. The factorial of a number X is equal to X times X-1 times X-2 etc down to one and is represented by X! Thus 4! is 24. For large values of X, Stirling’s approximation can be used to find the gamma function which is readily converted to the factorial by the relation:

\[ X! = \Gamma(X + 1) \]

To find the factorial of X with the BASIC program shown in listing 1, execute a jump to subroutine at line 5000. On return, the factorial of X will be in G. If for some reason the gamma function itself is wanted, remove the first statement from line 5010 and GOSUB 5000 with the argument in YO.

The subroutine works by finding the gamma function of a number six values larger than the argument:

\[
(X + 5) = \Gamma(N)
\]

\[
\exp \left\{ \frac{1}{12X} \left( 1 - \frac{1}{30X^2} \right) - X \right\}
\]

\[
\Gamma(X) = \Gamma(N)/(X(X + 1)(X + 2)(X + 3)(X + 4))
\]

This function is only approximate, as can be seen in the sample run of listing 2. The returned value should be rounded to the nearest integer.

Listing 1: BASIC program for determining factorials using the gamma function.

```
10 REM TEST FACTORIAL SUBROUTINE
20 INPUT "FACTORIAL OF " X: GOSUB 5000
30 PRINT "THE FACTORIAL OF " X; " IS "; G
40 GOTO 20
5000 REM GAMMA FUNCTION G(X)
5010 YO=X+1: Y=Y0+5: Y2=Y*Y*30: Y1=SQR(2*3.14159/Y*Y+1)
5020 G=Y1*EXP((1-1/(30*Y2))/(12*Y)-Y)/YO
5030 FOR I=1 TO 4: G=G/(YO+I): NEXT: RETURN
```

Listing 2: Sample run of the factorial program. Notice that the answers are not exact. The truncated integer portions of the smaller results are exact factorials; as the factorials grow in size, the result quickly exceeds the precision of the floating point representation of the numbers.
Since my computer system is continually in a state of flux, I sometimes lose track of the addressing for the various memory boards. To eliminate the hunt-and-seek method of locating unprotected memory blocks, I put together the routine in listing 1 (see page 208) to examine all memory space from hexadecimal 0000 to FFFF and report the start and end addresses of all available spaces.

A memory location exists and is not protected if the processor can write a word to memory and read back the same word. However, since any given memory location may have a value from 0 to FF (the range of the 8080 processor), some care must be exercised in declaring a location as existing and available.

To address this problem, I use a double store routine in which the processor first stores one arbitrary number and then another different number. If the processor reads back the correct number for both stores, that location is a valid unprotected memory cell. [This could also be used as a memory failure check if the two values used were hexadecimal 0000 and FFFF . . . RGAC]

Two notes are needed relative to listing 1. First, the line with the pound sign (#) is the link back to the calling routine. If the FMAR routine is called as a subroutine, this line should be replaced with a return instruction. Second, note that upon exiting, the DE register pair points to the next address past the last address pair from the routine. The pointers for start and end of free memory blocks may be pulled out with LHLD or POP instructions.

Also, the routine itself should be located in protected memory (along with the operating system, for instance) since the routine will self-destruct if located in unprotected memory. Be sure to provide sufficient room for the DE register pair to expand.

Total memory requirements for this routine are 66 bytes plus the stack area for the DE register pair storage of free memory boundaries.

If desired, the FMAR routine may be used to simply output the addresses to a Teletype or terminal.

---

**64KB MICROPROCESSOR MEMORIES**

- **S-100** - $695.00
- **SBC 80/10** - $750.00
- **LSI 11** - $750.00
- **6800** - $750.00

**Cl-S100** — 64K x 8 on a single board. Plugs directly into the IMSAI, MITS, TDL, SOL and most other S-100 Bus computers. No wait states even with Z80 at 4Mhz. Addressable in 4K increments. Power requirement 6 watts. Price $695.00.

**Cl-1103** — 8K words to 32K words in a single option slot. Plugs directly into LSI 11, LSI 11/2, H11 & PDP 1103. Addressable in 2K increments up to 128K. 8K x 16 $390.00. 32K x 16 $750.00 qty. one.

**Cl-6800** — 16KB to 64KB on a single board. Plugs directly into Motorola's EXORcisor and compatible with the evaluation modules. Addressable in 4K increments up to 64K. 16KB $390.00. 64KB $750.00.

**Cl-8080** — 16KB to 64KB on single board. Plugs directly into Intel's MDS 800 and SBC 80/10. Addressable in 4K increments up to 64K. 16KB $390.00. 64KB $750.00

Tested and burned-in. Full year warranty.

**Chrislin Industries, Inc.**

Computer Products Division
31352 Via Colinas • Westlake Village, CA 91361 • 213-991-2254

Circle 47 on inquiry card.
Listing 1: 8080 assembly language program for finding areas of memory that are free and unprotected. Modifying the command on line 6 allows the program to start looking at any point in memory.

0000  *Free Memory Allocation Routine
0001  * locates available unprotected memory
0002  *
0003  * coming in: D&E point to location
0004  * where results are to be stored
0005  *
0006  FMAR: LXI H,0 ;SET H & L TO 0000
0007  FMAR1: CALL LOOK ;LOOK FOR FIRST FREE LOCATION
0008  JZ REP1 ;FOUND IT, REPUBLIC IT
0009  FMAR2: CALL CHECK ;LOOK FOR END OF MEMORY
0010  JNZ FMAR1 ;NOT YET, LOOK SOME MORE
0011  # JMP EXEC ;END OF MEMORY, RETURN TO EXECUTIVE
0012  REP1: CALL REPOR ;REPORT FIRST FREE LOCATION
0013  FMAR3: CALL CHECK ;SEE IF AT END OF MEMORY
0014  JNZ FMAR2 ;NOT YET, CONTINUE LOOKING
0015  FMAR4: DCH H ;REPORT LAST LOCATION
0016  CALL REPOR ;AND USE CHECK TO EXIT
0017  JMP FMAR3 ;AND USE CHECK TO EXIT
0018  TRYON: CALL LOOK ;LOOK FOR A FREE LOCATION
0019  JZ FMAR1 ;NOT VALID, LOOK FOR START OF NEXT FREE MEMORY
0020  *
0021  LOOK: MOV C,M ;SAVE MEMORY IN REGISTER C
0022  MOV M,H ;WRITE H INTO MEMORY
0023  MOV A,M ;READ MEMORY INTO A
0024  CMP H ;SEE IF A AND H AGREE
0025  RNZ ;NO, NOT VALID MEMORY
0026  MOV M,L ;OK PASS 1, THIS TIME PUT IN L
0027  MOV A,M ;READ BACK INTO A
0028  MOV H,C ;PUT C BACK INTO MEMORY
0029  CMP L ;SEE IF A AND L AGREE
0030  RET ;RETURN WITH FLAGS SET
0031  *
0032  CHECK: SUB A ;SET A TO 0
0033  INX H ;INCREMENT H &L
0034  CMP H ;SEE IF H=0
0035  RNZ ;NOT YET, RETURN
0036  CMP L ;SEE IF =0
0037  RET ;AND RETURN
0038  *
0039  REPOR: MOV A,L ;GET THE LOW ADDRESS
0040  STAX D ;STORE WITH D&E POINTER
0041  DCX D ;DECREMENT POINTER
0042  MOV A,H ;GET HIGH ADDRESS
0043  STAX D ;STORE WITH D&E POINTER
0044  DCX D ;DECREMENT POINTER
0045  RET ;RETURN

The 5 byte code that does the same translation is as follows:

DAA
ADI 90H
ACI 40H

The latter assumes that the carry and the auxiliary carry are reset, which is the case in all applications that I could find of this translation.

Checkbook Balancing Routine

Loring C White
26 Boswell Rd
Reading MA 02119

Every month the bank statement arrives and we have to go through cancelled checks and the usual mathematical ritual to reconcile our figures with those of the bank. Here is some software the computer enthusiast can use to balance a checkbook. The program in listing 1 is written in MITS 8 K BASIC Revision 3.2 (used on my Altair 8800 computer). [Since the MITS 8 K BASIC language was written and implemented by the Microsoft Company, this same listing should work with minor changes on a number of computers besides the Altair. These include the Apple II with the "Applesoft" BASIC, the Radio Shack TRS-80 with Level II BASIC, and the Commodore PET computer. . . CH/ If you have printer or Teletype, you can get hard copy of all pertinent information for later references.

The program has the following features:

- The initial printout is a listing of all outstanding checks by check number, date and amount.
- A list of all cancelled checks as they are entered as well as a final summary list is given.
- A new, updated list of outstanding checks is provided to update the list of checks appearing in the data statements. Provision is made for this listing to be in data format so that it can be punched on tape to make the program update easier.
- The computer will search for each check listing as it is entered during the program run.
- Input statements are provided for entering the bank statement balance; service charge and deposits not entered on the statement.

5 Byte Hexadecimal to ASCII Converter

I was recently challenged by a colleague to find the most efficient 8080 code to translate hexadecimal 0 thru F (stored in the accumulator) into ASCII 0 thru 9 and A thru F (also in the accumulator). After I came up with a 5 byte translation, he showed me a well-published 6 byte translation (of which I was unaware) which is as follows:

<table>
<thead>
<tr>
<th>ASI</th>
<th>90H</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAA</td>
<td></td>
</tr>
<tr>
<td>ACI</td>
<td>40H</td>
</tr>
<tr>
<td>DAA</td>
<td></td>
</tr>
</tbody>
</table>

Ashwin L Doshi
5830 Green Valley Cir 105
Culver City CA 90230
Listing 1: Checkbook balancing routines for Microsoft (MITS) BASIC. The data statements contain data that will be checked.
• A final summary is provided giving the total of all outstanding checks, checkbook balance and the checks returned from the bank.

How It Works

To implement the program it is necessary to provide a list of all checks written by number, date, and amount in the data statements at the end of the program. When I first started writing the software I included the name of the company but later discovered that this information is not really needed.

The first data statement in the program of listing 1 is:

600 DATA 100, 12876, 18.75

The statement says that check number 100 was written on December 8, 1976 for the amount of $18.75. (I usually carry a number of blank checks in case I need to write a check. I always number this type of check with 100. At the end of the month I may have several checks with number 100 but this is no problem, because they are also identified with the date and amount.)

The computer, when searching for each check, looks for all three pieces of information before assuming that the check has been located. Listing each check on a separate line uses up more memory, but there are good reasons for doing this that become apparent when you run the program.

Using the Program

After all the checks are listed in the data statements, as shown in the program, you are ready to run the program. Take the cancelled checks you get from the bank and input the check number, date and amount the same way you entered the information in the data statements. Then hit carriage return. The program will search the data list for the check and deduct it from the balance, printing for example:

"CANCEL CHECK #: 100
DATE: 12876
AMOUNT: $18.75"

If the check is not located in the data, the computer types a question mark meaning that either the check isn't there or you have not entered the data correctly.

After all the checks have been entered, type 0,0,0 for the last check and hit carriage return. The computer will give you a complete list of all the cancelled checks just entered plus the total of all the outstanding checks. You will be asked to enter the bank statement balance and any deposits not shown and the service charge, if any. Using this information, the program calculates the balance in your checkbook. In this way you can reconcile your arithmetic with that of the bank.

Normally at this point it is necessary to change the data statement list by eliminating all the cancelled checks received from the bank. This would mean searching and typing some of the line numbers. When I developed the program I decided to let the program do this work, so you will be asked if you want an updated "data" list of the outstanding checks.

If you have a mass storage device, you can store the data statements. The program lists all the outstanding checks in the required data format, including new line numbers. The program can then be updated by entering the information back into the program. All data statement numbers not stored will have to be deleted by hand. This is now an easier job because these numbers are at the end of the program and no searching by the operator is required. Also, don't forget to deduct the service charges from your checkbook balance.

Before developing this software I used to dread receiving "that envelope" from the bank, but now I actually look forward to it in spite of the fact that it requires a bit of effort to enter the required information into the computer.

<table>
<thead>
<tr>
<th>List</th>
<th>Our Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>CROMEMCO 20% DISCOUNT</td>
<td></td>
</tr>
<tr>
<td>System III</td>
<td>5990</td>
</tr>
<tr>
<td>System II</td>
<td>3995</td>
</tr>
<tr>
<td>16K Ram</td>
<td>595</td>
</tr>
<tr>
<td>NORTH STAR 16% DISCOUNT</td>
<td></td>
</tr>
<tr>
<td>Horizan I-DD kit</td>
<td>1599</td>
</tr>
<tr>
<td>Horizan I-DD kit</td>
<td>1599</td>
</tr>
<tr>
<td>Horizan I-DD asm</td>
<td>1899</td>
</tr>
<tr>
<td>Horizan II-DD kit</td>
<td>1999</td>
</tr>
<tr>
<td>Horizan II-DD asm</td>
<td>2349</td>
</tr>
<tr>
<td>16K Ram kit</td>
<td>399</td>
</tr>
<tr>
<td>16K Ram asm</td>
<td>459</td>
</tr>
<tr>
<td>VECTOR GRAPHICS 20% DISCOUNT</td>
<td></td>
</tr>
<tr>
<td>Vector M 1 315k disk</td>
<td>874</td>
</tr>
<tr>
<td>Vector MZ 2 315k disks</td>
<td>1795</td>
</tr>
<tr>
<td>Intertube CRT</td>
<td>496</td>
</tr>
<tr>
<td>LA-36 DecWriter</td>
<td>799</td>
</tr>
<tr>
<td>Eicon Selectric Interface</td>
<td>949</td>
</tr>
<tr>
<td>Integral Data IP125</td>
<td>199</td>
</tr>
<tr>
<td>Integral Data IP225</td>
<td>199</td>
</tr>
<tr>
<td>Compu Cruise</td>
<td>5 % Discount</td>
</tr>
<tr>
<td>Radio Shack</td>
<td>5 % Discount</td>
</tr>
</tbody>
</table>
| Professional A/r, A/p, Ledger, Payroll, Medical Billing software with customization available. Send for our catalog — Some prices are too low to quote.

SARA TECH
COMPUTERS
P.O. Box 692
400 Base
Venice, FL
33595
(813) 485-3559

Circle 317 on inquiry card.
Attention Computer Dealers and Booksellers!

BITS Inc.'s ENTIRE BOOK INVENTORY AT WHOLESALE PRICES!

- More than 200 books to choose from
- More than 50 publishers represented
- Small press and self-published authors
- All books professionally reviewed
- Exclusive distributor for the BITS PROGRAMMER PAD™
- Immediate shipment
- 800 WATS line number for fast service
- We service world wide

Exclusive from the BOSS

Because the BOSS is concerned with the needs of your customer, the microcomputer user, we have developed the BITS PROGRAMMER PAD™ — an ingenious form custom tailored to the 8080A, 6800, Z-80, 1802, or 6502. Architecture is laid out with contiguous memory spaces to allow for critical memory allocations, data movement, tables, and stack manipulation.

The other side is for the program — with pre-numbered lines and columns for addresses, object codes, labels, instructions, and comments. BITS PROGRAMMER PADS™ are time-saving helpers for hand assembling programs.

Each 50 page pad is of durable stock that will hold up to erasures, and is punched for a 3 ring binder. Makes programs easy to write, use, and understand. Retail is $2.50 each pad.

See Your Dealer for the
BITS PROGRAMMER PAD™
A Peek at Poke

Users of TRS-80 Level II BASIC will find the POKE function handy for the occasional manual patching of object programs. However, it’s frustratingly slow and annoying to be forced into decimal notation. Listing 1 is a Level II BASIC program residing in upper limit statement numbers for a 16 K byte

```
65509 CLS: PRINTCHR$(14); L% = 32767
65510 GOSUB 65512
65511 POKE L% + 16016, L%: GOTO 65510
65512 GOSUB 65528
65513 IF A$ = "": THEN L% = L% + 1 ELSE GOTO 65522
65514 GOSUB 65528
65515 GOSUB 65529
65516 D% = A% * 4096
65517 GOSUB 65528
65518 GOSUB 65529
65519 D% = D% + A% * 256
65520 GOSUB 65528
65521 GOSUB 65529
65522 D% = 0
65523 GOSUB 65528
65524 D% = D% * A% + 16
65525 GOSUB 65528
65526 GOSUB 65529
65527 D% = D% * A% + 1 ELSE IF % = 0 THEN RETURN
65528 AS% = INKEY$: IF A$ = "": THEN 65528 ELSE 65529
65529 ELSE 10 THEN RETURN ELSE A% = 10 THEN 65528 ELSE 16 THEN RETURN ELSE STOP
```

Listing 1: Level II BASIC program for the TRS-80 which allows hexadecimal data to be loaded into memory.

```
10 X = 32 + RND(159): REM GET A RANDOM NO. BETWEEN 32 AND 191
20 FOR I = 0 TO 1023: POKE 15360 + I, X: NEXT I: REM FILL THE SCREEN
30 FOR I = 0 TO 1000: NEXT I: GOTO 10: REM WAIT AWHILE AND DO IT AGAIN
```

Listing 2: Example of a program to fill the screen of the TRS-80 with graphic characters.

```
ORG 16526D
DW START
ORG 32000D
DS 1
START: LXI H, 32000D
MOV C, M
INTO C
LXI H, 3000H
LXI D, 0400H
VIDEO DISPLAY STARTS HERE (HEX)
SIZE OF DISPLAY (HEX)
NXT: MOV M, C
LOAD THE DATA FOR DISPLAY
COUNT THE
JNZ EOK
REMAINING
DCR E
LOCATIONS IN
RTC
VIDEO DISPLAY
EOK: INX H
AND FILL THEM ALL
JMP NXT
WITH THE DATA
END
```

Listing 3: An assembly language program which can be called by the modified version of listing 2 to fill the screen quickly. Use the hexadecimal loader to put the object code of this program into memory.
TRS-80 system, which enables fast keyboard entry of hexadecimal code.

The starting address is entered as :HLLL followed by the successive data bytes, which may be spaced as appropriate for clarity in on-screen checking. An invalid character causes a return to the COMMAND mode. The following trivial example illustrates its use.

Example

The BASIC interpreter is too slow for dynamic graphics, as the program in listing 2 illustrates. Run it and see how slowly the screen loads. Now replace statement 20 by:

20 POKE32000, X:X=USR(0):
REM FILL THE SCREEN FASTER,

which calls the machine language subroutine in listing 3 to do the same job much faster. Insert the assembled object code using the hexadecimal loader, noting that memory size must now be less than 32000:

: 408E 017D
: 7D01 210074E21003C110004711DC2127D
C823C30B7D

Now run the program again.

Attention: Buffalo NY Apple II Owners

Gary Weir has written from Buffalo NY with information about a new Apple II users group in his area. Called the Apple Byters Corp, they are highly motivated to provide new owners of the Apple II with the help they may need to successfully program and utilize their investment. A booklet is currently being prepared combining insights and solutions to bugs previously encountered by the club's members. A copy and its updates are included in the $5 membership fee. Apple II owners or potential owners should contact Gary at 225 Walton Dr, Snyder NY 14226 concerning meeting times and locations.

Apple Bay Area Computer Users Society

ABACUS (Apple Bay Area Computer Users Society) meets the second Monday of each month at the Hayward BYTE Shop, 1129 B St, Hayward CA. They have an active membership of 40 and have developed a club library of 200 programs. They are negotiating to trade libraries with several other clubs. Membership is $12 a year which includes a monthly newsletter. Contact Ed Avelar, president, at (415) 583-2431 or David Wilkerson, secretary, at (415) 482-4175.

Mexican Computer Club

We have been notified of the existence of a Mexican computer club. Called the Microcomputer Club, this group is primarily concerned with the Apple II and OSI products. They are interested in exchanging information and experiences with other computer groups. Contact Alfredo Buzali, tte de Quijote #5, Mexico 10, D F or call 5-89-22-79 between 7 and 8 PM.

Central Alabama TRS-80 Computer Society

Several TRS-80 users in Montgomery AL have formed the Central Alabama TRS-80 Computer Society. They are planning a club library, a local newsletter and a club computer. Another aim is to provide each new member with a membership package which would contain magazine subscription blanks, addresses of hardware and software suppliers, and other information pertaining to the TRS-
80. The meetings are held on the third Tuesday of each month at various locations around Montgomery. Contact Walter F Bray, 2073 Rexford Rd, Montgomery AL 36116.

Newsletter for Sorcerer Owners

Orders are now being accepted for an independent user newsletter dedicated solely to the Exidy Sorcerer. The $15 subscription price includes all ten issues of volume one, and the first issue will be available around July 1st. The Source will include items of general interest to Sorcerer owners, such as program listings, how-to-do-it articles, and hardware and software reviews. Contact ARESCO, POB 1142, Columbia MD 21044.

Sorcerer Users Group

Computer Mart of Massachusetts has announced the formation of the Sorcerer Users Group. The purpose of the group is to set up a channel of communication between Sorcerer owners and to provide information on hardware and software developments to the Sorcerer user. The group has a membership of about 30 people. The $5 membership fee includes the monthly newsletter, The Exidy Monitor. Contact Computer Mart of Massachusetts Inc, 1395 Main St, Waltham MA 02154.

North American Computer Association

The North American Computer Association (NACA) recently began its third year with a membership of approximately 20 independent businessmen in the computing systems field. One of the objectives of the organization is to increase the efficiency of each member's individual organization by pooling all the different programming developments and the selling and servicing techniques used by the various members. NACA meets once a month in Dallas TX, and interested businessmen are welcome to attend. Contact Tom Crites, Suite 811, 1001 Main St, Lubbock TX 79401.

Small Computer Users Join England's Central Program Exchange

The Central Program Exchange (CPE) at The Polytechnic, Wolverhampton, is opening its doors to users of small computers in an effort to coordinate the free interchange of programming. The Exchange has 72 members, and currently holds a library of over 200 programs in BASIC, FORTRAN and ALGOL. Individual members can obtain CPE services for $10 per year. This entitles members to a catalogue, newsletter and up to ten CPE programs as listings or paper tapes. As the personal element expands, CPE also proposes to offer cassette versions at a small extra charge. Contact Dr G Beech, Central Program Exchange, Dept of Computing and Mathematical Sciences, The Polytechnic, Wolverhampton, ENGLAND WV1 1LY.

Software Magazine for Microcomputers

The Software Exchange magazine provides information about the latest software that has been developed. Included are reviews, abstracts and articles about software for today's microcomputers. The Software Exchange is published bimonthly. Subscriptions are $14.95 per year in the US, Canada and Mexico. International subscriptions are $19. Contact The Software Exchange, POB 55056, Valencia CA 91355.

Free Newsletter Features Computer Product Marketing Information

Crossroads is a free periodic newsletter which highlights tools and techniques in selling software, data services and turnkey systems. Crossroads provides helpful hints, insights to trends, results of experiments and generally, the successes and failures associated with development, sale and support of computer based products. Contact Editor, Crossroads, Cross Associates, Suite 830, 9000 Keystone Crossing, Indianapolis IN 46240.

6800 Users Newsletter

The Chicago Area 6800 Users Newsletter is a monthly publication aimed at providing information and assistance to those users of the 6800 microprocessor. For further information, contact Phillip Schuman, 1354 Finley, Lombard IL 60148.

A Computer by Any Other Name

A typographical error in "Build a Computer Controlled Security System for Your Home: Part 3" by Steve Ciarcia (March 1979 BYTE, page 150) may have caused some head scratching among our readers. The caption for figure 1 contained the following sentence: "Op amp IC2 is used as a computer to convert the output accordingly." The sentence should have read as follows: "Op amp IC2 is used as a computer to convert the output accordingly..." Mr. Ciarcia did not attempt to construct his circuit using a programmable op amp.
PET WORD PROCESSOR

This program permits composing and printing letters, flyers, advertisements, manuscripts, etc., using the COMMODORE PET and a printer. Script directives include line length, left margin, centering, and skip. Edit commands allow the user to insert lines, delete lines, move lines and paragraphs, change strings, save onto cassette, load from cassette, move up, move down, print and type. The CmC Word Processor Program addresses an RS-232 printer through a CmC printer adapter. The CmC Word Processor program is available for $29.50. Add $1.00 for postage and handling per order.

Order direct or contact your local computer store.

C/PM SOFTWARE TOOLS

ED-80 TEXT EDITOR

THE PROGRAMMER’S MOST IMPORTANT SOFTWARE TOOL

— WHY NOT MAKE IT YOUR BEST?

ED-80 encompasses the features found on large mainframe and minicomputer editors, such as the IBM 370, CDC 1100, UNIVAC 1100, and the DEC PDP-11 series computers, plus special features designed for 8080-based operating systems. ED-80 provides a context editor which is compatible with C/PM and its derivatives, including IMDOS, DOS-A, DOE, etc.

Over 50 commands are provided, including forward or backward LOCATE, CHANGE, and FIND commands; INSERT, DELETE, REPLACE, APPEND, PRINT, LIST, MACRO, and other editor commands. Once defined, they may be subsequently executed, or recalled for iterative execution of concatenated commands. Line numbers are dynamically generated at any point in a macro.

The WINDOW command allows instantaneous full screen displays of both the current and surrounding lines for further editing, and provides forward and backward scrolling in the full screen mode. Designed for today’s high speed CRT’s and video monitors, the WINDOW command separates ED-80 from all other available editors, and is not hardware dependent.

Up to three MACRO commands may be defined for iterative execution of concatenated editor commands. Once defined, they may be subsequently executed, or recalled for observation. A MACRO may consist of a single operation, configuration parameters for tailoring the editor to the user’s keyboard and environment are provided through the use of the C/PM Dynamic Debug Tool (DDT). The WINDOW command separates ED-80 from all other available editors, and is not hardware dependent.

A CURRENT LINE NUMBER is internally maintained by the editor for displaying when prompting for input and with certain other commands. Line numbers are dynamically adjusted as the result of line inserts and deletes, and may be used for positioning within the file. They are not stored or associated with the text in any manner.

ED-80 is thoroughly documented with a User’s Manual of over 35 pages describing each command and feature, and includes numerous examples. It is a 9.5K byte program and requires only an 8K byte core and a minimum C/PM operating system of 20K is recommended. A User’s Manual and standard size single density diskette are $69.00. A User’s Manual is $7.50, refundable with purchase. A COP and money orders are shipped next day. COP orders require 10% deposit. Personal checks must clear before shipping. Include $2.00 shipping/handling per order.

SOFTWARE DEVELOPMENT AND TRAINING, INC.
P. O. Box 4511
Huntsville, Alabama 35802

C/PM® is a trademark of Digital Research.
Comments on "A High Level Language for 8 Bit Machines"

Glen Newton
Sperry-Univac
Roseville MN 55113

"A High Level Language for 8 Bit Machines," by Ted Williams and Steve Conley (July 1978 BYTE, page 152) discusses the interpreter for a simple language. If we take the language as given and ignore minor errors in the examples and flowcharts (such as pushing a variable "near operand stack" rather than onto it), several substantial errors remain.

First, evaluation is claimed to start "in the innermost parentheses." Following the flowchart in figure 2 or table 2 or the example in listing 3 shows that this is not true, despite the incorrect annotation accompanying listing 3. Expressions are evaluated from left to right until parentheses are encountered. In order for evaluation to begin within the innermost parentheses, in the language described in the article, each binary operator except the last would have to be followed by a left parenthesis. Since the programmer cannot define his own functions, the result of evaluation will be the same as if evaluation had begun in the innermost parentheses if the language's intrinsic functions have no side effects.

Second, the claim that although interpretation provides some advantages, "the price paid for this feature is memory" is misleading. The combination of source code,
Circle 183 on inquiry card.

**DP SUPPLIES?**

**Key Can Do!**

**FLOPPY DISKS**

- Standard or Mini ........ 2.98 ea.
- Memorex ................ 4.50 ea.
- 32 Hard Sector (Shugart) .... 2.96 ea.
- Micom Preformatted .......... 7.50 ea. (Min. order: 100 ea.)
- Dual Density .............. 4.25 ea.
- Dual Sided ............... 5.50 ea. (Order in units of 20)

**DIGITAL CASSETTES**

- TRS-80 (15 min.) ........ 1.49 ea.
- ANSI (Notch) .............. 4.90 ea.

**RIBBONS**

- Blue & Brown Ribbons ......... 32.95 doz.
- Qume or IBM 6240 Type .......... 29.95 doz. (New high quality)

**TERMS:** First-time customers send check with order to avoid credit check delay. VISA/Master Charge accepted.

ORDER NOW FROM

JOHN RICHARDS

KEY SUPPLY CO.

2101 S. IH 35, Suite 300
Aust in , TX 78741 (512) 443-1347

All products from major manufacturers fully guaranteed. No limit while quantities last.

---

**HARD DISC FOR $100 MICROs**

The XCOMP DCF-10 Disc Controller provides the OEM with a high performance, low cost interface for fixed and removable (2315 or 5440) cartridge disc drives. The DCF-10 is currently supported by two operating systems. For information or manuals, contact XCOMP.

---

**OMSI PASCAL™**

Reliable, efficient, production Pascal compiler for the DEC PDP-ll family, including the LS-ll.

**Full Language**

All elements of Standard Pascal, including the capabilities not found in student Pascal. Extensions for complete low-level control with direct memory and I/O device access, embedded assembler code, FORTRAN procedure interface.

**Production**

Integrated with DEC operating systems (RSTS/E, RT11, RSX, IAS). Compatible with existing file structures, editors, and utilities. Interactive symbolic Debugger with breakpoints and full trace.

**Performance**

Fast one-pass compiler runs in 16K words (32KB), translates thousands of lines per minute. Produces compact PDP-ll code that runs circles around interpretive or threaded languages.

**Proof**

In production use since 1975 — now at more than 300 customer sites. Warranted for 1 year after purchase.

Write for information, demonstration, manuals, and benchmark.

---

**BYTE BACK ISSUES FOR SALE**

The following issues are available:


Cover price for each issue thru August '77 is $1.50 plus 25¢ postage and handling ($3.50 total foreign).

- September '77 thru '79 issues are $2.00 plus 50¢ postage and handling ($4.00 total foreign).

Send requests with payment to:

BYTE Publications
70 Main St.
Peterborough
NH 03458

Attn: Back Issues

---

Circle 392 on inquiry card.
A landmark book by John L. Stewart, with technical information never before available. Based on years of research with partial support through the original Air Force Bionics program of the 1960's.

Now you can understand and build devices that behave like the human ear—or a thing called "Hal".

- Speech recognition for the robot
- Aids for the deaf and deaf-blind
- Reliable voice control
- Speech bandwidth compression
- Speech security
- Binaural localization
- Bat-like echoranging
- Sonar target recognition
- Control of animals with sounds
- Language training
- Speech enhancements
- and much, much more . . .

Hardware representations give new understanding of man—not only how, but also why the ear works as it does.

A far-reaching new theory—complete—sophisticated—powerful—destined to influence not only computers, but also concepts in physiology for decades to come.

Hardware representations give new understanding of man—not only how, but also why the ear works as it does.

A far-reaching new theory—complete—sophisticated—powerful—destined to influence not only computers, but also concepts in physiology for decades to come.

Fourth, the authors claim that "the lack of statement labels excludes the possibility of errors caused by not nesting DO loops within each other (which is possible in a language like FORTRAN)." In fact, the possibility exists; just take any appropriate FORTRAN nonnested, overlapping DO loop example and remove the statement numbers to see how the error is possible. The difference is that with statement numbers or labels the compiler or interpreter would have sufficient information to detect the error; without them the error must go undetected because the resulting program is syntactically correct.
Fifth, like the factorial function which is presented to illustrate recursion in programming primers, the use of recursion to find matching ENDIFs during interpretation is unnecessary overkill. The nonrecursive use of an "unmatched IF" counter is adequate and conceptually simple. Furthermore, it avoids the problem that "care must be taken in allocating and preserving local data within SEARCH during recursion."

Finally, although APL, like the language presented in the article, does not use operator precedence within expressions, APL expressions are evaluated from right to left, not left to right. Furthermore, APL has numerous nonstandard operators, providing some justification for its no precedence evaluation; in contrast, the language presented has only standard arithmetic operations plus functions. Thus the claim that the use of precedence in this language would lead to confusion is probably unfounded. Probably the best justification for the decision to have no precedence is that it simplifies implementation somewhat. However, the authors' claim that "this procedure minimizes the size of the stack" is incorrect, as shown by example 2. The FORTRAN expression \( A - B \cdot C \) requires parentheses to be expressed in a precedenceless language. The parentheses, in turn, require an extra level on the operator stack (in general, one for each level of nesting). Example 2 shows that a precedenceless language can, for some expressions, require more, not less, stack space than a language using precedence.

<table>
<thead>
<tr>
<th>Language</th>
<th>Expression</th>
<th>Operator Stack (Maximum)</th>
<th>Operand Stack (Maximum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FORTRAN</td>
<td>( A - B \cdot C )</td>
<td>( - ) ( * )</td>
<td>( C ) ( B ) ( A )</td>
</tr>
<tr>
<td>precedence-less</td>
<td>( A - (B \cdot C) )</td>
<td>( - ) ( - ) ( * )</td>
<td>( C ) ( B ) ( A )</td>
</tr>
</tbody>
</table>

Example 2: Stack size comparison.

---

**Special Offer**

Now you can have a good laugh on us! That's right. If you buy Calculating with BASIC now, you'll get our hilarious book, Take My Computer... Please! at 1/2 price — that's $3 off, on us! And you'll be sure to laugh. With SCELBI's BASIC routines working in your computer, you'll have plenty of time to enjoy the knee-slapping humor of Take My Computer... Please! Order now. That's Calculating with BASIC for only $7.95; Take My Computer... Please! just $2.95 additional (sold separately for $5.95).

Calculating with BASIC

Here's a variety of programs in BASIC language to help the student, scientist, engineer, technician or hobbyist apply the language to practical problems. Covers mathematics, finance and statistics, mechanical engineering and electronics. For fun between such serious applications, Hangman and Space Capture games.

Special offer, both books $10.90 • No. 32 Cal/BASIC only $7.95 • No. 30

---

**Personal Information Management System**

Plain talk on what a computer can do for you. How to use a computer without knowledge of programming. 15 examples include personal mailing list, accounts payable — even an intelligent ham radio log. For the TRS-80, PET and others. $9.95 • No. 10
In my experience (at the Bronx High School of Science and at home with my own 6502 system) the most enjoyable part of computing is the coding of algorithms. I know several languages, and I find some beauty in almost every language. The languages I know are BASIC, FORTRAN, LISP, APL, PL/I, and SNOBOL4. BASIC has simplicity, FORTRAN has the virtue of speed (FORTRAN compilers have developed quite a bit over the years), LISP has a straightforwardness unparalleled in most other languages; PL/I has the virtue of strong structure, and while I know almost no Pascal, it is obvious that it, too, shares this virtue. APL has sheer array processing power and great elegance with its implicit looping and other simplifying features. And, finally, I get to SNOBOL4, by far my favorite.

I feel that SNOBOL4 is one of the most powerful languages in existence. Like APL, it is loaded with elegance and implicit looping, and, also like APL, it lacks the standard structures for repetition of BASIC, FORTRAN, PL/I, and Pascal such as the FOR-TO or DO loops. These structures are not needed as much in SNOBOL4 programs. In addition, the language is powerful enough to permit user defined functions which are implementations of these structures. An example of the powerful implicit looping coupled with some explicit looping is the following statement, which will (in the full scan mode) permute the characters in the string $S$ so that they are in increasing lexical order. This is useful in certain applications which involve set operations:

```
LEX_ORD S LEN($S) $A LEN($S) $B
*LGT (A,B) = B A :S(LEX_ORD)
```

SNOBOL4’s major feature is its dexterity with string manipulation, particularly the operation of pattern matching (ie: the language is good at scanning strings; looking for patterns; and processing them when found). But in addition to these capabilities, SNOBOL4 yields considerable power with respect to data manipulation. I know of no other language (not even APL, which specializes in array manipulation) that allows an array to have an integer in one element, a real number in the next, a string in the next, another array in another, itself in still another, etc. One may put any datatype into anything, and one may also create user defined datatypes if desired. The reaction of some people to all this is indifference, but they are missing the point; the best part is knowing you can do it. Besides, one of the most important applications of a language of SNOBOL4’s string processing capabilities is implementation of experimental languages, and with these other abilities, one may create all sorts of arbitrarily complex languages.

While all these abilities may seem confusing at this time, when they are fully understood they are simple to use and the good programmer will soon master them. Opponents to the language say they feel that the language’s power invites unstruc-
tured programming because facilities such as run-time symbol tables and run-time SNOBOL-4 code compilation are easy powers to get carried away with. But if programmers take the time and care to know the language they are programming in, they will be in full control. It is possible to create well-structured functions which even redefine themselves during execution. This can simplify a program considerably, but it must be done carefully or the program will be an undebuggable mess.

I recently wrote a function in SNOBOL-4 that takes the inner product of arrays of arbitrary dimensions—that is, of any size and any number of dimensions. In APL, this function is a primitive (built-in) function, but I challenge anyone to produce the same in BASIC, FORTRAN, or PL/I. Like APL's generalized inner product, my function allows any two operations to be utilized in the formation of the product array. The definition in SNOBOL-4 is easily followed. Upon call, the function goes through some initialization, then redefines itself and calls itself recursively for each dimension of the involved arrays. In this manner, it is evident that the function will work as well for multidimensional arrays as for vectors, and verifying it for vectors is very easily done. This function is a good example of the freedom with which SNOBOL-4 processes all sorts of datatypes.

I cannot deny that SNOBOL-4's powers may be easily abused, so I must warn that it is a language only for programmers who can discipline their own thinking and don't need a computer language to force them to do so. For those people, SNOBOL-4 will perform amazingly well.

SNOBOL-4 has remained a language found only in large batch computers for too long. It is time to introduce it to the personal computer enthusiast, who can use its great powers to his or her own ends. (It has been found that SNOBOL-4 is extremely good for game programming.) And so, any fellow BYTE reader who knows and loves SNOBOL-4, please join me in my crusade for SNOBOL-4 on microcomputers. I am aware of the fact that there are real reasons why SNOBOL-4 has thus far run only on large computers, but these troubles must be overcome. I also hope I have sparked interest in any potential SNOBOL-4 users reading this. If what I have described intrigues you, look into the language. You won't be sorry.
Random Comments

David Thornley
2600 Bryant Av S, #205
Minneapolis MN 55408

In the September 1978 BYTE ("Letters," page 17), Scott Johnson inquired about the production of random numbers, particularly hardware-generated ones. The first and foremost consideration in generating and using random numbers is to access Donald E Knuth's *The Art of Computer Programming: Volume 2, Seminumerical Algorithms*. Most of what I am going to say is derived from there.

First, beware of assuming that a process, whether hardware or software, produces random numbers simply because the process by which it produces numbers is incompletely understood. If you wish to use such a source, test the results for randomness using every test you can think of. There are many good ones in Knuth's book. The Z-80 refresh register, by the way, can be a good source for one random number, but is not recommended for more than one. As far as I can tell, the refresh counter is incremented every time an instruction fetch occurs, which makes it rather deterministic, although if a variable delay is imposed (such as waiting for an entry from the keyboard) it could be used.

For outside randomness, just look around you. Plug your computer into your stereo receiver, set the selector to AM, find a frequency away from any broadcasts, and fiddle with the volume until you get random bits from the static. (To even out the distribution of low and high bits, take the transitions from low to high and high to low as your bit input — in other words, take 2 bit signals, throw out 00 or 11, and treat 01 as 0 and 10 as 1.) This may or may not work, but if it does work it is a quick way to randomness. Give some thought to encouraging noise in the system. Read random numbers off the cassette of your favorite rock group... be creative.

For those, like myself, who know something about programming but are lost with hardware, this formula is taken from Knuth's book cited above:

\[ X_{n+1} = (a \times X_n + c) \mod M \]

where M is the word size you are using (probably hexadecimal 10000), a is between hexadecimal 300 and 7C00, and has 5 or D as its last digit, and c is odd and somewhere in the neighborhood of hexadecimal 3800. The calculation must be performed exactly, which is much easier in assembler than in BASIC; in the former, one merely disregards the inevitable overflow. Starting with \( X_0 \) at any initial value, this will give a long series of good pseudorandom numbers.

Finally, for people with RND functions, here are several tips: Generating random numbers until the user hits the BREAK key (or otherwise inputs something) is a great way to get a random seed as long as the system does not somehow reinitialize the seed before the program uses the random numbers. Or, to make an intrinsically questionable generator work, throw out a random number of numbers as follows:

\[
\begin{align*}
&\text{LET } J = \text{INT}(10 \times \text{RND}(0) + 1) \\
&\text{FOR } I = 1 \text{ TO } J \\
&\text{LET } X = \text{RND}(0) \\
&\text{NEXT } I
\end{align*}
\]

This would fit well in a program as a subroutine, to be called whenever a random number was desired.

I hope this information will be of use to some people.
June 2, University of Wisconsin — Parkside Computer Fair III, Kenosha WI. Contact Don Pleit, UW-P Computer Fair III, University of Wisconsin-Parkside, Kenosha WI 53141.

June 3-6, 1979 International Summer Consumer Electronics Show, McCormick Place, Chicago IL. This show serves as the marketplace for the entire consumer electronics industry. Contact Consumer Electronics Show, 2 Illinois Center, Suite 1607, 233 N Michigan Av, Chicago IL 60601.

June 4-5, Computer Cryptography, Massachusetts Institute of Technology, Cambridge MA. Instruction in the Data Encryption Standard and the new public key cryptographic systems will introduce a working knowledge of the use of cryptography in computer applications. Managers and operators of computer systems will also become acquainted with economic and implementation issues as well as techniques for using this new science in communication networks. Contact MIT, Center for Advanced Engineering Study, Cambridge MA 02139.

June 4-6, Laser Beam Information Systems, New York NY. This seminar will cover the application of laser technology to image and data manipulation in the form of scanning, transmission and reproduction. It will lead the student through the principles and practices of laser beam information systems in preparation for direct application to such fields as facsimile, computer memory and display, target identification, reconnaissance, photo composition, and image manipulation. Contact The University of Chicago, Center For Continuing Education, 1307 E 60th St, Chicago IL 60637.

June 4-7, 1979 National Computer Conference, New York Coliseum, New York NY. NCC '79 will feature a premier showcase of the state of the art in computing and data processing. Leading organizations, large and small, will show the latest equipment and services in approximately 1500 booths. More than 100 program sessions are planned, emphasizing the four major areas of management, applications, science and technology, and social implications. In conjunction with NCC '79, a Personal Computing Festival of commercial exhibits, application demonstrations, and technical sessions on microcomputer systems and applications will be held at the Americana Hotel. Contact NCC '79, c/o American Federation of Information Processing Societies Inc, 210 Summit Av, Montvale NJ 07645.
June 6-8, Twelfth Annual Association of Small College Computer Users in Education Conference, Denison University, Granville OH. Sessions will include the presentation of papers, demonstrations of the educational use of microcomputers, computer text book surveys, discussions with authors of computer texts, administrative uses of computers in small colleges, and a tutorial on microprocessors. Contact Douglas Hughes, Computer Center, Denison University, Granville OH 43055, (614) 587-0810.

June 6-8, Eighth Annual Conference of the MUMPS Users Group, Marriott Hotel, Atlanta GA. Papers will be presented on all aspects of MUMPS development, implementation, and use. Contact Judith Faulkner, Program Committee, Department of Psychiatry, Clinical Sciences Ctr, 600 Highland Av, Madison WI 53792.

June 6-8, Computer Contract Negotiation, New York NY. This three day course is designed to give participants sound answers to the complex ramifications of preparing and negotiating computer contracts. Contact Brandon Consulting Group Inc, 505 Park Av, New York NY 10022.

June 11-13, Minicomputers and Distributed Processing, Chicago IL. This seminar will examine the uses, economics, programming, and implementation of minicomputers. Contact The University of Chicago, Center For Continuing Education, 1307 E 60th St, Chicago IL 60637.

June 13-15, Computer Applications in Industry, Grenoble FRANCE. This symposium is intended as a forum for the discussion of recent advances in the applications of computers to industrial processes. The symposium will cover basic problems in computer science as related to industrial applications. Contact ALPES Congres, Avenue d'Innsbruck, 38029, Grenoble-Cedex, FRANCE.

June 19-21, International Microcomputers/Minicomputers/Microprocessors '79, Palais des Expositions, Geneva SWITZERLAND. Focusing on the changing state of the art in mini/microcomputers and microprocessors, the 1979 conference program will probe advances in systems and equipment with emphasis on practical applications and uses of minicomputers and microcomputers as well as the techniques important to their development.

June 19-23, First Annual Meeting of The American Association of Physics Teachers, New Mexico State University, Las Cruces, NM. The theme of this meeting will be the use of microcomputers in physics teaching. Contact American Association of Physics Teachers, Graduate Physics Building, SUNY at Stony Brook, Stony Brook NY 11794.


June 25-26, Forum on Information Resource Management, Drake Hotel, Chicago IL. Addressing the theme: "Information Resource Management in the Years of Change," the forum will provide an outlook for the next decade in terms of information systems technology. Contact Ken Burroughs, DBS Systems, 1500 N Bearegard St, Alexandria VA 22311.

June 25-29, Applied Numerical Methods, The University of Michigan, Ann Arbor MI. This course is intended for individuals in industry and branches of the government who wish to acquire a working knowledge of fundamental numerical methods. Emphasis will be placed on computer solutions to practical engineering and scientific problems. Contact Engineering Summer Conferences, 400 Chrysler Ctr, North Campus, The University of Michigan, Ann Arbor MI 48199.

June 27-29, Data Processing Operations Management, Toronto Canada. This seminar will emphasize the management skill and techniques applicable to the data processing operations function. Contact The University of Chicago, Center For Continuing Education, 1307 E 60th St, Chicago IL 60637.

June 27-29, Machine Processing of Remotely Sensed Data, Purdue University, W Lafayette IN. The symposium will focus upon the theory, implementation and novel applications of machine processing of remotely sensed data. Contact Purdue University, Laboratory for Applications of Remote Sensing, 1220 Pattier Dr, W Lafayette IN 47906.

July 9-20, Computing Systems Reliability, University of California, Santa Cruz CA. Contact Institute in Computer Science, University of California Extension, Santa Cruz CA 95064.

July 11-13, Microcomputer Applications, Southern Technical Institute, Marietta GA. See August 13 for description. Contact Dr Richard L Castelluccis, Southern Technical Institute, Electrical Engineering Technology Dept, 534 Clay St, Marietta GA 30060.

July 16-27, Introduction to Digital Electronics and Microcomputer Interfacing, Lexington VA. This hands-on laboratory course is for academic and industrial personnel. There will be approximately 50 hours of laboratory instruction with one microcomputer laboratory station for each two participants. Contact Prof Philip Peters, Dept of Physics, Virginia Military Institute, Lexington VA 24450.

July 19-20, BASIC: A Computer Language For Executives, New York NY. Executive computing will be discussed, including problem solving, planning, forecasting and database systems. Also to be covered are programming fundamentals, the mindless computer, sequence, decision and iteration, computer languages and BASIC. Contact American Management Associations, 135 W 50th St, New York NY 10020.

July 23-27, Finite Element Method In Mechanical Design, The University of Michigan, Ann Arbor MI. This course is intended for engineers working in mechanical design where knowledge of stresses, displacements, or vibratory motion is important. No previous experience with finite elements is assumed. The course will familiarize the attendee with finite element modeling concepts and will review the fundamentals on which the method is based. Contact Engineering Summer Conferences, 400 Chrysler Ctr, North Campus, The University of Michigan, Ann Arbor MI 48109.

August 1-3, Microcomputer Applications, Southern Technical Institute, Marietta GA. The emphasis of this seminar will be on the applications of microcomputers in industry. Software, hardware and interfacing techniques will be discussed. Contact Dr Richard L Castelluccis, Southern Technical Institute, Electrical Engineering Technology Dept, 534 Clay St, Marietta GA 30060.

August 6-8, Pattern Recognition and Image Processing, Hyatt Regency O'Hare, Chicago IL. This conference is sponsored by the Machine Intelligence and Pattern Analysis Committee of the IEEE Computer Society. The program will consist of submitted and invited papers and a large trade show of graphics and image processing equipment. Contact FRIP 79, P0B 639, Silver Spring MD 20901.

August 8-10, SIGPLAN Symposium on Compiler Construction, Boulder CO. This symposium will consider methods of constructing compilers and experiences with them. The emphasis will be less on theoretical methods and more on techniques applied to real compilers. Contact Prof Leon Osterweil, Dept of Computer Science, University of Colorado, Boulder CO 80309.

August 8-10, First Annual Conference on Research and Development in Personal Computing, Hyatt Regency O'Hare, Chicago IL. This conference is sponsored by the Association for Computing Machinery (ACM) Special Interest Group on Personal Computing (SIGPC). A large trade show of personal computer and graphics equipment is planned.
accompany an assortment of papers, panels, user group meetings, workshops, and person to person poster booths. Contact Bob Gammill, Computer Science Div, Dept of Mathematical Sciences, 300 Minard Hall, North Dakota State University, Fargo ND 58102.

August 13-15, Conference on Simulation, Measurement and Modeling of Computer Systems, Boulder CO. This conference will feature performance prediction techniques employed during the design, procurement and maintenance of computer systems. It will provide a forum for both applied and theoretical work in the disciplines of performance monitoring, modeling, and simulation of computer systems. Contact Gary Nutt, Xerox PARC, 3333 Coyote Hill Rd, Palo Alto CA 94304.

August 13-16, Q-GERT Network Modeling and Analysis, Ramada Inn, Lafayette IN 47905. This course will provide the attendee with the information necessary to model complex systems using Q-GERT. Emphasis will be placed on the procedures for modeling and analysis. Contact Pritsker and Associates Inc, POB 2413, W Lafayette IN 47906.

August 13-17, High Speed Computation: Vector Processing, The University of Michigan, Ann Arbor MI. In this course, the architectural, software, and algorithmic issues of vector architecture are coordinated through the discussion of concepts in computation, computer architecture, and by detailed study of current vector processors and their use. Contact Engineering Summer Conferences, 400 Chrysler Ctr, North Campus, The University of Michigan, Ann Arbor MI 48109.

August 19-22, International Conference on Computing in the Humanities, Dartmouth College, Hanover NH. This conference is intended to foster computer research and technique in all areas of humanistic study, to promote international cooperation in the development of digitized on-line data banks, and to make the results of research available. The program will include a plenary session each evening and shorter sessions during the day. Contact Stephen V F Waite, Kiewit Computation Ctr, Dartmouth College, Hanover NH 03755.

In order to gain optimum coverage of your organization's computer conferences, seminars, workshops, courses, etc. notice should reach our office at least three months in advance of the date of the event. Entries should be sent to: Event Queue, BYTE Publications, 70 Main St, Peterborough NH 03458. Each month we publish the current contents of the queue for the month of the cover date and the two following calendar months. Thus a given event may appear as many as three times in this section if it is sent to us far enough in advance.
The Sixth Colloquium on Microwave Communications was held in Budapest between August 29 and September 1, 1978. The organization was undertaken by the Scientific Society for Telecommunications and the Research Institute for Telecommunication of Hungary by sponsorship of the International Union of Radio Sciences and the Hungarian Academy of Sciences. The following principal subjects were on the agenda of the meeting: communication systems – trends and foundations; circuit theory and computer aided design; electromagnetic fields and antennas; microwave circuits and devices; and materials for microwave applications. The proceedings containing all papers have been issued in two volumes of 944 pages in English, and are available at a price of $30 plus postage. Contact OMKDK Technoinform, Budapest, VIII Reviczky u 6 HUNGARY.

Fourth European Conference on Electrotechnics Announcement and Call for Papers

The fourth European Conference on Electrotechnics, EUROCON '80, will be held in Stuttgart, Germany on March 24 thru 28, 1980. The conference theme is "From Electronics to Microelectronics – Trends and Applications." Key professionals and industry leaders will provide a comprehensive overview as well as reports on the latest developments in this area. The conference will feature presentations on fundamental and applied research, and provide a forum for discussion of the latest developments in the field of telecommunication. The conference will be held in Munich, Germany on October 6-9, 1980. The conference theme is "From Electronics to Microelectronics – Trends and Applications." Key professionals and industry leaders will provide a comprehensive overview as well as reports on the latest developments in this area. The conference will feature presentations on fundamental and applied research, and provide a forum for discussion of the latest developments in the field of telecommunication.

IEEE Conferences and Meetings

An extensive listing of IEEE Computer Society sponsored conferences and meetings through 1981 is available by contacting Harry Hayman, Executive Secretary IEEE, BOB 639, Silver Spring MD 20901.

More Cryptographic Notes

 Anyone looking for an in-depth article on data encryption should read two papers brought to our attention by William Flynn. One is a reprint of an article by Ehrsam et al which appeared in the IBM Systems Journal, Volume 17, Number 2, entitled "A Cryptographic Management Scheme for Implementing the Data Encryption Standard." The cost is $0.95 for each reprint. The second paper is "FIPS Publication 1980." It is available from the US Department of Commerce, National Technical Information Service, 5285 Port Royal Rd, Springfield VA 22161, at a cost of $1.75 for a paper copy or the fiche.

NEW FROM MOUNTAIN HARDWARE.
THE APPLE CLOCK.

New utility for your computer.

Now, there's a real time clock for the Apple II*: the Apple Clock from Mountain Hardware.

It keeps time and date in 1mS increments for one year. On-board battery backup keeps the clock running in the event of power outage. Easy to use with BASIC using routines carried in on-board ROM. That means you can time events, put time and date on printouts, create games in which elapsed time is important...and many more. Mountain Hardware offers a complete line of peripheral products for many fine computers.

Available at your dealer's now.

Mountain Hardware, Inc.
300 Harvey West Blvd.
Santa Cruz, CA 95060 (408) 429-8600

*Apple II is a trademark of Apple Computer, Inc.

Call for Papers: The Eighth World Computer Congress

The Eighth World Computer Congress (IFIP '80), sponsored by the International Federation for Information Processing (IFIP) will be held in Tokyo, Japan on October 6 thru 9, 1980 and in Melbourne, Australia on October 14 thru 17, 1980. The Congress will feature presentations on state-of-the-art developments in technology, equipment, and applications prepared by information processing professionals from around the world. In order to identify and schedule these speakers and topics, the Program Committee has recently issued a formal call for papers. Those papers accepted will be delivered in either Tokyo or Melbourne, and in some cases at both locations. Potential authors should contact AFIPS, 210 Summit Av., Montvale, NJ 07645 to receive a copy of a brochure which explains all requirements and necessary qualifications.

The Sixth Colloquium on Microwave Communications Offers Proceedings

The Sixth Colloquium on Microwave Communications was held in Budapest between August 29 and September 1, 1978. The organization was undertaken by the Scientific Society for Telecommunication and the Research Institute for Telecommunication of Hungary by sponsorship of the International Union of Radio Sciences and the Hungarian Academy of Sciences. The following principal subjects were on the agenda of the meeting: communication systems – trends and foundations; circuit theory and computer aided design; electromagnetic fields and antennas; microwave circuits and devices; and materials for microwave applications. The proceedings containing all papers have been issued in two volumes of 944 pages in English, and are available at a price of $30 plus postage. Contact OMKDK Technoinform, Budapest, VIII Reviczky u 6 HUNGARY.

Fourth European Conference on Electrotechnics Announcement and Call for Papers

The fourth European Conference on Electrotechnics, EUROCON '80, will be held in Stuttgart, Germany on March 24 thru 28, 1980. The conference theme is "From Electronics to Microelectronics – Trends and Applications." Key professionals and industry leaders will provide a comprehensive overview as well as reports on the latest developments in this area. The conference will feature presentations on fundamental and applied research, and provide a forum for discussion of the latest developments in the field of telecommunication. The conference will be held in Munich, Germany on October 6-9, 1980. The conference theme is "From Electronics to Microelectronics – Trends and Applications." Key professionals and industry leaders will provide a comprehensive overview as well as reports on the latest developments in this area. The conference will feature presentations on fundamental and applied research, and provide a forum for discussion of the latest developments in the field of telecommunication.

IEEE Conferences and Meetings

An extensive listing of IEEE Computer Society sponsored conferences and meetings through 1981 is available by contacting Harry Hayman, Executive Secretary IEEE, BOB 639, Silver Spring MD 20901.

More Cryptographic Notes

Anyone looking for an in-depth article on data encryption should read two papers brought to our attention by William Flynn. One is a reprint of an article by Ehrsam et al which appeared in the IBM Systems Journal, Volume 17, Number 2, entitled "A Cryptographic Management Scheme for Implementing the Data Encryption Standard." The cost is $0.95 for each reprint. The second paper is "FIPS Publication 1980." It is available from the US Department of Commerce, National Technical Information Service, 5285 Port Royal Rd, Springfield VA 22161, at a cost of $1.75 for a paper copy or the fiche.

NEW FROM MOUNTAIN HARDWARE.
THE APPLE CLOCK.

New utility for your computer.

Now, there's a real time clock for the Apple II*: the Apple Clock from Mountain Hardware.

It keeps time and date in 1mS increments for one year. On-board battery backup keeps the clock running in the event of power outage. Easy to use with BASIC using routines carried in on-board ROM. That means you can time events, put time and date on printouts, create games in which elapsed time is important...and many more. Mountain Hardware offers a complete line of peripheral products for many fine computers.

Available at your dealer's now.

Mountain Hardware, Inc.
300 Harvey West Blvd.
Santa Cruz, CA 95060 (408) 429-8600

*Apple II is a trademark of Apple Computer, Inc.
from Computer Headware . . .
a Self-Indexing Query System
for your Apple II, North Star, or CP/M machine

THE MM-103 DATA MODEM
AND COMMUNICATIONS ADAPTER

FCC APPROVED
Both the modem and telephone system interface are
FCC approved, accomplishing all the required protective
functions with a miniaturized, proprietary protective
coupler.

WARRANTY
One year limited warranty. Ten-day unconditional
return privilege. Minimal cost, 24-hour exchange policy
for units not in warranty.

LOW PRICE—$319.95 For Modem AND Coupler

Call for further information:
VOICE: (703) 750-3727
MODEM: (703) 750-0930 (300 baud)

Potomac Micro-Magic, Inc.
Write for brochure:
First Lincolnia Bldg., Suite B1
4810 Beauregard St.
Alexandria, Va. 22312
Table 1: An example of a quick relocation scheme designed with a 6800 processor in mind. This set of instructions would be stored along with the program on the auxiliary memory to direct the loader as to how to reinsert the data into main memory each time the program was run. The point of this scheme is to provide a minimal amount of computation when a program is loaded from a library into memory prior to execution. Similar schemes can be chosen for any particular computer's architecture.

<table>
<thead>
<tr>
<th>Command to Run Time Loader</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start absolute loading:</td>
<td>The header code is followed by the absolute start address. In this case, the loader behaves as any other loader. There is no relocation of the data and instructions that follow. Loading starts at the address given.</td>
</tr>
<tr>
<td>Start relative loading:</td>
<td>The header code is followed by an address. Loading begins at the first available address, as determined by the operating system. From this point on, a relocation factor will be added to all instructions and data flagged for relocation.</td>
</tr>
<tr>
<td>Skip bytes:</td>
<td>This code is followed by a number designating the number of bytes to be skipped. This is useful in defining uninitialized buffers and is more efficient than repeated uses of code to reserve one or two bytes (see below).</td>
</tr>
<tr>
<td>Define absolute start address:</td>
<td>The header code is followed by the absolute start address. If the routine is a subroutine, this code would not be used as the module has no start address. When this code is used the program will be started at the specified address once loading is completed.</td>
</tr>
<tr>
<td>Define relative start address:</td>
<td>Similar to the preceding code; however, program execution will start in a position relative to the first location.</td>
</tr>
<tr>
<td>One byte:</td>
<td>The header code is followed by one byte. This code gets no relocation, because it is either an instruction without an address, or data which is too small to be an address.</td>
</tr>
<tr>
<td>Two bytes absolute:</td>
<td>The header code is followed by the two bytes. This code also receives no relocation because it is either an absolute address value, a one byte immediate instruction with its data byte, or it is a relative address instruction which is self-relocating.</td>
</tr>
<tr>
<td>Three bytes relative:</td>
<td>The header code is followed by the 3 byte instruction. This code will receive a relocation factor.</td>
</tr>
<tr>
<td>Three bytes absolute:</td>
<td>The header code is followed by a 3 byte instruction with an absolute address value which is unchanged in loading.</td>
</tr>
<tr>
<td>Two bytes relocatable address values:</td>
<td>The header code is followed by the address data. The address data is always relocatable.</td>
</tr>
<tr>
<td>End:</td>
<td>At this point, control returns to the program that called the loader if no starting address was given in the loading module. If the loading module contained a start address that address is called.</td>
</tr>
</tbody>
</table>

Although one normally thinks of timesharing as only working on large computer systems, it is possible to run even on small systems. Many of the newer large scale timesharing systems use virtual memory and swapping, which is not possible or practical on smaller machines. Virtual memory requires mapping hardware (a machine with interruptable instructions, such as an IBM 370). Swapping requires a reasonably fast disk, which will cost at least $2000. What we are left with is an in core system that keeps everything running in real memory at all times.

The first consideration is the assembler and loader. In your current system, a program's location can be assigned only at assembly time. On a timesharing system, the programmer may not know where the program will be located in memory. The reason knowledge of this location is conditional is that a decision point in the design of the system has been reached. If the system is to be nonrelocatable, the programmer may define the location of the program. The problem that arises here is that if, at the time the program is to run, the place in memory that the program was supposed to run in is already occupied, it cannot be loaded. On the other hand, if the system is capable of relocating, the program can be put anywhere in memory. This produces the additional benefit that subroutines do not have to be assembled with the program. To perform this relocation the assembler leaves offset information in the object tape or file which the loader will interpret as it goes.

One possible relocation code scheme is shown in table 1. Of course, all sorts of schemes are possible. Note that relocation alone will take some amount of coding and execution time.

The second consideration is the allocation of system resources. In most cases this should concern only IO devices, although there may be some systems with interrupts not associated with IO devices. There are
ATTENTION: COMPUTER DEALERS

Compu/Think invites you to preview our new integrated business micro-computer system at the June NCC in New York. It has to be seen to be believed! System features:

- 108,544 character semiconductor memory
- Resident ROM Operating System
- Resident ROM Microsoft BASIC
- Resident ROM machine language monitor
- Interactive de-bug facility
- High resolution graphics
- Full screen editing including split screen and individual field modes
- Two disk storage versions:
  1) 712,000 character memory
  2) 2,400,000 character memory

all at retail prices of from $4,495.00 to $5,995.00

We will also be showing our software and other peripheral products for the Commodore PET and Radio Shack TRS 80 including dual disk drives.

Location and Dates
Sheraton Center
Booths 130 and 131
New York, New York

Week of June 4th, 1979

Dealer Inquiries Invited

Contact:
Frank R. Price
Director of Marketing
3260 Alpine Road
Menlo Park, CA 94025
(415) 854-2577

“COMPUTER SYSTEMS FOR BUSINESS”

Circle 71 on inquiry card.
basically three types of IO devices. The first and most common type of device is the single owner. This is a device which can only be used by one task at a time. (A task is a program running in the timesharing system.) An example of a device which must be single owner is a cassette recorder. It would just not do to have someone else’s data in the middle of your program.

The second type of IO device is the shareable unit. The most common example of this is the floppy disk. For a disk to be correctly shared, the operating system routine which is handling the disk must reposition the heads every time the disk is used. Most systems already use this method, but there are those that have a call to position the head and another set of calls to read, write and verify. Separate calls cannot be used because a second task might reposition the heads before the first task had a chance to read or write.

The third type of IO device is the device that is the system’s alone. An example of this is the clock interrupt, a solitary interrupt device. It must be the system’s job to keep track of time. It is also the charge of the system to keep track of which devices are owned by which tasks. The system must place all of the task’s allocated devices back on the available list if a “cancel the program” function is executed.

When a task wants to perform input or output, it might use a considerable amount of system time monitoring status lines, thereby making timesharing impossible, unless all, or at least some of the devices are interrupt driven. The best way to handle things is to have a routine which will cause a task to wait until an interrupt is received for that task, then let the task handle the interrupt, including polling. So far, the routines required are summarized in table 2. (This is not to say that these are the only routines you will ever need. Table 2 is probably the minimum set of functions you will ever need.)

When handling disk interrupts, it is necessary to keep track of which task, if any, is using the disk. When a task requests the use of a disk or other shared device, it must get a return code stating whether or not the device is busy. Otherwise, the system must queue its request (make the program wait and handle the request whenever it can).

A third consideration is scheduling. Each task has a status: ready to run, running, running with an interrupt pending, or waiting. At some point, the system must stop running one task and begin running another.

We will require the operating system to reschedule the tasks every time a task asks to wait. Since that task cannot proceed, we will perform a task that is not in a wait state. There are three other times when we may optionally reschedule the tasks: every interrupt, every clock interrupt, or every interrupt and system call. These methods are called demand scheduling, event scheduling, time slicing, and quick scheduling, respectively. The fastest method is to wait for WAIT calls. The other three methods are faster, depending on how you look at things.

The actual method of scheduling leads to another decision point. The scheduler may be foreground-background, round robin, or priority scheduling. Foreground-background is the fastest. In this type of scheduling, the system scans down the list of tasks and runs the first nonwaiting task. When this method is used, the position on the list is the important factor.

Round robin scheduling starts the search for an executable task after the last task running. The search starts at the top of the list when it hits the bottom. This way gives every task its chance to run.

Priority scheduling requires a list of priorities. This scheduler runs the task with the highest priority which is not waiting. This is the fairest method because each task is given exactly what it deserves. When you run off the bottom of the list, using either the foreground-background or priority scheduling method, you have the option of starting over or executing a WAIT instruction. Although it will cost a byte of program memory, it will save considerable time on a 6800 or similar machine, since the interrupt vectoring will be half done by the time you get the interrupt.

The above covers most of what you need, but there are a few more minor considerations:

Creation of tasks: A task has to get into the machine somehow. Two possible methods come to mind. One is the typical time-sharing method with each terminal getting its own task. The other is to add a system call which adds a new task.
Figure 1: A system set up with each processor having its own mass storage device and IO peripherals.

Figure 2: This arrangement uses resource sharing. To make this arrangement work, processor to processor data links must be added. Timesharing and multiprogramming can be useful in the personal system. What happens when two children and two adults must share several terminals? What about the case when you want to do a listing or assembly on a slow printer while continuing an editing operation on a separate source file? The smallness of the scope of a computer does not rule out the use of resource sharing and multiprocessing.
Memory: You can set things up so that each task has a fixed amount of memory (which may or may not be reset between tasks) or use some sort of a system where the tasks can acquire and free memory dynamically.

Niceness: Programs must be nice to one another, as very few of the machines around have any sort of memory protection or privileged instructions.

Machine considerations: When an interrupt occurs, or a task is otherwise stopped, the registers, including the program status word (PSW), and stack pointer must be saved and later restored. Depending on the type of programs you run and your type of machine you may have to save and restore all or part of page zero. If you have a 6502, you will also have to deal with the stack's page.

Reentrancy: Programs which can be run concurrently by more than one task are reentrant. You may wish to set up some way of effectively using reentrant programs, such as having a null task, into which may be put reentrant subroutines; or by having various small reentrant routines always in the same place in memory, such as multiply and divide.

There are other methods of going about this completely, which I mention only in passing. Many BASIC systems will have one BASIC interpreter in memory along with multiple programs, and will execute one line of BASIC code and then go on to the next pseudotask. This will also work for APL, although long matrix operations will tend to extend the intervals between transitions from one process to another. (Of course, it is a debatable point whether or not a time-sharing APL and two workspaces will ever fit into the same memory at one time.)

Multiple processor timesharing systems are also possible. Assuming that you have a central processor with disks and printers, there is a method that can save a lot of money. This method is resource sharing. Figure 1 shows a typical group of three computers each working independently. Each processor handles everything with inefficient use of the printers and disks. Figure 2 depicts a resource sharing setup. This requires the addition of processor to processor data links. In this setup, each peripheral processor does the computing while the central processor handles queued IO and interrupts much like the simple timesharing systems above.

VAK-4 16K STATIC RAM BOARD
- Designed specifically for use with the AIM-65, SYM-1, and KIM-1 microcomputers
- Two separately addressable 8K-blocks with write protect
- Designed for use with the VAK-1 or KIM-4* motherboards
- Has provisions for mounting regulators for use with an unregulated power supply
- Made with 1st quality 2114 static ram chips
- All IC's are socketed
- Completely assembled, burned-in, and tested

We manufacture a complete line of high quality expansion boards. Use reader service card to be added to our mailing list, or U.S. residents send $1.00 (international send $3.00 U.S.) for airmail delivery of our complete catalog.

*Product of MOS Technology

Circle 78 on inquiry card.
About the Author

C Brian Honess is currently assistant professor of management science in the College of Business Administration at the University of South Carolina. He reports that he has been an active "building" radio amateur (ham) for 20 years; his interest in computers goes back to programming scientific business applications on an IBM 1620. He learned about what was inside computers by buying a surplus IBM 704 from the government, and slowly taking it apart (donating, selling and scrapping the parts as he went). Another 704 was eventually purchased, and this time it was built back up, from the inside out. This is not exactly a typical personal computer.

Three Types of Pseudorandom Sequences

Random numbers are extensively used in virtually all areas of data processing, from the simplest games for a hobby microprocessor, up to the most complex business and scientific applications. Deterministic games programmed without the benefit of some random parameter soon become boring and easy to "beat," so it would seem that random number generation and testing should be of interest to even the neophyte programmer or computer hacker when trying to get a simple game up and running. Random numbers are used extensively in various business applications. For example, random numbers would be used by an auditor faced with a large number of transactions to audit, and using a sampling technique to only look at a certain percentage of representative transactions. The number of checkout stations at your local discount department store may have been determined by using a mathematical model of the store, wherein the arrival and departure of "customers" was simulated using random numbers. Market research makes extensive use of random numbers, in selecting the people, streets, blocks, households, etc, to interview or to mail questionnaires. A mathematical model can also be "built" of an element, molecule or compound, and a particle introduced at random and collisions counted. Suppose further that you had a photograph of some obscure planet, covered in an extremely irregular way with areas you assumed to be water. You could divide the photograph into small squares, or maybe overlay with a piece of graph paper, and then "take shots" at the grid with a random number generator, wherein the random number would determine the coordinates of the "shot" and you could then tally the number of "hits" and "misses" and thereby determine the number of hits out of the total number of shots, and get an approximation of the percentage of the surface covered by water.

Before reading on, let me suggest that you try a short experiment. Consider the set of integers from 0 to 99, and quickly write down a list of random 2 digit numbers. Use whatever your current idea of random is, and make a list of 100 numbers. Later we'll see several methods for determining how random your numbers are, but I'll hasten to guess that they won't be very random. Psychologists repeatedly show that the average human just cannot think up random numbers. Upon inspection, there might be too many 4s compared with 6s, or maybe very few 0s and an abundance of 5s.

While it's true that a machine can produce a much better selection of truly random numbers than a human, the problem is that the numbers produced by the machine aren't really random either. If you could build a perfect roulette wheel, you'd get truly random numbers, but the mechanical considerations of such a device are, of
**AT LAST!**

A MICROCOMPUTER SYSTEM WITH THE SPEED AND POWER TO HANDLE A BUSINESS WORK LOAD.

The Computex 16-bit MICROENGINETM CPU processes Pascal (UCSD version 3.0) five times faster than any comparable unit, and at least twenty times faster than the 8080 or Z80. Still our X-part SystemsTM are price competitive with 8-bit systems.

$2695* ready to run

* LIMITED TIME cash price. 10% DOWN, guaranteed priority

MICROENGINETM specifications:
- 16-bit P-code CPU
- 64K bytes RAM
- Floppy disk controller
- Full DMA
- Floating point hardware
- 2 parallel RS232 i/O ports
- 2 parallel hi/g ports
- Pascal and Basic compilers
- Text editor,
- File manager
- CPU and memory diagnostics
- Symbolic Pascal debugger

Also available:
- Complete turn-key systems
- CRT terminals
- High speed printers
- Text quality printers
- Floppy disk drives
- Applications software

Customer satisfaction is guaranteed, Full refund with the return of any product within 10 days. Complete technical catalog $1.

5710 Drexel Avenue
Chicago, IL 60637
(312) 644-3183

**LEEDEX Corporation**

2300 East Higgins Road • Elk Grove Village, Illinois 60007 • (312) 364-1180 • TLX: 25-4786

Generous dealer discount available
course, impossible, to say nothing of the costs, speed, maintenance, testing, and so forth. There is really not much need to strive for such a device for the usual application of random numbers, because there are some mathematical methods which produce what are called pseudorandom numbers. Implemented on a computer, they are quite fast, easy to implement, and just as much fun to play with as a roulette wheel!

Before looking at some of these methods, I might mention that there are a couple of other ways to get random numbers for your games, experiments, or business applications. You could always punch or key numbers, and assume the ability to extract the center four digits as the generation can be illustrated by this example. Here we use 8 digit decimal numbers, and assume the ability to extract the center four digits as the 4 digit random number for each cycle. [In principle this algorithm could be done on a binary basis by picking the middle 16 bits of a 32 bit product, or the middle 32 bits of a 64 bit product ... CH] All versions of this algorithm are subject to the problem of degeneration, since if the middle digits happen to become 0, the square will continue to be 0 through successive generations of the algorithm.

![Figure 1: Operation of the center squared method of random number generation can be illustrated by this example. Here we use 8 digit decimal numbers, and assume the ability to extract the center four digits as the 4 digit random number for each cycle.](image)

The earliest computer oriented method for producing pseudorandom numbers was probably the center squared method. In this method we begin with a $2n$ digit number, square it, and then extract the center $2n$ digits from the $4n$ digit result, and this becomes the next random number, and also becomes the number which is squared in the next iteration. For example, suppose you want some $4$ digit random numbers. In this case, of course, $n = 2$, and let's assume we start off with the number 4321 as our "seed" value. Figure 1 shows the process through three iterations.

This method makes a good little program to assign to a beginning programming class because it is easy to explain, easy to determine what the answers "should be," but it has several problems which arise as you get deeper into the problem. In FORTRAN or BASIC, lacking any specific digit manipulation instructions, the hard part comes when you try to strip off the digits either side of the center. Listing 1 shows a simple BASIC program which will generate one random number. [This program assumes an interpreter with greater than eight digits of arithmetic precision]. Here, we see that we desire four digits, and enter the seed 4321. Squared,

### BASIC Program

```
100 PRINT "INPUT A 4-DIGIT SEED";
110 INPUT N
120 LET N = N * N
130 LET N = N / 100
140 LET N = INT(N)
150 LET A = A / 10000
160 LET A = INT(A)
170 LET A = A * 10000
180 LET N = N - A
190 PRINT N
200 END
```

Listing 1: A BASIC program which accomplishes one generation of the center squared method of calculation. Note that this program assumes an interpreter with at least eight decimal digits of accuracy.
**NEED EIA CABLE?**

**Data Set has it!**

They don’t call us “The Company with a Lot of Connections” for nothing! Whatever your interface cable needs, call on Data Set. We have all types of cable and connectors, pinned to your specifications — ribbons, coax, twin-ax, Telco, junction boxes... to name just a few.

<table>
<thead>
<tr>
<th>THESE ITEMS IN STOCK</th>
</tr>
</thead>
<tbody>
<tr>
<td>EIA RS 232 C Cables — All 25 Pins Wired</td>
</tr>
<tr>
<td>MALE to MALE or MALE to FEMALE</td>
</tr>
</tbody>
</table>

Specify when ordering:

- 3-foot length $17.50 ea.
- 5-foot length $18.50 ea.
- 10-foot length $21.00 ea.

**SPECIAL TO JULY 15, 1979 ONLY!**

10% Discount on any of the above items.

PLEASE MAKE PAYMENT WITH ORDER.

New catalog available

The Company with a lot of Connections

Data Set Cable Company, Inc.

We serve you from 2 locations:

- 722 Danbury Road — P.O. Box 622
  Ridgefield, Connecticut 06877
  (203) 438-9684

- 3650 Paraiso Avenue, #21
  Las Vegas, Nevada 89103
  (702) 873-2133

---

**WE HAVE IT**

What is IT? The New Pascal Microengine.

**IT** features the new Western Digital 16 Bit Pascal Microengine CPU, 64K RAM, (2) RS232 ports, (2) parallel ports & (2) Shugart 8014 dual density drives. **IT** will directly execute Pascal generated P-Code (the only CPU on the market designed to directly execute a high level language), & **IT** will run compiled BASIC. Wait, that’s not all — **IT** normally sells for $4,495, but you can have **IT** for $4,195. Dealer prices are much lower. Plus we have software galore.

Call us about **IT** at (803) 756-6000.

**THE PASCAL MICROENGINE**

FROM THE COMPANY THAT GIVES YOU TOMORROW’S INVENTIONS TODAY
100 PRINT "HOW MANY NUMBERS DO YOU WANT?";
110 INPUT J
120 PRINT "INPUT A 4-DIGIT SEED";
130 INPUT N
140 FOR I = 1 TO J
150 LET N = INT(N*N/100)
160 LET A = INT(N/10000)*10000
170 LET N = N - A
180 PRINT N
190 NEXT I
200 END

Listing 2: A BASIC program which will generate a list of random numbers using the center squared method. The program embeds a revised form of the calculation of listing 1 within a FOR-NEXT loop.

this becomes an 8 digit number in line 120. Line 130 divides by 100 in the first step of several necessary to get out the four center digits. Of course if you wanted 2 digit random numbers your seed would have been a 2 digit number; you'd have a 4 digit square, and you would change line 130 to divide by 10. For 6 digit numbers, you'd change it to divide by 1000, etc. Line 140 completes the removal of the right-hand two digits by integerizing the number. This resulting 6 digit number is then set aside, and you start removing the front two digits. This is done by dividing by 10000, integerizing the result and then multiplying by 10000. In line 180 you subtract this number from the one previously set aside and out come the center four digits, the new random number. If you are working with 2 digit random numbers, the divisor in line 150 would be changed to 100 and you'd then multiply by 100 in line 170.

One number isn't going to be enough for most applications, so let's put in a loop and get "n" numbers. Listing 2 shows the modifications necessary. Also, we'll combine lines 120 to 140, and lines 160 to 170 in listing 1.

I remember when I first coded this method in a beginning FORTRAN class. I've forgotten what 4 digit seed the instructor used at the time, but it was a revelation when I found out about something he called "degeneration." I'm sure a simple program can be written to discover any and all of the 4 digit seeds which will cause this program to degenerate to zero, but let's assume that there is at least one, and that Murphy's Law will guarantee that this particular one is the seed you choose for your first run. It is not difficult to imagine that there is a 4 digit number, which, when squared, will have four zeros in the middle. Maybe your number squared will be 12000034, or 65000025, etc. This being the case, you'll get 0000 as your next random number until you discover what is going on and get out of the loop. Listing 3 shows how we'll test for that problem and perform an ad hoc fix; we'll just call for another seed when a random number of zero is obtained.

Our final try at the center square program still doesn't solve one of the worst problems with this method. The method doesn't give very long periods for many seeds, and you really can't predict what the results will be until you try it. The method starts repeating numbers, and even the place where it starts repeating can't be determined without trying it. For example, you may print out 722 different numbers, and then it will start repeating the last 34 of them. The method is easy, and it is fun, and it may just produce all the pseudorandom numbers you need for your application.

Fibonacci Series Technique

A second method for generating random numbers makes use of the Fibonacci series, so named for its discoverer Leonardo of Pisa, known as Fibonacci (meaning son of Bonaccio). Leonardo was perhaps the greatest European mathematician of the Middle Ages, and if not for him you might be programming your machine using Roman numerals, because it was Leonardo who recognized the enormous superiority of the Hindu-Arabic decimal system with its positional notation and the zero symbol, over the much clumsier Roman system. Table 1 shows several numbers in the Fibonacci series, and you'll notice that each number is simply the sum of the previous two numbers. Actually, we could make up any number of series by starting with any...
Circle 120 on inquiry card.

Computer Lab of New Jersey

Computer Lab sells the best S-100 Bus products at the best possible prices. Not only are our prices great, so is our delivery. We offer a 10% discount on most major lines, plus a 5% additional discount for a cash purchase.

<table>
<thead>
<tr>
<th>LIST PRICE</th>
<th>OUR CASH PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Godbout 8K Unkit</td>
<td>$139.00</td>
</tr>
<tr>
<td>Godbout 16K Unkit</td>
<td>$295.00</td>
</tr>
<tr>
<td>Thinker Toys Super RAM 16K Kit</td>
<td>$299.00</td>
</tr>
<tr>
<td>Vector Graphic 8K Assembled</td>
<td>$245.00</td>
</tr>
<tr>
<td>Problem Solver 16K Assembled</td>
<td>$429.00</td>
</tr>
</tbody>
</table>

Subject to available quantities. Prices quoted include cash discount. Shipping and Insurance Extra
Cut-off Date July 15

Call for our prices on:
Cromemco, Dynabyte, Godbout, Integral Data Systems, IMC, Ithaca Audio, Mea, Micropolis, Mountain Hardware, Mullen, Oliver, SSM, Soroc, Tarbell, TEI, Teletek, and many other fine products.

Computer Lab of New Jersey
141 Route 46 • Budd Lake, N.J. 07828
Phone: (201) 691-1984
HOURS: Monday & Friday: 12 to 6, Tuesday-Thursday: 12 to 9
Saturday: 10 to 5
Call or write for our free catalog & price list
(a) The Fibonacci Series

\[
\begin{array}{c|c}
 n & F_n \\
\hline
1 & 1 \\
2 & 1 \\
3 & 2 \\
4 & 3 \\
5 & 5 \\
6 & 8 \\
7 & 13 \\
19 & 4181 \\
20 & 6765 \\
21 & 10946 \\
22 & 17711 \\
\end{array}
\]

(b) Some Characteristics of the Fibonacci Series

- Final digit (LSD) repeats in cycle of 60
- Last 2 digits repeat in cycle of 300
- Last 3 digits repeat in cycle of 15000
- Last 4 digits repeat in cycle of 150000
- Last 5 digits repeat in cycle of 1500000

Note: this is also the Fibonacci series.

Table 1: The Fibonacci series is a numerological phenomenon which is generated by the following definition: the next term in the series is the sum of the previous two terms, with the first two terms defined to be a value of 1 as a starting point. At (a) are listed several representative sections of the Fibonacci series, and at (b) are shown several miscellaneous characteristics of the Fibonacci series abstracted from the mathematical literature. This series can be used as a basis for a random number generator, as described in the text.

two numbers and letting their sum be a new random number, and repeating this for our desired number of iterations. The reason that we'll use the Fibonacci series specifically, and not any other series, is that the characteristics of the Fibonacci series have been studied, and we know several facts about it that will be of interest. Table 1 for example shows that if we want more than 60 single digit random numbers, the Fibonacci series isn't going to work. Of course we could start extracting 2 digit numbers from different parts of the numbers produced, but here we're on our own as far as statistical characteristics are concerned.

Listing 4 shows a BASIC program for calculating and printing "n" random numbers of five digits each. Notice that the generator is seeded with two seeds from table 1. These could have been INPUT, of course, and in that way a different series of random numbers could be produced. I've chosen the first two 5 digit numbers in the sequence, but there is nothing special about them. Also, you might consider having the generator run through the loop a number of times before it starts printing the output. This could be easily implemented with another INPUT statement and another FOR ... NEXT loop, or maybe by just adding the number of unwanted numbers to J, and then putting in an IF to suppress printing of the first J-N numbers. Listing 4 is straightforward: after determining how many numbers you want, it takes the two seeds and calculates the first number. It is possible that the result will be over five digits when the two previous numbers are added, but it can never be greater than 199998 (99999 + 99999), so we check for this condition in line 160 and simply subtract 100000 if the number is larger than 99999. Lines 190 and 200 serve to shift the second number into the location previously holding the first number, and the new random number into the location previously holding the second number, and we're ready for a new iteration.

In order to find the nth Fibonacci number, you needn't go up to "n" one at a time. There is an easier method, although you might not think so when you see the formulas in figure 2. You might try to find the 20th Fibonacci number with your

100 PRINT "HOW MANY NUMBERS DO YOU WANT?";
110 INPUT J
120 LET A = 10946
130 LET B = 17711
140 FOR I = 1 TO J
150 LET N = A + B
160 IF N < 100000 THEN 180
170 LET N = N - 100000
180 PRINT N
190 LET A = B
200 LET B = N
210 NEXT I
220 END

Listing 4: A BASIC program which implements a Fibonacci series random number generation technique. The program works machines of finite precision (even though the Fibonacci numbers eventually get infinitely large) because only the low order digits are kept as part of the pseudorandom number. Since the high order portion of a Fibonacci number has no effect on the low order portion during calculation of the next number, it is possible to completely ignore the high order part.
New North Star Software

DOS + $35.00
Enables any program to execute all North Star Disk and/or Meca Tape commands. Allows batch command list and more.

PRO-TYPE WORD PROCESSOR $75.00
Easy to learn. Combines text input, editing and printing in one program. Features right margin justification, tabs, paging, underlining, relocation of text blocks, etc. Requires only 8K of memory. Manual alone. $25.

GUIDE TO BASEX $33.00
A new interactive compiler similar to BASIC for 8080-type microcomputers (Z-80, 8085). Executes programs up to 10 times faster than equivalent programs while requiring about half the memory space. Features include: array variables; string manipulation; arithmetic operations on signed 16 bit integers; and versatile I/O communication functions. Manual alone $8.

BASEX TAPE AND DISK GUIDE $35.00
Allows your BASEX programs to access up to four North Star Disk and/or Meca Tape drives. All operations can be executed from the Keyboard. Manual alone $20.

Specify: North Star Disk/Meca Tape/Other Send for Free Literature

INTERACTIVE MICROWAVE INC.
P.O. Box 771, State College, PA 16801
(814) 238-8294

TRS-80 SOFTWARE
32K with 2 DISK DRIVES

PAYROLL SYSTEM ............... $235
Includes:
a) File Maintenance
b) Payday Entries
c) Earnings Record
d) Payroll Register
e) Write Pay Checks
f) Write Other Checks
Handles up to 300 employees per diskette. Automatically calculates FICA, FED. TAX, UNEMPLOYMENT and much more.

ALSO AVAILABLE

ACCOUNTS RECEIVABLE ...... $195
ACCOUNTS PAYABLE ......... $195
INVENTORY CONTROL with
BILLING & ACCT’S REC. ...... $550
MANUALS .................... $29.95/ea.
CUSTOM PROGRAMS & OTHERS

CAI
1st Security Bank Bldg.
3306 W. Walnut, Suite 507
Garland, TX 75042
PHONE: (214) 272-3211
With money order or certified check, orders shipped within 24 hours.

HOW TO BUY A BUSINESS COMPUTER

WHEN TO BUY • WHEN NOT TO BUY • HOW TO CHOOSE CONSULTANTS • DATA GATHERING • PACKAGED VS CUSTOM SOFTWARE • CONTRACTS • FINANCING • WARRANTIES AND MAINTENANCE • INSTALLATION MANAGEMENT AND MUCH MORE . . . . .

"SUPER BOOK!" DP Consultant, Mercer Island, Washington.
"I wish I'd had this book before I bought my computer!" TV Station General Manager, California.
"It's the best book I've seen on the subject. Send me 5 copies to send to my clients!" CPA, Orange County, California.
"I really learned something from this book and I'm in the business. I'm recommending it to my clients." DP Consultant, Alhambra, California.

Here's a straightforward approach to business computer purchase and installation. It will save you time and money.

ORDER NOW! If not completely satisfied, return within 30 days for a full and immediate refund.

8 1/2 x 11 Softbound = 178 pp. = $12.95
Credit Card Orders 1-805-964-7448

DDC PUBLICATIONS
5386 Hollister Ave., Santa Barbara, CA 93111
Rush copies of "Winning The Computer Game" at $12.95 per copy. (ICA residents add 6% sales tax)

NAME ____________________________
ADDRESS ____________________________
CITY/STATE/ZIP ____________________________

[ ] Check [ ] MasterCharge [ ] Visa
Card No. ____________________________ Exp. Date __________

With money order or certified check, orders shipped within 24 hours.
number. Formula (b) is also an exact calculation if the result is rounded to the nearest integer. This particular program is the RANDU program named RANDU.

In the source document cited, this algorithm is given as a FORTRAN subroutine of the Power Residue Method. It is this method that is usually favored by hardware manufacturers, software writers and mathematicians, because long periods prior to repetition can be assured, and the numbers generated hold up well to statistical tests for randomness. The method is, however, machine dependent since it relies on the word size of the machine. The Power Residue Method is the method employed in RANDU, an extremely popular random number generator appearing in the "Scientific Subroutine Package" (IBM publication number H20-0205) for the IBM System 360 and 370 computers. The publication gives a FORTRAN listing of this subroutine and documentation on how to use it, and also delineates a FORTRAN listing and instructions for use of GAUSS, which is a program for producing a normal distribution of random numbers. The methods can easily be extended to distributions other than the normal. Background on the number theory aspects of the Power Residue Method can be obtained in another IBM booklet, "Random Number Generation and Testing" (IBM publication number C20-8011).

Listing 5 shows a BASIC version of a program to produce one random number on a 32 bit machine. The program can be easily modified, of course, along the lines we followed for the center squared and Fibonacci methods covered earlier. The multiplier in line 130 is $2^{-31}$ and of course you’ll be rounding it to fit your particular BASIC compiler. Line 130 simply transforms our new random number $X$ into a floating-point version between 0 and 1, which is a more usual way of delineating random numbers. With a 32 bit machine (1 sign bit) we use $2^{-31}$, and this would be changed to correspond to the particular machine upon which the method is implemented. The multiplier in line 120 is also machine dependent. It has the form: $8i \pm 3$, where $i$ is any integer. The trick here is to choose $i$, such that the resultant multiplier is close to $2^{b/2}$. Since $b = 32$ for this example ($b$ is the number of bits), then we

$$F_n = \frac{1}{\sqrt{5}} \left[ \left( \frac{1 + \sqrt{5}}{2} \right)^n + \left( \frac{1 - \sqrt{5}}{2} \right)^n \right]$$

$$F_n = \frac{\phi^n}{\sqrt{5}} = \frac{(1 + \sqrt{5}/2)^n}{\sqrt{5}}$$

rounded to nearest integer.

(c) $\left(\text{Golden ratio}\right)^k = \left( \frac{1 + \sqrt{5}}{2} \right)^k = \phi^k = 1.61803^k \ldots$

Figure 2: The program of listing 4 was an iterative calculation. It turns out that there are several ways to calculate Fibonacci numbers directly which do not involve iteration. Formula (a) is an exact calculation of the $n$th Fibonacci number. Formula (b) is also an exact calculation if the result is rounded to the nearest integer. Formula (c) defines a criterion for making the Fibonacci sequence pass various statistical tests which would otherwise fail: pick every $k$th number where $k$ is chosen so that the "Golden ratio" to the $k$th power is relatively large compared to the low order portion of the Fibonacci numbers which is used as a random number output.

Listing 5: A BASIC program to calculate one cycle of a pseudorandom sequence using the power residue method. This particular program is the algorithm used for a 32 bit machine as found in the IBM System 360 and 370 "Scientific Subroutine Package," IBM Publication Number H20-0205. In the source document cited, this algorithm is given as a FORTRAN subroutine named RANDU.

```
100 PRINT "INPUT ANY ODD INTEGER";
110 INPUT N
120 LET X = N * 65539
130 LET Y = X * 0.4656612873077392578125E-09
140 PRINT X ; Y
150 END
```

Listing 5: A BASIC program to calculate one cycle of a pseudorandom sequence using the power residue method. This particular program is the algorithm used for a 32 bit machine as found in the IBM System 360 and 370 "Scientific Subroutine Package," IBM Publication Number H20-0205. In the source document cited, this algorithm is given as a FORTRAN subroutine named RANDU.
want the multiplier to be close to \(2^{16} = 65536\). If \(i = 8192\), then the multiplier will be \(65536 + 3 = 65539\). The seed multiplied by the multiplier produces a product which is 2b bits long and we discard the b high order bits, and the remaining b low order bits become the random number and the input seed for the routine for the next number. Using this method we will get \(2^{b-2}\) terms before repeating. Actually, the sign bit doesn't count, so we'll have \(2^{31} - 2\) or \(2^{29}\), or over half a billion numbers before repeating. I'm not about to try and prove this, but I will give it a "go" with a smaller machine assumed.

Let's assume a 6 bit machine. This should produce \(2^{6-2}\) or \(2^4 = 16\) numbers before repeating, and that shouldn't be too difficult to inspect manually. We want a multiplier of the form \(8i \pm 3\) which is close to \(2^{b/2} = 2^6/2 = 2^3 = 8\). If \(i = 1\), we'd have \(8 \times 1 + 3 = 11\) and \(8 \times 1 - 3 = 5\). Both of these possibilities are equally 3 away from our desired value of 8, so let's try both.

Table 2a shows how we get started using 8 as the multiplier, and table 2b shows the whole cycle of all 16 numbers produced. Table 2 also shows that if we had chosen a multiplier of 11 the procedure would also have produced 16 numbers before repeating.

You've probably noticed that the two columns of numbers in table 2 just don't look too random. Both columns have numbers that always end in 1. For the 11 multiplier case, the 4th digit is always 0, and the 5th digit alternates between 0 and 1. For the 5 multiplier case, the 5th digit is always 0 and the 4th digit alternates between 0 and 1. Obviously the low order bits are far from random. If you wanted random digits, and not random numbers, it would obviously be to your advantage to choose high order bits, or possibly the bits you discarded when you cut the product from 12 to six bits. The usual scheme, after developing the numbers in table 2, would be to place the binary point at the beginning of the 6 bit numbers, and thereby transform the whole list to a distribution between 0 and 1.

Testing Randomness

Tests of the randomness of a series of numbers usually fall into one of two major categories, those that examine the digits appearing in the numbers and those that
(a) 1. Choose an odd integer starting value. We'll choose the 6 bit number 100001 (simply because it'll be easy to multiply).
2. Choose the multiplier. (We already decided on 5, binary 101.)
3. Compute the product. \((100001) \times (0000101) = 000100100101\)
4. Cross out the first six bits, and you have the new number.
   \(5000001 \times 100101 = 100101\)
5. \((100101) \times (000101) = 111001\)
6. \((111001) \times (000101) = \text{etc.}

Table 2: The power residue method, adapted to a 6 bit example with two possible multipliers. The algorithm is shown at (a), and the complete set of 16 pseudorandom output states is listed in this table at (b). Note the deviations from randomness apparent in the regular patterns seen in the two low order bits of each number.

(b)  
<table>
<thead>
<tr>
<th>Multiplier = 5</th>
<th>Multiplier = 11</th>
</tr>
</thead>
<tbody>
<tr>
<td>((000101))</td>
<td>((000101))</td>
</tr>
<tr>
<td>((001001))</td>
<td>((001001))</td>
</tr>
<tr>
<td>((011011))</td>
<td>((011011))</td>
</tr>
<tr>
<td>((101010))</td>
<td>((101010))</td>
</tr>
<tr>
<td>((110000))</td>
<td>((110000))</td>
</tr>
<tr>
<td>((111011))</td>
<td>((111011))</td>
</tr>
<tr>
<td>((000000))</td>
<td>((000000))</td>
</tr>
<tr>
<td>((010011))</td>
<td>((010011))</td>
</tr>
<tr>
<td>((100100))</td>
<td>((100100))</td>
</tr>
<tr>
<td>((100001))</td>
<td>((100001))</td>
</tr>
</tbody>
</table>

Treat the numbers as points in the interval 0 to 1. Some tests can handle either case, of which the Chi-square test is one. It can be applied directly to the digits produced, or to groupings of the digits, or we can divide the interval 0 to 1 into subintervals and see how many of the random numbers fall into each of the subintervals and apply the Chi-square test to see if the distribution is biased.

Table 3: A random number sequence can be tested with various statistical measures. One excellent test is the Chi-square test, here illustrated with a hypothetical single digit decimal random number generator with the observed frequencies shown in a trial of 500 cycles of calculation. If the result were truly random, of course, the expected frequencies of each digit would be uniform. The Chi-square test involves calculating the characteristic number shown by the formula here (using this table's data). This characteristic number is then used with a statistical reference table of the Chi-square distribution and the number of degrees of freedom allowed by the statistics (here \(v=9\)), to check the quality of the pseudorandom sequence.

\[
X^2 = \sum_{i=1}^{k} \frac{(o_i - e_i)^2}{e_i} = \frac{(a_1 - e_1)^2}{e_1} + \frac{(a_2 - e_2)^2}{e_2} + \ldots + \frac{(a_k - e_k)^2}{e_k}
\]

where \(e_i\) is each expected frequency, and \(o_i\) is the actual observed frequency. If we had a generator which produced 250 digits we would expect each of the digits 0 through 9 to appear 25 times, although the digits might actually appear more or less than 25 times. Assume that your random number generator has just produced a series of 500 digits. You count all the zeros, ones, etc, and tabulate these observed frequencies (as in table 3) along with the expected frequency in each case of 50. You have counted 58 zeros, 28 ones, etc. You next put these observed and expected frequencies into the \(X^2\) formula and arrive at an answer of 46.45 as shown. At this point we need to turn to a Chi-square distribution table, which can be found in the back of almost any statistics book. Table 4 shows a portion of such a table and will suffice for most of our needs for uses like this application of the Chi-square statistic. The table is entered after you calculate the "degrees of freedom" in the column labeled "v" and after you
TR-80 disc software
WORD PROCESSOR Avoid word processors converted from other system hard to load objects file & cannot store text in disk. Our is specifically designed for the TRS-80. Written in BASIC. No special hardware and text limit. $39
INVENTORY V: Drive others use inefficient sequential file, we use 8-dig key for fast on-line random access. Reports give order info, performance summary etc. $39
MAIL print report & labels sorted by any field. Random access, special buffering technique $39
DATA BASE MANAGER You can maintain a data base & produce reports without any programming. Define fields, types, screen & report formats using menus. Use up the required 32K memory. $49
KEY RANDOM ACCESS UTIL. happy, blocking, buffering auto 1/0 error retry. Put your disk into optimal use $19
ACCOUNT manage client accounts & account receivable. Reports fields for general use. Automatic billing & transaction recording. 32K req. $39
Full documented Fast delivery. Our competitors offers $99 cassette word processor, $90 on memory inventory, inflexible mail system. 18K data base.

MIKEN Optical Co.
51 Abbott Ave
Worcester, MA 01606
(213) 472-1210

 electrosensitive paper
MANUFACTURED TO SPECS OF AXIOM, CENTRONICS, SCOPE, UNIVAC, RADIO
SHACK, etc.

Circle 21 on inquiry card.

Circle 143 on inquiry card.

Circle 5 on inquiry card.
Table 4: An abbreviated portion of a standard Chi-square table used as described in the text to check the quality of a pseudorandom sequence.

<table>
<thead>
<tr>
<th>v</th>
<th>$x^2_{995}$</th>
<th>$x^2_{99}$</th>
<th>$x^2_{95}$</th>
<th>$x^2_{90}$</th>
<th>$x^2_{75}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.88</td>
<td>6.63</td>
<td>3.84</td>
<td>2.71</td>
<td>1.32</td>
</tr>
<tr>
<td>5</td>
<td>16.7</td>
<td>15.1</td>
<td>11.1</td>
<td>9.24</td>
<td>6.83</td>
</tr>
<tr>
<td>9</td>
<td>23.6</td>
<td>21.7</td>
<td>16.9</td>
<td>14.7</td>
<td>11.4</td>
</tr>
<tr>
<td>10</td>
<td>25.2</td>
<td>23.2</td>
<td>18.3</td>
<td>16.0</td>
<td>12.5</td>
</tr>
<tr>
<td>19</td>
<td>38.6</td>
<td>36.2</td>
<td>30.1</td>
<td>27.2</td>
<td>22.7</td>
</tr>
<tr>
<td>24</td>
<td>45.6</td>
<td>43.0</td>
<td>36.4</td>
<td>33.2</td>
<td>28.2</td>
</tr>
</tbody>
</table>

determine the level of significance you want to test. The degrees of freedom in our case are $10 - 1 = 9$. This simply means that after we have determined nine of the observed frequencies, the 10th one is fixed. The frequencies have to add up to 500, so we have "nine degrees of freedom." Traditionally, the Chi-square statistic is used to test the hypothesis that the numbers are randomly distributed. If the computed value of Chi-square is greater than the critical value read from the table, we would then conclude that the observed frequencies differ significantly from the expected frequencies and we would reject the hypothesis of randomness at whatever level of significance we select. The levels of significance often used are 0.05 and 0.01, corresponding to the $X^2_{.95}$ and $X^2_{.99}$ columns respectively, in the table. Going back to our example, we calculated a value of 45.56, but in the table for nine degrees of freedom and at the .01 level of significance, we see that the critical value of Chi-square is 21.7. Since $45.56 > 21.7$ we therefore conclude that the observed distribution of numbers produced by our generator differs significantly from the expected distribution at the 0.01 level of significance, and we therefore cast considerable suspicion on our random number generator. As previously mentioned, we could take our list of generated numbers in the 0 to 1 interval and set up some subdivisions of this interval. Next, we could see how many of the numbers fell into each subinterval, calculate the expected frequency for the subintervals, and apply the Chi-square test in the same fashion.

A second test frequently applied to random numbers is called the "poker test," but is in reality similar to the frequency test already considered. In the poker test we look for specific combinations of digits. For example, suppose we are generating 5 digit integer random numbers in the interval 00000 to 99999. Probability theory tells us the number of numbers we should have where all digits are the same, like 22222 or 66666 etc. We can also calculate the expected number of pairs, three-of-a-kind and full houses, etc. The Chi-square test can be applied to the analysis of the results.

Figure 3: Several formulas for the run test of a pseudorandom sequence.

<table>
<thead>
<tr>
<th>Run length</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$(5n + 1) / 12$</td>
</tr>
<tr>
<td>2</td>
<td>$(11n - 14) / 60$</td>
</tr>
<tr>
<td>k (for $k &lt; n - 1$)</td>
<td>$2 \left{ \frac{(k^2 + 3k + 1)n - (k^2 + 3k^2 - k - 4)}{(k + 3)!} \right} / (k + 3)!$</td>
</tr>
<tr>
<td>n - 1</td>
<td>$2 / n!$</td>
</tr>
</tbody>
</table>
The Magic Machine is an introduction to computing for young children. The drawings and text show how two children find uses for a computer in their home.

The Magic Machine will help the child in your life to understand some of the functions of computers in his world, and to better understand the importance of computing in your world.

The Magic Machine comes COMPLETE WITH CRAYONS, and is lots of fun to color and read.

ISBN 0-931718-17-1

$2.00

Buy this book at your favorite computer bookstore or order direct from BYTE BOOKS. Add 50¢ per book for postage and handling.
The Physicians Microcomputer Report

The Physicians Microcomputer Report is a monthly publication for doctors who wish to become better informed about the computer and its application in the field of medicine. Some of the features include: software news, calculator corner, computers in patient health care, microcomputer hardware news, the bargain market, and computer articles of special interest to the physician. Additionally, the report contains articles on nonmedical applications such as linking your computer to a stock portfolio information center. Another intent of this publication is to facilitate the exchange of information between physicians who own computers. For this purpose the magazine has a listing of user groups.

The Physicians Microcomputer Report is available for $12.50 for students. Contact Dr. Gerald M. Orosz, POB 6483, Lawrenceville NJ 08648.

Circle 591 on Inquiry card.

Attention Readers, and Vendors...

Where Do New Products Items Come From?

The information printed in the new products pages of BYTE is obtained from "new product" or "press release" copy sent by the promoters of new products. If in our judgment the information might be of interest to the personal computing experimenters and homebrewers who read BYTE, we print it in some form. We openly solicit releases and photos from manufacturers and suppliers to this marketplace. The information is printed more or less as a first in first out queue, subject to occasional priority modifications. While we would not knowingly print untrue or inaccurate data, or data from unreliable companies, our capacity to evaluate the products and companies appearing in the "What's New?" feature is necessarily limited. We therefore cannot be responsible for product quality or company performance.

Complete Microcomputer System from Gimix

Gimix Inc has announced its complete System 68 microcomputer. It features the following: a ferro-resonant constant voltage power supply; an SS-50 motherboard (15 50 pin and eight 30 pin gold plated slots); a 6800 processor board that holds four 2708s and three independently programmable software timers; the Gimix 16 K byte software readaddressable static programmable memory boards organized into four separately controllable 4K byte blocks, which allows the user as much memory as can be contained in the mainframe.

Dual-in-line package switch features allow use of existing SwTPC and MSI compatible software. The system is video based using the Gimix video board and advanced GMXBUG 3 K byte read only memory monitor that contains the standard utility functions plus routines that facilitate software development.

The price of $1395 includes the motherboard, switches, fan, power supply, video board, 3 K GMXBUG version.

TRW LSI Products Introduces New Generation of Multipliers

A new series of monolithic multipliers, designated the MPY/HJ series, provide n by n bit multiplication of 24, 16, 12 and 8 bit numbers. All four multipliers have improved input registers that feature simplified clocking so that no data-hold time (clock overlap) is necessary. The three largest multipliers (MPY-24, -16 and -12HJ) feature improved output registers that can be made transparent for asynchronous output. They also feature a programmable selection of output product formats and can intermix two's complement numbers with numbers in absolute magnitude in the same operation.

All the new circuits are plug compatible with their first generation counterparts. Inserting one into a socket wired for an /AJ device automatically masks out the new /HJ features while still providing faster operation and reduced power consumption.

The MPY-24HJ contains a new shift and normalize feature, and yields a 48 bit product in 200 ns. The MPY-24HJ is supplied in a standard 64 pin dual-in-line package. The MPY-16HJ produces a 32 bit product in 100 ns and is pin compatible with the older 16 bit multipliers. Like the MPY-24HJ, it can be expanded to operate on 32, 48, 64 and larger numbers. The MPY-12HJ multiplies a pair of 12 bit numbers and yields their product in 80 ns. It is ideal for digital signal processing applications such as fast Fourier transforms and digital filters. The MPY-8HJ produces a 16 bit product in 65 ns. A fast version of the 8 bit multipliers called the MPY-8HJ-1 is being offered. It produces a 16 bit product in 45 ns and is intended for use in digital television systems.

Prices are $59 for the MPY-8HJ; $71 for the MPY-8HJ-1; $103 for the MPY-12HJ; $157 for the MPY-16HJ and $310 for the MPY-24HJ. For more information, contact TRW LSI Products, POB 1125, Redondo Beach CA 90278.

Circle 592 on Inquiry card.

2, 8 K byte static programmable memory, 2 port parallel I/O (input/output) board, cable and two disk regulator board. For further information, contact Gimix Inc, 1337 W 37th Pl, Chicago IL 60609.
Zilog Announces Availability of 16 Bit Z8000 Microprocessor

Zilog Inc has announced the availability of a Z8000 microcomputer processor circuit that offers users the architectural resources of mini and large mainframe computers in a single circuit device. The processor is available in two versions: the Z8001 in a 48 pin ceramic dual-in-line package that allows the user to address up to 8 M bytes of memory; and the Z8002 in a 40 pin ceramic dual-in-line package. The 40 pin Z8002, designed for smaller, less memory intensive applications, is compatible with the 48 pin Z8001, but the 40 pin processor’s addressing is limited to 64 K bytes in each of its 6 address spaces.

A scaled N/MOS depletion load silicon gate device, the Z8000 processor densely packs 17,500 transistors on a device which is 238 by 256 mils. The Z8000 is designed for both minicomputer and microcomputer applications. The Z8000 contains 24, 16 bit registers that reduce the number of memory references needed in programming. Sixteen of those registers are general purpose. The Z8000’s problem solving instruction set supports seven different data types from single to 32 bit words, has 8 addressing modes, and 418 usable op code combinations.

Pricing for the Z8001 is $195 for 1-9 pieces, $162.50 for 10-99 quantities and $140 for lots of 100 and up. The Z8002 sells for $125 for 10-99 pieces, and $107.10 for lots of 100 and up. For further information contact Zilog, 10340 Bubb Rd, Cupertino CA 95014.

New Software Compatible With Any Z-80 or 8080 CP/M System

Graham-Dorian Software Systems has developed four complete software program packages for payroll, inventory, cash register, and apartment management. All programs are compatible with any Z-80 or 8080 CP/M system, and can be ordered in eight inch (double or single density) or five inch floppy disks. Each program package contains a disk with CBASIC-2 compiler, CBASIC-2 run command, the Graham-Dorian software program in INT and BAS file form, plus a users manual and hard copy source listing. The four programs sell for $695 each. One CBASIC-2 is free with a program order, others cost $89.95 each. For further information contact Graham-Dorian Software Systems, 211 N Broadway, Wichita KS 67202.

Text Processing Software

Digitran Systems Inc has announced a text processing system which uses special commands for text formatting applications. It is intended for use with 8080 and Z-80 microcomputer based systems. The commands include multiple line spacing; left and right margin control; indentation; paging; optional right margin justification; centering and underlining text; no-frill modes; automatic page numbering; page and line length control; and the printing of left, right and center header titles and footer titles with optionally different titles based on even and odd pages. Also included is the ability to input extra data from a file or the console terminal during the formatting process.

The text processing system will automatically loop for repeated formatting applications such as form letters. A preprocessing program is able to select a subset of the extra text data according to a user specified matching pattern. The output of the text processor can be directed to either the console terminal, line printer, or a disk file.

The source code of the text formatter has been written in CBASIC and runs under the CP/M operations system. It is available on eight inch floppy disks with a comprehensive manual at a cost of $250 per copy. A well documented source code is also available for an additional fee. For further information contact Digitran Systems Inc, 5001 16th Av, Brooklyn NY 11204.

A Powerful Disk Based Operating System for 6800 Microprocessors

The CP/68 operating system for the 6800 family of microprocessors furnishes big system features and capabilities for microcomputers. A combination of memory resident and transient commands provide the system's flexibility. With the CP/68 operating system it is possible to add your own commands to the system. PIP (Peripheral Interchange Program) allows transfer of data between physical devices. Wildcard operation of all disk commands lets the user specify files either ambiguously or unambiguously.

Other features of the operating system are complete device independent I/O (input/output); sequential and random file access methods; dynamic allocation and expansion of files; command files; and chaining and overlaying of user programs. It fits in less than 8 K bytes and can be relocated anywhere in memory; the extended instruction set includes 19 new 6809-type instructions (PSHX, PULX, etc); all disk operating system services are available through a single supervisor call; and it easily interfaces to new devices and peripherals.

The operating system supports functions that STRU8AL+ used to provide in its runtime package. The operating system runs on Percom, ICOM, MSI, Smoke Signal, Micropolis and SwTPC systems. For further information contact Hemenway Associates Inc, 101 Tremont St, Suite 230, Boston MA 02108.
**What's New?**

**PERIPHERALS**

**S-100 Single and Double Density Disk System**

The IBM System 34, like the original single density DISCUS I, DISCUS 2D comes fully assembled with a controller board and a Shugart SA800R full-size drive mounted in a cabinet with a power supply.

The S-100 controller board utilizes the Western Digital 1791 dual density controller device and also has power on jump circuitry, 1 K bytes of programmable memory, 1 K bytes of read only memory with built-in monitor, and a hardware universal asynchronous receiver-transmitter with a data rate generator to simplify I/O (input/output) interfacing. It is capable of handling up to four drives.

Software includes BASIC-V, virtual disk BASIC, DOS and Disk/ATE assembler and editor. Extra cost optional software, including CP/M Microsoft Extended Disk BASIC and FORTRAN, is available. The price is $1149 for the completely assembled single and double density system, and $795 for each additional drive. For further information, contact Microtronix, POB Q, Philadelphia PA 19105.

Circle 588 on Inquiry Card.

**Light Pen Complements Apple II Computer**

Symtec Inc, POB 462, Farmington MI 48024 has announced a low cost light pen for microcomputer use. The Symtec light pen is supplied complete with interface and provides an X, Y coordinate number to the bus when the pen is activated by a touch sensitive switch or from software control. The pen can provide up to 255 Y values and 511 X values and is software dividable to fit any screen size.

The Apple version of the light pen can resolve a single high resolution point and can be used with all of the Apple graphics features and text. This version is provided with a demonstration cassette written in Integer BASIC for easy modification by the user if desired and allows use of the pen in the user’s own programs. A complete listing of the light pen routine and suggested uses is included in the applications manual. The light pen is priced at $249.95.

Circle 586 on Inquiry Card.

**X,Y Plotter Unit from Sylvanhills Laboratory**

This X, Y plotter includes a plotter, drawing surface, electronics, and power supply completely assembled and ready for interface to any 8 bit transistor-transistor logic parallel port. The pen holder accepts any writing instrument or stylus 7 to 11 mm in diameter, encoded for 0.01 inches per pulse (0.005 inch optional). The maximum pen travel speed is 2.5 inches per second with a 24 V supply. A basic 8080 software program is included in the owner’s manual. Applications include architectural, mechanical, and schematic drawing; printed circuit board artwork; positioning of small objects; computer generated art; games; and others.

The plot driver software is available as ASCII source files on paper tape and CP/M small disk formats. TEL and Cromemco small disk formats are also available. Both the BASIC and assembler source are provided, and contain comments which guide the user in making source modifications.

Unit-1 with an 11 by 17 inch drawing area is $1,049; Unit-2 with a 17 by 22 inch drawing area is $1,249. The plotters are also available in kit form with console and power supply priced separately. The owner’s manual can be purchased for $5. For further information, contact Sylvanhills Laboratory Inc, POB 646, Pittsburg KS 66762.

Circle 588 on Inquiry Card.

**TRS-80 Expandable Interface**

Microtronix has introduced an expandable interface for the Radio Shack TRS-80. The basic interface unit uses low power Schottky circuitry, the standard Radio Shack 40 pin bus, and provides the following features: two joysticks for games, screen editing and educational instruction; stereo sound using two RCA 1863 programmable integrated circuits; parallel printer interface. At an introductory price of $129.95, the interface may be ordered with a $29.95 optional real time clock. Joysticks and music may be controlled directly from the user’s BASIC program, using the INP and OUT commands. For further information, contact Microtronix, POB Q, Philadelphia PA 19105.

Circle 589 on Inquiry Card.
CASSETTE SOFTWARE

For 6080/2-80 µC...  
BASIC ETC — Developed by the co-authors of the original Tiny BASIC, BASIC ETC is easy to use yet includes commands and functions required for powerful business and scientific programs as well as for hobby applications. 9.5K bytes of RAM, 1200-baud cassette and 42-page user's manual ............... $35.00

Cassette Operating System — EPROM (2708) CDS for the Percom CI-812 dual peripheral interfacing PC card... $39.95

If you’re programming on a 6800 µC, you’ll want these development and debugging programs written by Ed Smith of the Software Works:

Disassembler/Source Generator — Disassembles SWTP Resident Assembler, TSC Mnemonic Assembler/Text Editor or Smokas Signal Mnemonic Assembler/Text Editor and produces compacted source code suitable for re-editing. Prints or displays full assembly-type output listing.

Prices Include a comprehensive instruction manual, Universal Adaptor Kit, IC Socket Kit, MITS 680b modem documentation, Universal Adaptor Kit (for program control of recorders), and an IC Socket Kit are also available.

Prices include a comprehensive instruction manual. Also available: "test Cassette, Remote Control Kit (for program control of recorders), IC Socket Kit, MITS 680b modem documentation, Universal Adaptor Kit (converts CIS-30+ for use with any computer).

Amiga 6869 Processor Card — With this SS-50 bus PC board, you’ll be able to upgrade with the microprocessor that Motorola designers describe as the “best 8-bit machine so far made by humans.”

The Electric Crayon™ — This color graphics system includes its own µP and interfaces to virtually any microcomputer with a parallel I/O port.

Printer Interface — For your TRS-80™. Interface any serial RS232 printer to your TRS-80™ with this system.

Support Relocating Program — Supplied on EPROM, this program relocates a program in any contiguous area of RAM or ROM to anywhere in RAM. Use to assemble and test programs in RAM, adjust programs for EPROM operating addresses and then move block to EPROM burner address. 652 bytes of RAM. Loads at hex 1000.

Relocating Assembler & Linking Loader (M686AS) $50.00

Relocating Disassembler & Segmented Source Text Generator (M686RS) $35.00


HARDWARE

Newtech Model 68 Music Board — Produces melodies, rhythms, sound effects, morse code, etc. from your programs. Includes manual with BASIC for writing music scores and assembly language routine to play them. Installs in SWTP I/O slot. Assembled and tested .......... $59.95

The Percom ELECTRIC WINDOW™ — Memory-resident and programmable, this video display character generator board for your SS-50 bus displays up to 24 80-character lines. Features dual character generators, dual-intensity high-lighting, one programmable register controls scrolling. Compatible with standard video monitors ...$249.95

SS-50 Prototype Cards: Large card (up to 70 40-pin ICs) $24.95

To order products or request additional literature, call Percom's toll-free number: 1-800-527-1592. For detailed technical information call (214) 272-3421.
Computer Terminals Directory

A user-oriented directory of computer terminals has been published by the Association of Time-Sharing Users (ATSU). This guide contains photographs and full page information about each of 120 terminals. In addition to the latest pricing information, the directory lists each terminal’s lease costs (when available), the number that have been installed, and information about whom to contact at each supplier. The Computer Terminals Directory is available for $3 in bound form. It is available as part of a membership in ATSU for $85, in loose leaf form, as it is part of the Association’s three volume Interactive Computing Directories. Orders for the Directory or for Association membership should be sent to ATSU, POB 9003, Boulder CO 80301.

The Slavemaster 2650 Multiprocessor System

The Slavemaster 2650 S-100 bus multiprocessor system is based on the MC68000 microprocessor. The system is composed of two identical S-100 cards interconnected by one ribbon cable. One is identified as the slave and the other the master. The only functional difference is that the master has the ability to reset, reset-jump, or stop the slave.

Both processors operate at full speed with fetch and execute cycles interleaved in such a way that precise single processor timing is maintained. Once synchronized, there is no interaction between the two processors. Communication between the two processors is through a common data base in the S-100 memory.

Some of the features of the Slavemaster card include Kansas City cassette interface, RS-232/20 mA serial I/O (input/output), keyboard interrupt on serial input, real time clock interrupt, power fail interrupt, eight vectored interrupts decoded on board, 4 K byte 2708 erasable read only memory sockets with dual-in-line package switches to select reset and power-on jump address. The kit is priced at $198 per board.

For further information, contact Victoria Micro Digital, 401 Dundee St, Victoria TX 77901.

Western Digital System Speeds Up Pascal

A set of integrated circuits which directly executes the object code from a Pascal compiler has been developed by Western Digital Corp, 3128 Red Hill Av, POB 2180, Newport Beach CA 92663. The 16 bit processor, which forms the basis of the Pascal Microengine product line, executes Pascal programs at least five times faster than conventional system software. The system uses the version of Pascal which was developed at the University of California at San Diego (UCSD). The UCSD Pascal software system includes a complete operating system with the Pascal compiler, BASIC compiler, file manager, screen-oriented editor, debugging program, and graphics package; all written in the Pascal language.

The four integrated circuits are the following LSI metal-oxide semiconductor components:

- an arithmetic device containing arithmetic and logic unit, micro-instruction decoding, and the register file;
- a microsequencer device containing macroinstruction decoding, portions of the control circuitry, microinstruction counters, and I/O (input/output) control logic;
- two MICROD devices containing the microinstruction read only memories and microdiagnostics.

Direct execution of the p-code (pseudo-code) produced by the Pascal compiler eliminates the previously required host operating system and p-code interpreter.

Additional features of the Microengine system include user-defined bus configuration, four levels of interrupts, single and multibyte instructions, hardware floating point operations, stack architecture, a 3.0 Mhz 4 phase clock (75 ns per phase) and a transistor-transistor logic compatible three-state interface.

Stand-Alone Microprocessors

Three stand-alone microprocessors, the µPD8048, µPD8748, and µPD8035, have been announced by NEC Microcomputers Inc, 173 Worcester St, Wellesley MA 02181. The µPD8048 contains the following features normally found in external support devices: 1025 by 8 bits of read only memory; 64 by 8 bits of programmable data memory; 27 I/O (input/output) lines; 8 bit interval timer and event counter; and oscillator and clock circuitry.

The µPD8748 (available late 1979) differs from the µPD8048 only in the use of an 1024 by 8 bit ultraviolet erasable read only memory for its program memory, while the µPD8035 is scheduled for applications using external program memory. The functional power of the units can be expanded using standard 8080A/8085A peripherals and memory products. The microprocessors are available in a standard 40 pin, plastic or ceramic dual-in-line package.

BASIC With Style

BASIC With Style by Paul Nagin and Henry Ledgard is intended for BASIC programmers who want to write carefully constructed, readable programs. This 134 page book offers short rules and guidelines for writing more accurate, error free programs. These simple elements of style enable the programmer to focus creativity on the deeper issues in programming.

Chapter 1 is an overview. Chapter 2 is a collection of simple rules, called proverbs. The proverbs summarize the major ideas of the book in terse form. Chapter 3 is an introduction to a strict, top-down approach for programming problems in any programming language. The approach is oriented toward the easy writing of complete, correct, readable programs. Chapter 4 gives a set of strict program standards for writing programs, and Chapter 5 elaborates on several important and sometimes controversial ideas discussed in the chapter on programming proverbs.

The cost of the book is $5.95. It is available from Hayden Book Co Inc, 50 Essex St, Rochelle Park NJ 07662.
TR5-80 FORTRAN PLUS
$340

ANADBEX PRINTER
Model DP-8000 $999

TR5-80 LEVEL III BASIC $42

As advertised in March issue. Leads on top of Level II is now a TR5-80 into a powerful system. Serves, debugging problems, uses keyboard 'source': Software cassette, has the power of a hardware modification. Guaranteed satisfaction! Cat No. 1372

TR5-80 ELECTRIC PENCIL
Character oriented word processing system. Produces mailing lists, business forms, large numbers of original correspondence. Simple control commands can be entered through the Electric Pencil. No carriage return or carriage feedations. Four formats of typing are done by the Electric Pencil! Also features right margin positioning, page numbering.

$95

S-100 COMPUTER BOARDS

VERBATIM 5 1/4" DISKETTES $27 box of 10
Cat No. Type
1147 Soft sector TRS-80, Apple
1148 Hand, 16 hole, North Star
1149 Hand, 16 hole, Micropolis

SHUGART SA-400 MINILLOPPY DRIVE $295
Hard and soft sectoring, single density, 35 track, requires power supply. Cat No. 1554

TR5-80 SOFTWARE CASSETTES

VERBATIM 5 1/4" DISKETTES $27 box of 10
Cat No. Type
1147 Soft sector TRS-80, Apple
1148 Hand, 16 hole, North Star
1149 Hand, 16 hole, Micropolis

Send for FREE SPRING CATALOG FEATURING:
FACTORY FRESH PRICED TO SELL!!
MINILOPPY, WIRE WRAP, BOARD ACCESSORIES, SOFTWARE AND MORE.

Pay by check, COD, Visa, or Mastercharge. Order by phone or mail. Please include phone number and / or address. This offer expires Dec 1st. Questions? 1-800-423-5878

Call Toll Free: (800) 423-5878
CA, HI, AK: (213) 886-9200

19355 BUSINESS CTR DR 686
NORTH RIDGE, CA 91324

HOBEE WORLD
Circle 200 on Inquiry card.
Universal Interface Converts IBM Selectric Typewriters

This universal interface unit has been designed for IBM Selectric typewriter conversions. The unit will interface to any RS-232, IEEE-488 or parallel port. A microprocessor is included on the circuit board for data flow control, formatting and character set selection. Installation on the Selectric is easy and does not affect normal typewriter operation. For those who do not want to convert their own typewriter, the company provides factory installation service. Selectric typewriters with conversion systems installed in accordance with factory instructions are still eligible for IBM warranty and service provisions. For further information, contact ESCON Products Inc, 171 Mayhew Way, Santa Clara CA 95051.

Circle 581 on inquiry card.

Printerm Model 879 Micro/Mini Printer

The Model 879 Micro/Mini printer is a high speed bidirectional printer which prints 120 characters per second at 75 lines per minute. It has a 9 by 7 or 9 by 9 high density matrix format, and provides up to four copies. The Model 879 is priced at $295 for the standard model. For further information, contact Printer Terminals Corp, POB 535, Ramona CA 92065.

Circle 582 on inquiry card.

Low Cost Modification to DECwriter Printer Adds Graphics

The Graphics II system is a low cost graphics modification for the Digital Equipment DECwriter II printer. It is available to upgrade existing printers, or can be factory installed with a new printer. The Graphics II system consists of a replacement circuit board for the DECwriter II and is plug compatible with internal cables for simple installation. The new circuit board uses the Fairchild F8 microprocessor.

The DECwriter is a dot-matrix printer, and the Graphics II allows printing of a dot anywhere on the page. Bidirectional line feed is introduced, and the Vector Graphics capability allows the printing of a line between any two points on the page by using ASCII characters to specify the end point coordinates. This means that graphics can be generated by using the printer keyboard. ASCII and APL character sets are standard, and other character sets can be used. Characters can be printed in any of your rotational orientations, and printed normal size, heavy bold face, or expanded width. The printing of bar code is also available.

The average printer speed has been increased to 50 characters per second, and data may be transmitted in bursts of up to 1000 characters at 1200 bps. Other features included as standard are EIA RS-232, 20 mA current loop and TTL interfaces, auto linefeed, top of form, and horizontal and vertical tabs.

The Graphics II system is priced at $850 as a field installed circuit card. For further information, contact Selanar Corp, 3054 Lawrence Expressway, Santa Clara CA 95051.

Circle 584 on inquiry card.

High Density Video Programmable Memory Module

The MTX-2064 and MMD-2480 are new members of the Matrox video programmable memory family (VRAM) of TV video controllers. The family provides an interface between any microprocessor and a TV monitor. On the input side the VRAMs look like a 1280 by 4098 by 8 bit static programmable memory with an access time of 500 ns. The output of the MTX-2064 is a video signal providing a flicker free display of 20 lines by 64 upper and lower case characters. The MMD-2480 provides 24 lines of 80 characters and limited graphics capability. No external refresh or memory is required. Any character may be displayed normally, inversely or blinking.

The bus structure permits direct interfacing to most micro and mini-computers. Being part of memory, the full power of the processor instruction set is available for display manipulations. A universal phase lock loop module permits the MMD-2480 to be locked to an external sync source such as a TV camera. Another option available for both models is a choice of American and European television standard field rates.

The units are completely self-contained and ready to use, including sync generator, programmable memory, read only memory and bus interface. They are housed in pin compatible 4.5 by 6 by 0.5 inch (11.43 by 15.24 by 1.27 cm) modules and draw under 800 mA from a single +5 V power supply. The MTX-2064 is priced at $295 and the MMD-2480 is $395. For further information, contact Matrox Electronic Systems Ltd, 2782 Bates Rd, Montreal, Quebec CANADA H3S 1BS.

Circle 583 on inquiry card.
Sankyo Magnetic Card Reader

$59

These Sankyo I/O units are capable of storing and retrieving over 400 characters of data in under two seconds. The flexibility of this device lends itself to numerous applications. As an input reader to a computerized security system, the computer has the ability of identifying the card holder and admitting only those individuals who are authorized to enter the premises during specified time frames. The device is also suitable for maintaining customer information files, or any other application where small amounts of information must be quickly entered into a data processing system.

Accepts 2" by 4" HP style mag cards. (Similar to bank cards.) Motorized feeder pulls the magnetic card across the four channel read/write head. MRP: $70.00. Full documentation.

SA800-R Floppy Disk Drive

The most cost effective way to store data processing information, when read/write is a prime factor. The SA800 is fully compatible with the IBM 3745 format. Write protect circuitry, low maintenance & Shugart quality.

$449.50

PORTABLE DATA ENTRY SYSTEM

These used data terminals were originally designed for chain store inventory control and order entry systems. The operator enters the inventory control number, merchandise on hand and the unit price. After all pertinent data has been entered into the recorder, the main warehouse is telephoned, the handset is placed in the acoustic coupler and all the recorded information is transmitted back to the master computer. With a little imagination and one of these portable entry systems, you should be able to exchange programs and computer information with associates across the country.

All units were removed from service in working condition. Original cost $3,500.

Each system comes complete with:

• Portable Cassette Drive Unit
• Removable Keyboard
• LED Display
• 5-44 Cable
• Acoustic Coupler
• Shoulder strap
• Full Documentation

DIGITAL CASSETTE DRIVE

This precision I/O assembly features remote software controlled search capabilities. Two independent computers direct motors allow the computer control direction and speed of the transport. The assembly consists of a Raymond cassette transport, chassis, mother board and three edge cards: read/write, cassette drive & control card. Current replacement values are over $7000. Schematics and complete documentation included. Used, but in excellent condition.

(213) 679-9001

All merchandise sold by California Digital is prairie grade. Goods are shipped F.O.B. Torrance, California. All items are subject to 6% California sales tax unless otherwise recorded. California residents add 6% sales tax. We accept VISA, Mastercard and DISC.

Circle 39 on inquiry card.
Polytonic Keyboard System Generates Orchestral Textures

The 1550 Stringz-n-Things kit is a polytonic keyboard system from PAIA Electronics, 1020 W Wilshire Blvd, Oklahoma City OK 73116. This multipurpose instrument is capable of generating orchestral textures consisting of violin, cello, and piano voicings. A separate output also provides piano only, to allow separate processing, amplification, or mixing of the two types of voices. A full complement of operator controls allows switch selectable keyboard splits, separate mixers for upper and lower keyboard, variable vibrato and chorusing rate and depth controls to allow reed organ and pipe organ voicings, and variable sustain controls for piano and strings.

A standard gate trigger allows the 1550 to be interfaced to any of the commercial synthesizers which feature systems interfacing jacks. This allows capabilities for brass synthesis, filtered strings, and other polytonic synthesizer effects.

Optional features include foot pedals for volume or sustain time control, foot switches for sustain control, and the 1551 stereo option to convert the mono string output to a true stereo output with two switch selectable modes of stereo operation. Other options include a processor interface to allow memorization of string or piano parts for later reproduction at any tempo and key desired. Also, the processor interface will allow the 1550 keyboard to simultaneously control a modular polyphonic synthesizer system.

The complete Stringz-n-Things kit including 84 page, step-by-step assembly and operation manual is available for $295.

Circle 604 on Inquiry card.

Right Angle PC Mount Original D Connectors

An expanded range of right angle, printed circuit mount original D type subminiature connectors has been introduced by Souriau Inc, 7740 Lemona Av, Van Nuys CA 91405. The 831 series has been updated to include a fixed contact strap and a nonmetallic, fully insulated plastic mounting bracket and a new Underwriters Laboratory 94-VO rated thermoplastic insulator with a temperature range of -55°C to +105°C (−67°F to 221°F). The 831 series modifications are available in all layouts from 9, 15, 25, 37 to 50 pin and may be used with units from competitive manufacturers.

A comprehensive 12 page catalog detailing subminiature D, original D, D*M, and Norman/D connectors and accessories is available free upon request.

Circle 606 on Inquiry card.

Standard Reference Alignment Cassette

Magnetic Information Systems has announced the introduction of an alignment reference metal cassette for use in the calibrating of digital and word processing equipment. This cassette is pre-recorded at 1600 flux changes per inch (FCI) on an optical alignment recorder which employs precision magnetic heads. The magnetic tape is especially made for the digital reference tape application. These cassettes are priced at $12.50 and are available in several special configurations. For further Information, contact Magnetic Information Systems Inc, 415 Howe Av, Shelton CT 06484.

Circle 608 on Inquiry card.

Energy Monitor Saves Money

The Energy Monitor is an electronic device with a built-in microcomputer that budgets energy use on a daily basis and converts kW usage to visual dollars and cents. The amount of energy used is continually and automatically displayed in dollar amounts on a lighted digital display. Set a budget, and if usage exceeds the desired budgeted amount, a warning flashes. At the end of the billing period the Energy Monitor automatically resets to zero and stands by to provide the savings on utility bills.

Installation is simple and inexpensive. A lighted panel displays eight functions: current dollar cost for energy used, of last bill, billing date, chosen energy budget, cost per kW hour, date and time of day. The unit retails for $295. For further information, contact Dupont Energy Management Corp, 3301 Conflans, Suite 102, Irving TX 75061.

Circle 607 on Inquiry card.

Computer Desk for Cromemco Computers

Cromemco is offering a new computer desk for the System Three and other Cromemco computers. The desk is designed and constructed to fit into any office surroundings or professional environment. The computer is mounted into a special shelf under the desk. This leaves the top free for a terminal, printer, or other unit, or as a work surface, while still providing the operator easy access to the computer for disk loading and unloading. The desktop is an attractive beige color designed to harmonize with the medium light wood veneer ends. The top surface is a tough, laminated plastic.

The Computer Desk (Model 23-MDSK) is available for $695. For additional information, contact Cromemco Inc, 280 Bernardo Av, Mountain View CA 94043.

Circle 607 on Inquiry card.
Assembled and Tested
Added at Ithaca Audio

Field-proven reliable engineering

Over 15,000 boards worldwide prove Ithaca Audio provides the quality and reliability you demand.

Ithaca Audio Boards are fully S-100 compatible, featuring gold edge connectors and plated-through holes. All boards (except the Protoboard) have fully buffered data and address lines, DIP switch addressing, solder mask and parts legend.

- **Z-80 CPU Board** still the most powerful 8 bit central processor available. Featuring power-on-jump, provision for on-board 2708's or 32K of 2716's.
- **Disk Controller Board** controls up to 4 single or double sided drives. Supported by a host of reliable software packages: K2 FDOS, Pascal, Basic and complete diagnostics.
- **K2 FDOS** Disk software in the DEC tradition includes character oriented text editor (TED), File Package (FP), Debugger (HDT), Assembler (ASMABLE), HEXBIN, 1 COPY, System Generator (SYSGEN) and more. Command syntax follows Digital's OS-8/RT-11 format. First in a family of high level software. Basic and Pascal available now. Soon-to-be-released Fortran.
- **Video Display Board** features the full 128 upper/lower case ASCII character set. Easy-to-read 16 line x 64 character format can be displayed on an inexpensive video monitor or modified TV set. Includes TTY software. Add our powerful K2 FDOS to create a versatile operator's console.
- **8K Static RAM Board** High speed static memory at a reasonable cost per bit. Includes memory protect/protect and selectable wait states.
- **2708/2716 EPROM Board** Indispensable for storing dedicated programs and often used software. Accept up to 16K of 2708s or 32K of 2716s.
- **Protoboard** Universal wire-wrap board for developing custom circuitry. Room for three regulators. Accepts any size DIP socket.

The leading manufacturer of blank S-100 boards is adding a new wrinkle—now all their boards are available assembled and tested.

"This is a natural progression for the company" according to Mr. James Watson, President. "Actually we've been supplying assembled and tested for some time to our volume customers and OEM's, particularly those overseas. Our production staff is now fully up to speed, so just about everything is available from stock." The company scheduled 6 months to phase in assembled and tested to allow time to build base inventories, before offering the boards to the public. "We feel this is quite important. A lot of companies have earned themselves a bad name in this business by announcing products they can't really deliver. We simply won't do that," Mr. Watson further explained that Ithaca Audio intends to remain leader in blank boards and expects to release a minimum of 6 new designs by August, which will be offered both blank and assembled and tested.

**Memory Prices**

**Tumble**

Ithaca Audio first to break 1¢/Byte Barrier

By cutting prices for 32K of RAM to $319 Ithaca Audio becomes the first computer vendor ever to offer high speed memory for less than a penny a byte. Commenting on the announcement, Steve Edelman, Director of Engineering said "Just a few years ago people were wishing for a penny a byte, and even now memory for most large computers costs about 2¢/byte and that's only in 1 Megabyte chunks." In fact it's the relative modest capacity of the 32K board that makes it so interesting. Users need not buy the full 64K to take advantage of the low price per bit. Furthermore, the board is available both as a kit and assembled and tested.

Delivery is stock to two weeks. Pricing is:

- 32K kit $319
- 32K A&T $359
- 64K kit $645
- 64K A&T $695

**8” Disk Drives**

Shugart compatible Memorex 550's are in stock.

Single and double density compatible, 330K bytes capacity with our controller or use your own.

Either way $456

**Pascal/Z Ready**

The first Pascal Compiler for the Z80, and the fastest Z80 Pascal ever is now ready. Over one year in development, Ithaca Audio was obviously pleased with the results. "We really have outperformed them" states Jeff Yackow, Director of Software Engineering, beaming over the recently released benchmark, in which Pascal/Z averaged better than five times the speed of a recent P-code implementation.

"Pseudo-code means a vendor only has to supply one compiler to lots of people using lots of different machines, and that makes his life very easy, but it also means users' programs execute significantly slower. Therefore, we chose to write a native compiler that delivers fast re-entrant ROMable code, with no need for an intermediate language and interpreter. That's where our speed comes from." As a matter of fact, Pascal/Z is often twenty times as fast as UCSD's implementation and may well be faster than dedicated Pascal machines such as the recently announced Western Digital Pascal Micro-engine. Unlike the Microengine, Pascal/Z does not require any new special CPU hardware and has the added benefit of compatibility with existing Z80 software.

Operational requirements of Pascal/Z are the Ithaca Audio K2 Operating system and 48K of memory during compiles. The output is standard Z80 Macrocode which is linked and run through the Ithaca Audio Macroassembler. Binary files may be as small as 2.5K, or even less if the full library is not used. The compiler, including the Macroassembler, is available on an 8" K2 floppy disk. Price including full documentation is $175.00. The Macroassembler is available separately for $50.00. Delivery is from stock.

**Software:**

For those that don't require the speed of a compiler like Pascal/Z, Ithaca Audio also offers the convenience of BASIC. BASIC/Z, an extended version of TDL's Super Basic, runs in slightly over 12K and is supplied in an 8" K2 disk for $75.00.

**SAVE Even More**

When you buy your software as a package K2 and Pascal/Z $225

K2, Pascal/Z and Basic/Z $275

**HOW TO ORDER**

Send check or money order. Include $3.00 shipping per order. N.Y.S. Residents include tax.

For technical assistance call or write to:

ITHACA AUDIO
P.O. Box 91
Ithaca, New York 14850
Phone: 607/257-0190

Circle 190 on inquiry card.

BY 11 June 1979

261
Personal Computer Software Packages

Time Series Analysis and Statistical Software Package for North Star

Potters Programs, 22444 Lakeland, St Clair Shores MI 48081 has announced a comprehensive time series analysis and statistical software package written in BASIC for the North Star floppy disk system. This package allows the user to load data into disk data files, edit the data, analyze it with a series of programs, and output the data in various convenient formats.

The analysis programs include a fast Fourier transform, auto correlation, cross correlation, distribution function, probability function, negative peak, positive peak, average, root mean squared, and various statistical and correlation calculations. The data can be recorded on disk from manual input or from analog to digital converters. It can be scanned and edited to remove obvious noise, and any part of the file can be analyzed by any of the methods. This package is available on North Star disk for $120.

Circle 576 on inquiry card.

Learn PET BASIC

PET BASIC Complete consists of twenty lessons of PET BASIC, including all the major BASIC keywords, cursor control, screen editing, and use of the cartography characters. This two cassette tutorial is especially designed for beginners Commodore PET users. The 170 page manual which accompanies the cassettes is indexed for quick reference, three holes punched for easy review, and reproduces all data appearing on the screen (except PET's graphics). Quizzes and exercises add to the fun of learning how to use and program the Commodore PET. The package is priced at $39.95. For further information, contact ARESCO, POB 43, Audubon PA 19407.

Circle 577 on inquiry card.

Software for the PET and TRS-80

Speakeasy Software has announced the availability of consumer oriented software for the PET and TRS-80, in addition to the Apple versions. The titles fall into two categories: the Continuing Education Series, which includes financial analysis and transactional analysis; and the Home Entertainment Series with Warlords, Bulls and Bears, Sports trivia, Microtrivia, and Kidstuff. For further information, contact Speakeasy Software Ltd, POB 1220, Kemptville, Ontario CANADA K0G 1J0.

Circle 578 on inquiry card.

Accounting Programs for Small Computers

The Standard Software Library is a series of books containing listings or programs written in BASIC with complete documentation. Each volume in the series is devoted to a single application.

The first three volumes deal with accounting programs for small computers. Volume 1 (General Ledger) enables a small business to set up a fully automated chart of accounts. Included are programs for editing, sorting, merging and posting of transactions. A trial balance report is available in either summary or detail at the user's option. Income statement and balance sheet reports may be obtained at the close of each accounting period with both current and year-to-date totals and percentages. Volume 2 (Accounts Receivable) provides a fully automated system for dealing with customer accounts. Volume 3 (Payroll) enables a business to automate all of the normal payroll functions.

All of the programs are written in a level of BASIC which is common to almost all current microprocessors and minicomputers. The modular nature of the programs and the accompanying documentation make it easy to revise the program to meet special user requirements. The price of the Standard Software Library is $49.95. For further information, contact Creative Computer Consultants Inc, POB 2111, Norwalk CT 06852.

Circle 580 on inquiry card.

Software and Hardware for Jolt and TIM Owners

Three new products have been announced by The 6502 Program Exchange, 2920 Moana, Reno NV 89509. The JAB (Jolt Adapter Board Kit) is a hardware device designed to interface the Jolt computer to the KIMSI S-100 Interface. The $19 JAB Kit includes a manual and all parts except the Jolt connectors. A program called ERAC (Editor and Resident Assembler Controller) was developed for users of the read only memory version of the Jolt Resident Assembler. ERAC allows source text and object code to be placed in programmable memory. Reading in 2 K bytes, ERAC is an extension of the RAP. A paper tape is available for $5 and the manual is $4.50.

LEDIP (Line Editor Program) is a compact line oriented text editor that readily lends itself to modification or expansion. LEDIP will output source text suitable for use with the programmable read only memory version of the Jolt Resident Assembler. The paper tape is $2.75, the manual is priced at $3.25 and the cross assembly is $5.

Circle 579 on inquiry card.
Parallel/Serial I/O Card with Modem

The 8P2SM Parallel/Serial I/O (Input/output) card with modem is the latest output card with modem. It combines eight parallel ports (including full handshaking) with two serial input and output ports. It also enables the user to configure one set of serial ports for full RS-232 operation, and the other as a full duplex answer or originate modem. A complete documentation package is included with the board. The price is $149 in kit form and $199 completely assembled and tested.

Circle 598 on inquiry card.

Self-Pace Logic Trainer

The Model 100 Broder Logic Trainer trains students without previous electronic background for digital electronic related assignments. It improves and grades the ability of the user. The Model 100 includes all gates, flip-flops, positive and negative edge triggered devices, master-slave clocking, preset and clear functions, Switch circuit and Venn diagram problems as well as BCD and binary counting modes are included.

Physical logic state manipulation and the visual display make for fast and retained learning. In operation, the user manipulates component logic states using the eight logic switches. Solving a problem requires logic switch manipulation to force a logic 1 at the problem card output, which will turn on the designated bar indicator. A manual, 40 digital problems, and a 9V battery cell are included. The Model 100 requires no wire or integrated circuit manipulation. It is priced at $69.95 and is available from L J Broder Enterprises Inc., 3192 Darvany Dr., Dallas TX 75220.

Circle 599 on inquiry card.

Floppy Disk Read Amplifier System From Motorola

Motorola has introduced its MC3470 Floppy Disk Read Amplifier System. Combining both linear and digital functions on one integrated circuit, the MC3470 provides all signal processing from the read head through to the standard logic level digital output.

Contain in the circuit are the required gain stages, an active differentiator-comparator for peak detection and a time domain filter for waveform shaping and elimination of false outputs. External connections for the required filter network, active differentiator and timing control components allow the system designer optimum flexibility in meeting overall system performance requirements.

This single monolithic device provides a standard TTL (transistor-transistor-logic) digital output which is free from amplitude and waveform variations present at the read head, with a guaranteed maximum unadjusted peak shift of 5.0%.

The MC3470 Floppy Disk Read Amplifier System is available in an 18 pin plastic dual-in-line package at the price of $5.95 for quantities of 100 and up. For more information, contact Motorola Semiconductors, POB 20912, Phoenix AZ 85036.

Circle 600 on inquiry card.

Apple II Software

The MUSE Co., POB 13365, Baltimore MD 21203 has announced a complete line of software for the Apple II computer. A full feature text editor ($17.95) allows management of a free form text. Multiple space compression and tape I/O (input/output) are used for efficient file storage. U-Draw ($17.95) is a high resolution programmable graphics editor with tape I/O for storing finished drawings. Documentation includes instructions for linking figures to user programs. The Electronic Crayon ($17.95) is a graphics editor similar to U-Draw but in low resolution color. The Music Box ($12.95) gives three octaves of sound with no additional hardware. Type in a song, and the Music Box will play it for you. Notation includes sharps, flats, note time, rests, dotted notes and tempo. It can be returned easily for special sound effects. The Number Cruncher ($9.95) is a set of single precision math and ASCII to hexa-decimal subroutines. Games which are priced at $12.95 each are also available.

Circle 801 on inquiry card.

DC Motor Speed Control in a Dual-In-Line Package

This monolithic integrated circuit DC motor speed control, housed in a 14 pin, low profile plastic dual-in-line package, is available from Cherry Semiconductor Corp., 3600 Sunset Av, Waukegan IL 60085. Designated the CS-175, the motor speed control is designed to provide maximum flexibility at a low cost. Requirements for adjustment and external components in multiple speed applications have been reduced by giving accurate, pin-programmable speed ratios for slow, medium, or fast motor velocities.

While many other applications are possible, the CS-175 is primarily intended for use with AC tachometer signals. The unit is capable of providing such stability that errors are dominated by terms created by the finite loop bandwidth made necessary to ensure stability with the dynamics of the specific motor and load.

The price for the CS-175 is $1.68; $.79 in 1,000 piece quantities; and $.65 in 10,000 quantities.

Circle 802 on inquiry card.

New Module Solves TRS-80 Cassette Drive Hang-Up

The TBUFF module is a simple inexpensive nonrepair shop solution for TRS-80 cassette drive hang-up. The module simply plugs in series with the remote cable between the TRS-80 and the recorder. TBUFF reduces the current passed through the reed relay in the TRS-80. At the same time, TBUFF delivers full power to the recorder, thus maintaining proper tape speed and volume levels. TBUFF sells for $7.95 (California residents add 6%). For further information, contact Web Associates, POB 60, Monrovia CA 91016.

Circle 803 on inquiry card.
VIDEO COMPUTER PROCESSING SYSTEM

OUR VP1 VIDEO SYSTEM CONSISTS OF THE FOLLOWING KITS:

- OCD 202C SOLID STATE VIDEO CAMERA KIT ASSEMBLED & TESTED .... $499.00
- VP-1 COMPUTER/VIDEO INTERFACE SYSTEM (3 BOARDS) ASSEMBLED & TESTED .... $999.00
- ASSEMBLED 8K MEMORY BOARD (OPTIONAL) .... $235.00

THIS VIDEO COMPUTER KIT CAN WORK WITH THE GE, REDICON, OR ANY OTHER 128 x 128 SENSOR CAMERA.

 Produktionspleads... Announces a Breakthrough in Computer Technology

A PICTURE MAY BE TAKEN BY OUR CAMERA, STORED IN A COMPUTER IN REAL TIME AND THEN DISPLAYED ON A CRT AT AN AFFORDABLE PRICE

GRAY LEVELS

THE CAMERA WILL TAKE BETWEEN 15 AND 100 FRAMES/SECOND, THE CAMERA CONNECTS TO THE PROCESSOR WITH SEVEN LINES. THIS INCLUDES VIDEO AND TIMING SIGNALS APPLICATIONS:

- CONTINUOUS SURVEILLANCE
- INSPECTION OF MOVING PARTS WITH PROPER PROBING
- VISUAL GRAPHIC INPUT TO A COMPUTER
- CHARACTER OR PATTERN RECOGNITION
- PICTURES MAY BE TAKEN DIRECTLY FROM A TV WITHOUT ELECTRICAL CONNECTIONS
- THE INTERFACE KIT MAY BE USED SEPARATELY AS A 128 x 128 16 LEVEL GRAPHIC DISPLAY

THE SYSTEM USES A STANDARD SOLID STATE SOFTWARE WHEN NOT ADDRESSED

PRINTED CIRCUIT BOARD

<table>
<thead>
<tr>
<th>Board</th>
<th>Material</th>
<th>Design</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRINTED CIRCUIT BOARD</td>
<td>NOMEX</td>
<td>4-LAYER</td>
<td>4 x 6</td>
<td>50</td>
</tr>
</tbody>
</table>

TRANSPORTERS

<table>
<thead>
<tr>
<th>Host Processor</th>
<th>Memory Size</th>
<th>Memory Type</th>
<th>Memory Capacity</th>
<th>Memory Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>16-bit</td>
<td>16KB</td>
<td>SRAM</td>
<td>16KB</td>
<td>$100.00</td>
</tr>
<tr>
<td>32-bit</td>
<td>32KB</td>
<td>DRAM</td>
<td>32KB</td>
<td>$200.00</td>
</tr>
<tr>
<td>64-bit</td>
<td>64KB</td>
<td>EDO RAM</td>
<td>64KB</td>
<td>$400.00</td>
</tr>
</tbody>
</table>

FUEL WAVE BRIDGES

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 MHz</td>
<td>10 MHz</td>
<td>$50.00</td>
</tr>
<tr>
<td>20 MHz</td>
<td>20 MHz</td>
<td>$100.00</td>
</tr>
<tr>
<td>30 MHz</td>
<td>30 MHz</td>
<td>$150.00</td>
</tr>
</tbody>
</table>

TANTALUM CAPACITORS

<table>
<thead>
<tr>
<th>Capacitance</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 pF</td>
<td>100 pF</td>
<td>$0.01</td>
</tr>
<tr>
<td>1000 pF</td>
<td>1000 pF</td>
<td>$0.10</td>
</tr>
<tr>
<td>1 nF</td>
<td>1 nF</td>
<td>$1.00</td>
</tr>
</tbody>
</table>

SANKEN AUDIO POWER AMPS

<table>
<thead>
<tr>
<th>Power Output</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 W</td>
<td>10 W</td>
<td>$25.00</td>
</tr>
<tr>
<td>30 W</td>
<td>30 W</td>
<td>$50.00</td>
</tr>
<tr>
<td>50 W</td>
<td>50 W</td>
<td>$100.00</td>
</tr>
</tbody>
</table>

TRICKS

<table>
<thead>
<tr>
<th>Trick</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>100X</td>
<td>100X</td>
<td>$50.00</td>
</tr>
<tr>
<td>200X</td>
<td>200X</td>
<td>$100.00</td>
</tr>
<tr>
<td>500X</td>
<td>500X</td>
<td>$250.00</td>
</tr>
</tbody>
</table>
The EXPANDORAM is available in versions from 16K up to 64K, so for a minimum investment you can have a memory system that will grow with your needs. This is a dynamic memory with the included on-board refresh, and IT WORKS!

- Bank Selectable
- Phantom
- Power 5VDC, ±16VDC, 5 Watts
- Lowest Cost Per Bit

Uses 4116 RAMS

PC Board is doubled solder masked and has silk-screen parts layout.

**DISC DRIVES**

Sugart SA400 5 1/2" with attractive metal case $295.00

Sugart 801 with attractive metal case $495.00

Siemens FDD 200-88 double sided double density $599.00

**CONTINENTAL SPECIALTIES CORPORATION**

**LOGIC PROBES**

CSS logic probes are the ultimate tool for board level design and testing. These back-workProbe on insert insertion of circuit conditions.

Simple to use; just pop power leads to circuit's power supply, set logic family switch to TTL, or CMOS.

**DISC CONTROLLER**

The Versatile Floppy Disk Controller

Only $159.00

**SAVE $1000.00**

**DM2700S DISK & CABINET with POWER SUPPLY**

DM2700S includes Siemens FD120-8 Disk Drive with the following features:

- Single or Double Density
- Hard or Soft Sector
- Door Interlock
- Write Protect
- Hard Sector Detection
- Data Cable
- 500 KBS Transfer
- Fan
- 800 KBS Unformatted
- Bit density 6536 BP1
- 8" Drives
- Sugar 800 Series Compatible

DM2700S Drive & Cabinet REG. $750 SALE PRICED $560.00

DM2700 Cabinet, Iess Drive DM2700 $249.00 $225.00

**STI00 PLUG BOARDS**

**SAVE**

**VECTOR PAK ASSEMBLED MICROCOMPUTER CASES**

Adjustable packaging system for S-100 bus microcomputers which will accommodate Altair 8800 and IMSAI 8080 board size cards.

- Smart looking, desktop unused handled by unflagged screws or fasteners.
- For 600 and 800 boards. Includes 8080 cards.
- Instantly accessible with snap out cover.
- Removable recessed front and rear panels.
- Fully adjustable interior mounting exists for out of board mounting within size limitations. No cutting or drilling necessary.
- Perforated bottom cover for cooler operation.

**DESCRIPTION**

Assembled case with perforated bottom cover. Installed mounting stud for card guides and receptacles or mother board. Cards too located, spanning limit to back. Cart gusset (12 pair) and chassis plate supplied uninstalled.

**PRIORITY ONE ELECTRONICS**

16723B Roscoe Blvd. Suite 102, Canoga Park, CA 91343

Terms: Visa, MC, BAC, Check. Money Order, C.O.D. U.S. Funds Only. CA residents add 8% sales tax. Minimum order $10.00. Prepaid U.S. orders less than $75.00 include 5% shipping and handling. Minimum $25.00. Excess refunded. In case, please include your phone no. Prices subject to change without notice.

We will do our best to maintain prices thru June 1979. OEM and Institutional orders welcomed. Phone orders welcome (213) 894-8171, (800) 423-5833. Inquiries invited.
The EXPANDORAM is available in versions from 16K up to 64K, so for a minimum investment you can have a memory system that will grow with your needs. This is a dynamic memory with the in-voluntary on-board refresh, and it WORKS!

- Bank Selectable
- Phantom
- Power 6VDC ±16VDC, 5 Watts
- Internal Power Bus
- Uses Popular 1416 RAMS
- PC Board is double sided, masked and has silk-screen parts layout.

The EXPANDORAM is available in versions from 16K up to 64K, so for a minimum investment you can have a memory system that will grow with your needs. This is a dynamic memory with the involuntary on-board refresh, and it WORKS!

- Bank Selectable
- Phantom
- Power 6VDC ±16VDC, 5 Watts
- Internal Power Bus
- Uses Popular 1416 RAMS
- PC Board is double sided, masked and has silk-screen parts layout.

- Extensive documentation clearly written
- Complete Kit includes all sockets for 64K
- Memory access time: 375ns.
- Cycle time: 500ns.
- No wait states required
- 16K boundaries and Protection via Dip Switches
- Designed to work with 8080, 8086 CPU's.

EXPANDO 64 Kit (4116) 16K $245.00 32K $310.00 64K $375.00 128K $440.00

The EXPANDORAM is available in versions from 16K up to 64K, so for a minimum investment you can have a memory system that will grow with your needs. This is a dynamic memory with the involuntary on-board refresh, and it WORKS!

- Bank Selectable
- Phantom
- Power 6VDC ±16VDC, 5 Watts
- Internal Power Bus
- Uses Popular 1416 RAMS
- PC Board is double sided, masked and has silk-screen parts layout.

- Extensive documentation clearly written
- Complete Kit includes all sockets for 64K
- Memory access time: 375ns.
- Cycle time: 500ns.
- No wait states required
- 16K boundaries and Protection via Dip Switches
- Designed to work with 8080, 8086 CPU's.

EXPANDO 64 Kit (4116) 16K $245.00 32K $310.00 64K $375.00 128K $440.00
**unbeatable GREAT JUMPERS**

**FLAT RIBBON CABLE ASSEMBLIES AT AFFORDABLE PRICES**

- Choice of 3 types of end connectors molded on and factory tested.
- Daisy chain and single end also available.

| P!lce | Sockets purchased in multiples of 50 per type may be combined for:
|-------|-------------------------------------------------------------|
| $20  | GOLD PLATED (best price)
| $25  | SOLDER TAIL, GOLD PLATED (only $3.30 additional)
| $30  | ALTAR MOTHERBOARD (available in 5000 qty.

* Solder Tail, Solder Lug, PLUS *

| BULK ALLOY WIRE | SOLE R TAIL on 140 spaced rows for 5000 sets.
|-----------------|-------------------------------------------------------------|
| 100"  | $2.75 /1000 sets
| 200"  | $5.50 /1000 sets
| 300"  | $8.75 /1000 sets

**OTHER POPULAR EDGE CONNECTORS**

All Edge Card Connectors are GOLD PLATED (not Gold Flash) Bodies are non brittle. Solder or Tin with Copper Coated Plated. (Gold over silver) or Nickel over silver. (Silver over silver) Bodies. Choose the one that suits your requirements.

- SPECIALS on 100" and 200" lengths for 5000 sets.
- PRICE INCLUDES DELIVERY.
- FREE SHIPPING if you order 100 sets or more.
- BUY wholesale!

---

**PRICE SUBJECT TO CHANGE WITHOUT NOTICE**

**ORDER TODAY**

1-800-454-5633

**PRIORITY ONE ELECTRONICS**

16732 Roscoe Blvd. Sepulveda, CA 91343

Terms, Visa, MC, BAC, Check, Money Order. C.O.D. U.S. Funds Only. CA residents add 8% sales tax. May not be combined with any other offer or discount. Individual orders under 100.00. Discount of U.S. orders less than $75.00 includes 3% shipping and handling, minimum $2.50. Excess refunded. Just in case ... please include your phone no.

**Prices subject to change without notice.**

**OEM and Institutional**

We will do our best to maintain prices thru June 1978.

Inquiries invited. Phone orders welcome (213) 894-8171, (800) 423-5633
What's New?

PUBLICATIONS

TRS-80 Microcomputer Technical Reference Handbook

Radio Shack has published a technical reference handbook for their TRS-80 microcomputer system. The illustrated 108 page book is intended primarily for technically oriented persons with a good working knowledge of digital logic circuits. Written in a straightforward, informal manner, the TRS-80 Microcomputer Technical Reference Handbook includes technical information and schematic diagrams for both Level I and II TRS-80 systems. Topics covered in the book include: Theory of Operation, Adjustments and Troubleshooting, The Outside World (connections to control external devices), parts list and fold-out schematics. The handbook is priced at $9.95 and is available from Radio Shack stores and dealers. For further information, contact Radio Shack, 1400 One Tandy Center, Fort Worth TX 76102.

Circle 588 on inquiry card.

Pascal: An Introduction to Methodical Programming

This book, intended for use in a first course in programming, is based on the Pascal language. It assumes no prior knowledge of computing and only elementary mathematical skill. It emphasizes programming principles, good style, and a methodical approach to program development. This introduction to Pascal includes a thorough treatment of both the fundamental language features and the few features which are not truly fundamental. The programming technique of incremental refinement is imparted by consistent example throughout the book. In addition, two chapters are devoted exclusively to programming methodology. Each chapter is followed by a number of exercises, answers to some of which are provided. This 306 page book is priced at $10.95. It is published by Computer Science Press Inc, 9125 Fall River Ln, Potomac MD 20854.

Circle 569 on inquiry card.

Z-80 Instruction Handbook

The Z80 Instruction Handbook by Nat Wadsworth is a handy, compact reference providing a clear detailed explanation of the Z-80 microprocessor instruction set. Standard Z80 mnemonics are used throughout and machine codes are presented in both octal and hexadecimal format. An index lists all instructions alphabetically along with machine codes and timing information. This 128 page book is priced at $4.95. For further information, contact Scelbi Publications, POB 133 PP STN, Milford CT 06460.

Circle 570 on inquiry card.

Connect Your Computer to an Automatic Musical Instrument

Vestal Press has recently announced the release of its 15th catalog. It contains all types of automatic musical instruments including music boxes, carousel organs, orchestrions (mechanical orchestras), reproducing pianos (player pianos that play with full artistic fidelity), violin playing machines, and all sorts of unusual musical devices. The catalog is available for $2 from Vestal Press, Dept B, POB 97, Vestal NY 13850.

Circle 571 on inquiry card.

Free Catalogs from Hayden Book Company

Two new catalogs that include personal computing and professional computing books are available from Hayden Book Co Inc. They feature Hayden's new and forthcoming books on introductory computing, programming, and applications and advanced technology. For free copies of either the personal or the professional computing catalog, write to Hayden Book Co Inc, 50 Essex St, Rochelle Park NJ 07662.

Circle 572 on inquiry card.

TRS-80 Monthly Newsletter

The TRS-80 Monthly Newsletter contains articles and programs (with complete program listings and instructions) related to business, personal finance, money management, games, practical applications and gambling. The programs are also available on cassette or floppy disk. A summary of the latest TRS-80 system developments and a list of TRS-80 related software are published in every issue. A one year subscription to this newsletter is $24. For more information, contact Mathematical Applications Service, POB 149 RS, New City NY 10956.

Circle 573 on inquiry card.

Comprehensive Microprocessor Design Manual Announced by TI

This self-teaching microprocessor design manual, written for both beginners and experts, is available from Texas Instruments Inc, Mall Station 54, POB 225012, Dallas TX 75222. 9900 Family Systems Design and Data Book offers more than 1,000 pages of educational and applications information that can help users develop a deeper understanding of the complex technology and the potential in microprocessors.

The first chapter discusses the semiconductor technology advances on which today's microprocessors are based. It also provides guidelines for selection and application of microprocessors and microcomputers, and lists general and basic design decisions. The second chapter is a product selection guide, covering the complete TI 9900 family of microprocessors, microcomputers, peripheral support circuits, assembled microcomputer modules, software and development systems. Chapter Three moves step-by-step through a "first encounter" with a 9900, describing basic concepts in an introductory application. Chapters Four, Five, and Six cover hardware and software design, architecture and interfacing techniques, programming methods and the instruction set.

Chapter Seven contains reference materials for development systems used by experienced system designers to develop 9900 software programs, debug, and prototype final systems. It also includes in-depth technical specifications on all currently available products in the 9900 family.

Chapter Nine offers detailed examples of real world uses of TI's 9900 product family in the design of a low cost data terminal, a floppy disk controller, and a simulated industrial control application.

The 9900 Family Systems Design and Data Book is priced at $9.95 (soft cover).

Circle 574 on inquiry card.

June 1979 © BYTE Publications Inc 269
Microchess 2.0, developed by Peter Jennings, has been designed for the 8 K PET and the 16 K Apple computers. In 6502 machine language, it offers 8 levels of play to suit everyone from the beginner to the serious player. At its highest level the program plays a good game and will beat most average players and many other chess playing programs. It examines positions by as many as six moves ahead, and includes a chess clock for tournament play.

Microchess checks every move for legality, handles castling and en passant pawn captures, and displays the current position on a graphic chessboard. You can play white or black, set up and play from special board positions, or watch the computer play against itself. Microchess 2.0 is available for $19.95 to $20.95.

New Family of RS-232 Switching Units

A new family of low cost miniature switching units has been introduced by Giltronix Inc, 3135 Avalon, Palo Alto CA 94306. The family, called RS232-X, switches serial RS-232 peripherals between several driving sources. Model RS232-X3 allows three driving sources. By turning the three position switch mounted on the RS232-X3, the user can select the driving device that will exchange data with the peripheral unit. A unique arrangement allows the cascading of two or more RS232-X switches, thereby expanding the selection from three devices to five or more. Model RS232-XF is similar to the RS232-X3 but switches additional signals. Both come with 25 pin female connectors. The price of the RS232-X3 is $64.95 assembled, and $47.95 in kit form. The RS232-XF is $78.95 assembled and $59.95 in kit form.

Multi-Universal Integrated Circuit Plug-In Adapter

This multi-universal integrated circuit plug-in adapter accepts integrated circuit patterns of up to 40 leads, including large scale integration, medium scale integration, and programmable memory devices. The adapter is used for mounting a variety of mixed devices which will then plug into any standard universal integrated circuit packaging panel.

The P/N 640-MUI adapter will accept the following packages: single-in-line, dual-in-line, memory package, interface, and large scale devices. The adapters are fabricated of 0.062 inch (0.157 cm) thick epoxy with electro-tin-plated circuitry. The plug-in contacts are brass, tin plated, with a gold plated beryllium copper four-time spring socket member.

They are available at prices ranging from $2 to $6 per unit. For more information, contact Garry Manufacturing Co, 1010 Jersey Av, New Brunswick NJ 08902.
*MEMORY SALE!* have it your way...

16K $295.00!! (4MHz) (Reg.$370.00)  32K $485.00!! (4MHz) (Reg.$620.00)

ALL BOARDS ASSEMBLED AND TESTED ....... (KIT PRICING AVAILABLE)
- Extended addressing allows board to exist anywhere in 256K memory on standard S-100 bus
- LOW Power, 1.6 amp per 16K
- 9 Regulators for perfect heat distribution
- Static, of course
- Phantom line
- Each 4K block locateable anywhere
- Fully tested and burned in for 48 hours

ADD-ON MEMORY CHIPS — $4.95 EACH!! (TMS 4044 or MM 5257) — 8 Chips — Minimum Order
*Sale extended one last month

Z-80 CPU (one serial chip set, less eprom) $195.00 (Reg. $280.00)
- 2 Parallel + 2 Serial Port
- 2 MHz or 4 MHz Switch Selectable
- Baud Rates 150-9600
- Power on Jump to On/Board Eprom (2708 or 2716)
- Memory Management on A16 and A17

VIDEO TERMINAL SIMULATOR $295.00 (Reg. $400.00)
- Plugs into S-100 Bus and simulates all functions of a Soroc or other RS-232 type terminal. A simple video monitor such as a Sanyo or Sony TV will perform as a smart terminal by writing into an IO Port.
- 2K Eprom, 4K Ram (2 video pages on 16 x 64)
- Lower Case Descenders (16 x 64 or 24 x 80)
- Tabs, protected fields, home/load cursor, blink, reverse video, underline, page erase, etc. (Intel 8275 CRT controller)

DOUBLE DENSITY DISC CONTROLLER $385.00
- CPM* Compatible, TARBELL Pin-out compatible
- On/Board Boot
- 2 or 4 MHz Jumper Selectable
- 8 inch Single or Double sided (5.25 inch available)
- 52 Sectors, runs CPM*, IBM Format

*CPM is a trademark of Digital Research, Inc.

**ORDER NOW!!**

SALES AND SERVICE

West: **DELTA PRODUCTS**
1653 E. 28th Street
Long Beach, Calif 90806
Tel (213) 595-7505

East: **DELTA PRODUCTS**
1254 South Cedar Road
New Lenox, Illinois 60451
Tel (815) 485-9072

**CIRCLE 89 ON INQUIRY CARD.**

Personal checks must clear before shipment • 90 day unconditional warranty • B of A, M/C Okay
**JADE Computer Products**

**DISK DRIVES**
- BS-1 4½" for $295.00
- SA-801 R $495.00
- FDB-100 $395.00
- 8 Slot, 35-Track drive, cabinet and power supply available for $49.95

**Vista V80 Mini Disk System**
- For TRS-80 for $395.00
- Includes disk drive, power supply, regulator board, and compact case.
- The V-80 offers 23% more storage capacity.
- Simply take it out of the box, plug it in, and it's ready to run. Requires 18K Level II, expansion interface.
- JADE SPECIAL PACKAGE DEAL $115.00

**EXPANDER'S BLACK BOX PRINTER**
- This 64-character ASCII impact printer with 80-column capability is portable and uses standard 8½" paper and regular typewriter ribbon. Base cover and parallel interface are included.
- Assembled and complete with manual and documentation.
- Only $470.00
- (90 day manufacturer's warranty)

**TRIDENTCOM 100 Intelligent Printer**
- Interface & Cable for TRS-80 $345
- Interface & Cable for Apple $60.00
- Quiet operation, no external power supplies. Only two driven parts.
- High reliability, clear 5 x 7 characters.
- Attractive metal and plastic case. Two rolls of paper for $5.00.

**JADE MAINFRAMES**
- Includes heavy duty power supply. (1) 8 volts DC @ 30 AMPS, (1) 16 volts DC @ 4 AMPS, 8-volt DC may be added.
- Only $389.00

**FLOPPY DISKS**
- 3M or VERBATIM
- FLOPPY DISKS
- 5¼" Minidiskettes
- Soft sector, 10 sector, or 16 sector
- $0.40 each or box of 10 for $4.00
- 8 in. Standard Floppy Disks
- 20±/s Section 4.75 each—10 for $42.50

**FLOPPY DISK INTERFACE**
- JADE FLOPPY DISK (Tarbell board)
- Kit $195.00
- Assembled & Tested $250.00
- S.D. Computer Products VERSA-FLOPPY

**Integral Data Systems**
- Check the impressive features of Integral's IP-125 Impact Printer
- Only $799

**LOADED WITH EXTRAS AT NO EXTRA COST**
- Microprocessor Controlled
- Serial RS-232 Interface
- Parallel TTL Interface
- Low cost thermal paper
- Microprocessor controlled
- Bidirectional look-ahead printing
- Double density controller chip
- Attractive metal and plastic case
- Two rolls of paper for $5.00

**3690-12 CARD EXTENDER**
- Card Extender to TRS-80
- Connect 50 pin side on 125 cards
- Attached connectors in both
- 3690-12 22½ in. 156 cards
- $12.00

&sect;_Vector Plugboards 8800V
- Universal Microcomputer plugboards line with 8001 bus. Complete with header pins and hardware 5½ x 10 1/2" $30.00

&sect;_8801-1
- Same as 8800V + extra one less power board & header pins
- 4 pin con spaced 156
- 4 pin con spaced 156
- $12.00

&sect;_Pattern plugboard for IC's
- Socket 114 1/16 84 pin con spaced 156
- 3601.5" x 4.5" $7.85
- 3621.5" x 4.5" $8.95

&sect;_Pattern plugboard for IC's
- Socket 115 1/16 84 pin con spaced 156
- 3621.5" x 4.5" $7.85
- 3621.5" x 4.5" $8.95

Circle 195 on inquiry card.
LEEDEX MONITOR
- 12" Black and White
- 12MHz Bandwidth
- Handsome Plastic Case
$139.00

JADE'S
DOUBLE DENSITY
Controller Board
KIT: $249.00
Assemb. & Tst: $299.00
- Single or Double Density Recording
- Full Size or Mini Floppy
- CPM Compatible in either density
- Programmed Data Transfer, no DMA
- Controls up to 8 drives
- IBM Format in either density
- Software Selectable Density
- This controller utilizes the proven reliability of the IBM standard format as well as the latest phase-locked-loop for data separation. All clocks are generated from an on-board crystal oscillator. Re-configuration is used to enhance data recovery reliability in the double density mode. Density selection is entirely transparent to the user. Single and double density diskettes can be mixed on the same system.

NEW!
JADE Z80 BOARD
IMPROVED DESIGN AND FEATURES
- On Board 2708 or 2716 EPROM
- Very Reliable At 1 MHz Or
2 MHz
- Power On Jump and Reset
- On Board USART (251)

ZMH Kit
Assembled & Tested $135.00
4 MHz
JADE BOOBA
with full documentation
Kit $110.00
Assembled & Tst $115.00
Bare Board $39.00

EPROM BOARD KITS
JGB 16 times 2708 or 2716 $69.95

Jade Memory
Expansion Kits for TRS-80 and Apple
4116's
Everything a person needs to add 16K of memory. Chips come neatly packaged with easy to follow directions. In minutes your machine is ready for games and more advanced software.
$82.00

New Prices
DYNAMIC RAM BOARDS
EXPANDABLE TO 64K
32K VERSION KITS
Uses 4115 (8Kx1, 250ns) Dynamic RAM's, can be expanded in 8K increments up to 32K:
8K $150.00 24K $249.00
16K $249.00 32K $459.00
4115 SALE $8 for $39.95

46K VERSION KITS
Uses 4116 (16Kx1, 200ns) Dynamic RAM's, can be expanded in 16K increments up to 64K:
8K $150.00 24K $249.00
16K $249.00 32K $459.00
64K $659.00

STATIC RAM SPECIALS
2141's, low power (1024x4)
1-15 10.99 100+ 9.95
450ns 300ns
9.00 8.00 6.50
TMS4044/MM5257, low power
450ns 6.00 7.50 6.50
300ns 9.50 8.75 8.00
420A (4Kx1, 200ns)
9.50 8.50 6.00
410D (4Kx1, 200ns)
8.25 7.00 8.75

JADE Computer Products
4901 W. ROSECRANS AVENUE
DEPARTMENT F 3
HAWTHORNE, CALIFORNIA 90250
U.S.A.

Cash, checks, money orders, and credit cards accepted. Add 5% sales tax on all parts delivered in California, Discounts available at OEM quantities.

WRITE FOR OUR FREE CATALOG
All prices subject to change without notice.

Circle 195 on inquiry card.
Full Standard PILOT on PET

Commodore PET owners can get full standard PILOT on a minimum size PET with the PETPILOT language processor and editor which is suitable for preparing long programs of up to 80,000 characters. The product features full BASIC in compute statements as well as two new keywords designed to make PILOT programming easier and faster. All language features of the most recent PILOT standard are implemented. Only the tape drive supplied with the PET is required to run any PILOT program. While simple PILOT programs can be created on a single drive PET, authors writing long programs will need the second cassette drive offered by Commodore.

The package offered by the PET-PILOT project contains both programs, a sample PILOT program, a teacher's manual, a quick reference card, and licenses to run the programs on a single PET. A tutorial course of 4 one hour lessons in effective use of PILOT is also available. The basic package costs $12, and the tutorial is an extra $8. Both products can be ordered by specifying the PET serial number to be licensed. For further information contact Dave Gomberg, 7 Gateview Ct, San Francisco CA 94116.

Circle 620 on inquiry card.

FORTRAN Compiler for 6800 Produces Relocatable Object Code

A FORTRAN compiler for 6800 microprocessors, which produces relocatable object code in a Motorola compatible format, has been introduced by Smoke Signal Broadcasting, 31336 Via Collinas, Westlake Village CA 91361. Programs are compiled to run under the company's DOS-68 disk operating system for scientific applications, number crunching and multidimensional array processing. The compiler is also complemented by Smoke Signal's Linking Loader for loading the object listing into any portion of memory specified. Requiring 24 K bytes of user programmable memory, the compiler has a data initialization capability, features arithmetic and logical IF statements, and handles sequential access files so that up to four files can be opened at any one time. FORTRAN library subroutines can also be built.

The 6800 FORTRAN compiler is priced at $99.

Circle 621 on inquiry card.

KIM-1 Control System

PCROS is a Process Control Realtime Operating System for the KIM-1 microcomputer board. The operating system is designed to function in the 1 K byte KIM-1 programmable memory. PCROS can control up to twelve switches and is driven by a real time clock routine that makes use of the KIM-1 timer and interrupt circuitry.

A process control language interpreter has been included as an integral part of PCROS. The interpreter utilizes the on board KIM-1 keyboard and display. The process control language interpreter provides nine commands for application program development: set switches, hold full-second current settings (up to 255), hold quarter-second current settings (up to 255), repeat command sequence, reset repeat loop, go to subroutine, return from subroutine, load and execute next program (from cassette tape), and halt. Application programs can contain up to 56 commands.

PCROS on KIM format cassettes with users manual is priced at $14.95. The assembly listing is available for $24.95. For further information contact H Geller Computer Systems, POB 350, New York NY 10040.

Circle 622 on inquiry card.
16K EPROM CARD-S 100 BUSS
$59.95 KIT
OUR BEST SELLING KIT!
USES 2708's!

Thousands of personal and business systems around the world use this board with complete satisfaction. Puts 16K of software on line at ALL TIMES! Kit features a top quality soldermask and silk-screened PC board and first run parts and sockets. All parts (except 2708's) are included. Any number of EPROM locations may be disabled to avoid any memory conflicts. Fully buffered and has WAIT STATE capabilities.

OUR 450NS 2708'S ARE $3.95 EA. WITH PURCHASE OF KIT
ASSEMBLED AND FULLY TESTED ADD $25

16K STATIC RAM KIT-S 100 BUSS
$295 KIT
FULLY STATIC, AT DYNAMIC PRICES

WHY THE 2114 RAM CHIP?
We feel the 2114 will be the next industry standard RAM chip (like the 2102 was). This means price, reliability, and quality will all be good. This chip has the cost, reliability, and proven track record of the 2102. The 2114 is FULLY STATIC! We feel this is the ONLY way to go on the 16-Bit BUS! We've all heard the HORROR stories about Dynamic RAM boards. A new problem for Dynamic RAM boards means trouble with DMA and Floppy DISK DRIVES. Who needs these kinds of problems? And finally, even among other 4K Static RAM's the 2114 stands out! Not all 4K Static RAM's are created equal! Some of the other 4K Static RAM boards use trouble-some, marginal and various timing windows. Not as critical as Dynamic RAM's. Some new competition's 16K boards use trouble-some devices. But not us! The 2114 is the ONLY logical choice for a trouble-free, straightforward design.

BLANK PC BOARD W/DATA $33
LOW PROFILE SOCKET SET $12
ASSEMBLED & TESTED $30
2114 RAM'S 8 FOR $99.95

8K LOW POWER RAM KIT-S 100 BUSS
250 NS SALE!
ADD $5 FOR 250NS!
$129 KIT
(450 NS RAMS)

Thousands of computer systems rely on this rugged, work horse, RAM board. Designed for error-free, NO HASSLE systems use.

KIT FEATURES:
1. Doubled sided PC Board with solder mask and silk screen layout. Gold plated contact fingers.
2. All sockets included.
3. Fully buffered on all address and data lines.
4. Phantom jumper selectable to pin 67.
5. FOUR 7805 regulators are provided on card.

Blind PC Board w/Documentation $29.95
Low Profile Socket Set...13.50
Support IC's (TTL & Regulators) $9.75
Bypass CAP'S (Disc & Tantalum) $4.50
ASSEMBLED AND FULLY BURNTED IN ADD $30

COMPLEMENTARY POWER TRANSISTORS
SILICON NPN AND PNP. TO-220 CASE VCEO - 40V. PD - 30 WATTS FOR AUDIO POWER AMPS. ETC.

TIP29 - NPN
TIP30 - PNP
YOUR CHOICE 3 FOR $1

NATIONAL SEMICONDUCTOR
CAR CLOCK MODULE - #MA6008
$6.99 each

NEW! Z-80 PROGRAMMING MANUAL
By MOSTEK, or Zilog. The most detailed explanation ever on the working of the Z-80 CPU CHIPS. At least one full page on each of the 156 Z-80 instructions. A MUST reference manual for any user of the Z-80. 300 pages. Just off the press.

16K DYNAMIC RAM CHIP
16K X 16Pin Package. Same as Mostek 4116S = 250 NS access 410 Volts. Our best price yet for this state of the art RAM Board. 4K, 8K and 16K RAM boards using this chip are readily available. These are new, fully guaranteed devices by a major mfg.

8 FOR $89.95
450 NSI 2708 EPROMS
Now full speed! Prime new units from a major U.S. Mfg. 450 N.SI Access time. 1K x 8. Equiv. to 4-1702 A's in one package.

$15.75 ea. $9.95 4 FOR $40.00

EXPERIMENTER'S HEATING PLATE
Large Manufacturers Surplus. 5/16 x 10 in. Made of 3/8 in. tempered glass with heating element laminated on back. Works 120V AC. Engineered by thermostat and two thermal fuses. Rated 120 Watts. Use for any heating application. All products are fabricated for heating ferric chloride to increase PC Board etching efficiency. Units are brand new, non-submersible.

WHILE THEY LAST -- $2.99 each

MALLORY COMPUTER GRADE CMOS 30000 MFD 15 WINDS
Small: 3 x 2 x 1 inches $1.99 ea. 3 FOR $5.95

The "COLOSSUS"
FAIRCHILD SUPER JUMBO LED READOUT
A full 80 inch character. The biggest readout we have ever sold. Super efficient. Compare at up to $2.95 each from others!
YOUR CHOICE
FND 843 Common Anode $1.49 (8 FOR $11.95)
FND 850 Common Cathode

TERMS: Add 30% postage, we pay balance. Orders under $15 add 75¢ handling. No C.O.D. We accept VISA, MasterCharge, and American Express cards. Tax rates add 5% Tax. Foreign orders (except Canada) add 20¢ P & H 90 Day Money Back Guarantee on all items

Digital Research Corporation
P.O. BOX 401247 Y GARLAND, TEXAS 75040 • (214) 271-2461

Circle 100 on inquiry card.
The PET BUSINESS SYSTEM

The PET is now a truly sophisticated Business System with the Floppy Disk and Printer which makes it ideal for professional and specialized fields: medicine, law, research, engineering, education, etc.

PET 2001 -
16K $995
32K $1295

• 16 or 32K Byt
• Dynamic RAM - 16K
• Upper/Lower Case
• Multiple Languages (BASIC included)
• Machine Language Monitor
• 8K ROM Expansion Slots
• 9" CRT

PET PRINTER
2023 $849
2022 $995

(Includes Tractors)

PET MUSIC BOX
Add music and sound effects to your programs. Compose, play, and hear music as you use the PET. Completely self-contained (no wiring). Free 3 programs including Star Wars theme, sound effects, etc. $39.

PET BUSINESS SYSTEM

The PET is now a truly sophisticated Business System with the Floppy Disk and Printer which makes it ideal for professional and specialized fields: medicine, law, research, engineering, education, etc.

PET 2001 -
16K $995
32K $1295

• 16 or 32K Byt
• Dynamic RAM - 16K
• Upper/Lower Case
• Multiple Languages (BASIC included)
• Machine Language Monitor
• 8K ROM Expansion Slots
• 9" CRT

PET PRINTER
2023 $849
2022 $995

(Includes Tractors)

PET MUSIC BOX
Add music and sound effects to your programs. Compose, play, and hear music as you use the PET. Completely self-contained (no wiring). Free 3 programs including Star Wars theme, sound effects, etc. $39.
North Star Utilities Package

With these programs the user can:

- Read a basic program directly from a disk and list all variables appearing in the program. (Listings can be made of variables versus line numbers or line numbers versus variables.)
- Selectively print out any statement, function or command versus the line numbers or versus the line numbers that it appears in.
- Print out a “flow chart” of the basic program versus line numbers.

This package is essential for examining and modifying basic programs. It is provided on a North Star Diskette for $15.00.

Potter's Programs
22444 Lakeland
St. Clair Shores, MI 48081
(313) 573-8000

Circle 310 on Inquiry card.

BASIC SUBROUTINE LIBRARY
Volume 1

- ARRAYS - minimum, maximum, sums, searching, sorting.
- MATRIX ALGEBRA - addition, subtraction, multiplication, transposition, determinant, inverse.
- SIMULTANEOUS EQUATIONS - non-symmetrical, symmetrical, banded, three-diagonal.

Any routine you'll ever need, involving arrays, matrix algebra or simultaneous equations can be found in this comprehensive collection of subroutines, compatible with any version of BASIC having subscripted variables.

Numerous examples show how to incorporate these subroutines into your programs or how to use them as stand alone programs.

Order now and save days of work.
$15.00 U.S. plus $2.00 for handling and postage.

VM Professional Application Software, Inc.
2703 Bainbridge Avenue
BURNABY, B.C. V5A 2S7

Circle 379 on Inquiry card.

FLOPPY DISK REPAIR
- PerSci and Shugart
- Quick turnaround
- Factory trained on PerSci

Computer Software Directory
FOR AS LITTLE AS $20/ YEAR!
EVEN IF YOU ONLY HAVE ONE
PROGRAM TO SELL, WRITE:
CYBERTRON
P.O. BOX 5056
BETHLEHEM, PA. 18015

Circle 90 on Inquiry card.
TRS-80®

SERIAL I/O
• Can input into basic
• Can use LINT and
LPRINT to output, or
output continuously
• RS-232 compatible
• Can be used with or
without the expansion
bus
• On board switch
selectable baud rates of
110, 300, 600, 1200, 2400,
parity or no
parity odd or even
• Jumper selectable
• TTL input and output
• Connects to Printer
• Software support
• Board only $19.50 Part No. 601A

APPLE II®

SERIAL I/O
• Baud rate is continuously adjustable from 0
• 6 stop bits
• 110, 150, 300, 600,
• 1200, 2400, parity or
no parity
• Jumper selectable speed
• Software support
• Board only $19.50 Part No. 602A

8K EPROM

PIECEON
Saves programs on PROM permanently
• 8K EPROM non-volatile memory
• Room for 8K bytes of
program memory
• TTL input and output
• Connects to any
peripheral
• Board only $39.00 Part No. 106A

SE-100
ACTIVE TERMINATOR
• Front panel terminals
• Software support
• Board only $39.00 Part No. 107A

To Order:
Mention part number, description, and price. In USA, shipping paid for orders accompanied by check, money order, or Master Charge. Outside USA, add $5.00 shipping charge. California residents add 7% sales tax. Shipment charges paid by C.O.D. orders. California residents must pay applicable sales tax. COD orders must be prepaid in US dollars. No C.O.D.'s. Checks and money orders must be payable in US dollars. Parts kits include sockets for all IC's, components, and circuit board. Documentation is included with all products. Prices are in US dollars. No open accounts. To eliminate tariff in Canada boxes are marked "Computer Parts." Dealer inquiries invited. 24 Hour Order Line 202-226-4084

For free catalog including parts lists and schematics, send a self-addressed stamped envelope.

ELECTRONIC SYSTEMS
Dept. B, P. O. Box 21638, San Jose, CA USA 95151

Circle 125 on Inquiry card.
The DATA-TRANS 1000

A completely refurbished IBM Selectric Terminal with built-in ASCII Interface.

Features:
- 300 Baud
- 14.9 characters per second printout
- Reliable heavy duty Selectric mechanism
- RS-232C Interface
- Documentation included
- 60 day warranty - parts and labor
- High quality Selectric printing
  Off-line use as typewriter
- Optional tractor feed available
- 15 inch carriage width

HOW TO ORDER
DATA-TRANS 1000
1. We accept Visa, Master Charge. Make cashier's checks or personal check payable to:
DATA-TRANS
2. All orders are shipped
F.O.B. San Jose, CA
3. Deliveries are immediate

ASCII KEYBOARD
• • • • • • • •
Mounted to DECWRITER Panel
By Cherry Products
ASSEMBLED $9.95

ASCII to Correspondence code converter
This bidirectional board is a direct replacement for the board inside the Trendata 1000 terminal. The on board connector provides RS-232 serial in and out. Sold only as an assembled and tested unit for $350.00. Part No. TA 1000

TIDMA:*
• Tape Interface Direct Memory Access + Record and play programs without bootstraps loader (no prom) has FSK encoder/decoder for direct connections to low cost recorder at 1200 baud rate, and direct connections for inputs and outputs to a digital recorder at any baud rate • S-100 bus compatible • Board only $35.00 Part No. 112, with parts $110 Part No. 112A

T.V. INTERFACE
• Converts video to AM modulated RF.
• Channels 2 or 3. So powerful almost no tuning is required. On board regulated power supply makes this extremely stable. Rated very highly in Doctor Dobbs' Journal Recommended by Apple • Power required is 12 volts AC C.T., or +5 volts DC • Board only $7.80 part No. 107, with parts $13.50 Part No. 107A

For orders and information
DATA-TRANS
2154 O'Toole St.
Unit E
San Jose, CA 95131
Phone: (408) 263-9246

T.V. INTERFACE
• Converts video to AM modulated RF.
• Channels 2 or 3. So powerful almost no tuning is required. On board regulated power supply makes this extremely stable. Rated very highly in Doctor Dobbs' Journal Recommended by Apple • Power required is 12 volts AC C.T., or +5 volts DC • Board only $7.80 part No. 107, with parts $13.50 Part No. 107A

For free catalog including parts lists and schematics, send a self-addressed stamped envelope.

ELECTRONIC SYSTEMS

Dept. B, P. O. Box 21638, San Jose, CA USA 95151

Circle 126 on inquiry card.
Circle 115 on Inquiry card.

8" Siemens FDD120-8 Drive
All Siemens's options included in this drive can be considered of the hard, good and soft, or single- or double density. (Others give only striped units) $425.00

"Power One" Model CP206 Floppy Power Unit. For two drives going full-out and possibly more on less severe service, 2.8A@24V, 2.5A@5V, 0.5A@9V. Beautiful quality. $99.00

DISKETTES (Standard)
8" Boxed 10 $39.00 5" Boxed 10 $34.55

Starbell ("It Works") Interface (Includes cable kit set for 2 drives) $265.00 BUT ONLY $215.00 with purchase of two drives.

Cable Kits $27.50

For two drives: $33.95, and for three drives: $38.95

CABINETS for FDD120 and 5" Drives, or CP206 power supply. Matte finish in 5 colors, water resistant black epoxy paint, stepping design. $29.99


9 Slot PCBD... ............. $30.95

ESAT2006 (Bi-Lingual) 80X24 Communicating Terminal. Scrolling, Full Curser, Bold, C8X matrix, 256 addressable characters 110-19,200 baud, etc. etc. etc. This terminal has been purchased by many agencies, universities & companies. Fully stand-alone. It is the only dual font terminal of any kind for less than $2500, Supplied complete and fully guaranteed: (many graphics applications) $349.00

NEW PRODUCT RELEASE!!!

10 Megabyte SUPER DISK!!!

Circle 230 on Inquiry card.

Californiam Computer Systems
18K RAM BOARD. Fully buffered addressable in 4 blocks. IEEE standard for bank addressing 2114's, 8080 etc. $124.95

CB-1 6080 Processor Board. 2K of PROM 256 BYTE RAM power-on/real Vector Jump Parallel port with status KIT $119.00 PCBD... $28.95

MB-8B Basic 8KX8 ram uses 2102 type rams, S-100 bus. Kit 450 NSEC... $135.95 PCB... $28.95

MB-16K X8 Static RAM uses MP140 Protection, fully buffered KIT... $299.95

MB-8A 2708 PROM Board. 8KX8, 8KX16 or 16KX8 kit without PROMS $75.00... $28.95

MB-8X 2708 PROM Board. 8KX8, 8KX16 or 16KX8 kit without PROMS or RAMS $72.00

ID-2 8080 8-bit parallel/10 port, 1/2 of boards is for Modulation KIT... $48.00 PCBD... $28.95

ID-2 Two serial I/O ports with full handshaking 20/60 ms current loop: Two parallel I/O ports KIT... $130.00 PCBD... $28.95

VS-1B 24 x 1 video board, upper lower left video clock, composite and parallel video with software, S-100. KIT... $125.00 PCBD... $28.95

Altair Compatible Mother Board, 11 x 11/4 x 4", Board only... $39.95. With 15 connectors... $94.95

Extended Board full size. Board only $9.48

With connector... $4.95

BP-1 synthesizer board S-100 PCBD... $42.95 KIT... $135.95

wmc inc. Wameco INC.

PC/1 FLOPPY CONTROLLER BOARD will drive ahurget, parrel,remic 5" & 8" drives up to 8 drives, on board PROM with power boot up, will operate with CP/M (not included). PCBD... $42.95

FPB-1 Front panel. 128 byte display. Byte or instruction single step. PCBD... $47.50

MEM-1 8KX8 fully buffered, S-100, uses 2102 type rams. PCBD... $28.95

QM-13 MOTHER BOARD, 13 slot, terminated, S-100 board only... $34.95

CPU-1 6080A Processor board S-100 with 8 level vector interrupt PCBD... $28.95

RTC-1 Real time clock board. Two Independent Interrupts. Software programmable. PCBD... $23.95

EM-1 17024 4K eprom card PCBD... $23.95

EPROM-1 2708/2718 8KX32 EPROM card PCBD... $23.95

QM-8 MOTHER BOARD, Short Version of GM-15, 9 Slot PCB... $30.95

MEM-1 16K X8 Fully Buffered 2114 PROM PCBD... $28.95

8080A... $99.95 2114 (450 NS) lowpr... $7.25

5101... $8.95 4116... $8.95

5101-8P... $8.40 1702A INTEL... $8.95

P.O. Box 424 • San Carlos, California 94070
Phone: 800-596-1805

Circle 211 on Inquiry card.

Visa or Mastercharge. Scroll account number, interbank number, expiration date and sign your order. Approve, postage will be added. Check or money order will be sent post paid in U.S. if you are not a regular customer, please charge, casher's check or certified money order. Otherwise there will be a two-week delay for checks to clear. Calif. residents add 6% tax. Money back 30 day guarantee. We cannot accept returned IC's that have been soldered to. Price subject to change without notice. Call 800-596-1805 service charge on orders less than $10.95.

VISA or MASTERCARD. Scroll account number, interbank number, expiration date and sign your order. Approve, postage will be added. Check or money order will be sent post paid in U.S. if you are not a regular customer, please charge, casher's check or certified money order. Otherwise there will be a two-week delay for checks to clear. Calif. residents add 6% tax. Money back 30 day guarantee. We cannot accept returned IC's that have been soldered to. Price subject to change without notice. Call 800-596-1805 service charge on orders less than $10.95.

Circle 230 on Inquiry card.
RCA Cosmac Super Elf Computer $106.95

Circle 311 on Inquiry card.

Super Elf includes a ROM monitor for program loading and editing with single step for program debugging which is not included in others at the same price. With single step you can see the processor operating with the uniqueศาสร์ address and data bus displays before, during, and after executing instructions. Also on-chip edit and instruction cycle are decoded and displayed on eight LED indicator lamps.

An RCA 1861 video graphics chip allows you to connect to your own TV with an inexpensive video monitor input port. There is a speaker system included for playing your own music or using many music programs already written.

The Super Elf may also be used to drive relays for control purposes. A 12 key HEX keyboard includes 16 HEX keys plus add, rest, recall, input, memory print.

Super Expansion Board with the 14 lesson/240 page instruction manual has been designed to allow you to decide how you want it optioned. The Super Expansion Board comes with 8K of low power RAM fully addressable anywhere in 64K with built-in memory protection and a cassette interface. Provisions have been made on the back panel for connections on the same board and it fits neatly into the hardwood cabinet along with the Super Elf. The board includes also for up to 64K of EPROM (7278, 7278-2716 or 2716) and is fully socketed. EPROM can be used for the monitor and Tiny BASIC or other purposes.

A KY2 Super ROM Monitor $9.95 is available as an on board option in 7278 EPROM which has been preprogrammed with a program loader, editor and error checking MULTI file cassette readable/writable. Trouble shooting cassette file analysis is exclusive from Quest. It includes register save and readout, block move capability and video graphics editor with blinking cursor. Break points can be used with the register save feature to isolate program bugs quickly, then follow with single step. The Super Monitor is written with subroutines allowing users to take advantage of monitor functions simply by calling them up.

Digital Temperature Meter Kit $12.95


Nicad Battery Monitor $8.95


Rockwell AIM 65 Computer $44.40

Integrated circuits from AC link to the circuit board. Based on actual experience and dollars saved. $44.40.

Power Supply Kit $12.95

Complete kit less case. $12.95.

Stopwatch Kit $26.95

Electronic, digital operation, 1/1000th of a second. 3.2768 MHz crystal accuracy. Tolerance 50 ppm. $26.95.

Hickok 3½ Digit LCD Multimeter $24.95

Input AC/DC 0.1mV-1000V, 5 ranges, 0.5% accuracy. $24.95. Available in 7½ digit. $49.95.

S-100 Computer Boards $58.95

Complete kit. $58.95.

FREE. Send for your copy of our NEW 1979 QUEST CATALOG. Include 25c stamp.

**Line Printer**

**Mini Disk System**

**C-10 Cassettes**

**Verbatim Diskettes**

**TRS-80 Complete System**

Description

- TRS-80 Complete System Level II-4K RAM
- TRS-80 Complete System Level II-16K RAM
- Expansion Interface
- Pertec FD200 Disk Drive
- BASF 6106
- Centronics 779 Printer
- Centronics 101 Printer
- Anadex DP-8000 Printer
- Centronics PT Printer
- 580 (selectric) Printer
- Memory Unit (installed)

Each

- Verbatim Diskettes ea. $4.95
- Maxell Diskettes ea. $7.50
- C-10 Cassettes $3.00
- C-30 Cassettes $23.95
- Paper (9 1/2" x 11" fanfold, 3500 sheets) $29.95

**BECKIAN ENTERPRISES**

**VRdata corp. MORE DATA PER DOLLAR**

**TRS-80 Complete System**

<table>
<thead>
<tr>
<th>Description</th>
<th>Each</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRS-80 Complete System Level II-4K RAM</td>
<td>$828.20</td>
</tr>
<tr>
<td>TRS-80 Complete System Level II-16K RAM</td>
<td>$889.20</td>
</tr>
<tr>
<td>Expansion Interface</td>
<td>$269.10</td>
</tr>
<tr>
<td>Pertec FD200 Disk Drive</td>
<td>$385.00</td>
</tr>
<tr>
<td>BASF 6106</td>
<td>$495.00</td>
</tr>
<tr>
<td>Centronics 779 Printer</td>
<td>$1299.00</td>
</tr>
<tr>
<td>Centronics 101 Printer</td>
<td>$1400.00</td>
</tr>
<tr>
<td>Anadex DP-8000 Printer</td>
<td>$995.00</td>
</tr>
<tr>
<td>Centronics PT Printer</td>
<td>$445.00</td>
</tr>
<tr>
<td>580 (selectric) Printer</td>
<td>$975.00</td>
</tr>
<tr>
<td>Memory Unit (installed)</td>
<td>$38.00</td>
</tr>
</tbody>
</table>

**1 MEG + OF DISK MEMORY on line for TRS-80**

**TRS-80 Complete System Level II**

**HUB Electronic S-100 Interface to TRS-80**

Kit $280.00
Assembled $350.00

**Outlet Hours:** Mon.-Fri.: 9 am—7 pm.
Sat. 12—5 pm.

**Write or call for new innovations—Printers, Disks, Etc.**

**BECKIAN ENTERPRISES**

**P.O. Box 3089**

**Simi Valley, CA 93063**

**All Prime Quality — New Parts Only**

**Satisfaction Guaranteed**

**RS232 & "D" TYPE SUBMINIATURE CONNECTORS**

<table>
<thead>
<tr>
<th>QUANTITY</th>
<th>1-4</th>
<th>5-9</th>
<th>10-24</th>
</tr>
</thead>
<tbody>
<tr>
<td>DE5 Male</td>
<td>1.45</td>
<td>1.25</td>
<td>1.05</td>
</tr>
<tr>
<td>DE5 Female</td>
<td>1.93</td>
<td>1.80</td>
<td>1.70</td>
</tr>
<tr>
<td>DE11066-1</td>
<td>2pc.</td>
<td>Grey</td>
<td>1.25</td>
</tr>
<tr>
<td>DE11066-2</td>
<td>2pc.</td>
<td>Grey</td>
<td>1.22</td>
</tr>
<tr>
<td>DB25 Male</td>
<td>2.20</td>
<td>2.10</td>
<td>2.00</td>
</tr>
<tr>
<td>DB25 Female</td>
<td>2.80</td>
<td>2.60</td>
<td>2.40</td>
</tr>
<tr>
<td>DB512 1</td>
<td>1pc.</td>
<td>Grey</td>
<td>1.30</td>
</tr>
<tr>
<td>DB512 2A</td>
<td>2pc.</td>
<td>Black</td>
<td>1.40</td>
</tr>
<tr>
<td>DB11066-3</td>
<td>2pc.</td>
<td>Grey</td>
<td>1.25</td>
</tr>
<tr>
<td>DC37 Male</td>
<td>2.70</td>
<td>2.50</td>
<td>2.35</td>
</tr>
<tr>
<td>DC37 Female</td>
<td>4.90</td>
<td>4.70</td>
<td>4.40</td>
</tr>
<tr>
<td>DC11066-3</td>
<td>2pc.</td>
<td>Grey</td>
<td>1.95</td>
</tr>
<tr>
<td>DDS Male</td>
<td>4.40</td>
<td>4.30</td>
<td>4.10</td>
</tr>
<tr>
<td>DDS Female</td>
<td>4.90</td>
<td>4.70</td>
<td>4.50</td>
</tr>
<tr>
<td>DDS12 1</td>
<td>1pc.</td>
<td>Grey</td>
<td>2.30</td>
</tr>
<tr>
<td>DDS12 1A</td>
<td>1pc.</td>
<td>Black</td>
<td>2.40</td>
</tr>
<tr>
<td>DDS018 2</td>
<td>2pc.</td>
<td>Grey</td>
<td>2.40</td>
</tr>
<tr>
<td>DDS018 3</td>
<td>2pc.</td>
<td>Grey</td>
<td>2.40</td>
</tr>
<tr>
<td>DDS018 4</td>
<td>2pc.</td>
<td>Grey</td>
<td>2.40</td>
</tr>
</tbody>
</table>

**MAIL ORDERS**

**NOTE:** CA residents please add 6% sales tax.

**WHAT YOU NEED IN THIS ADVERTISEMENT. PLEASE WRITE US. WE WILL**

**TERMS:** Minimum Order $10.00. Add $1.25 for handling and shipping. All orders over $25.00 in USA and Canada WE PAY THE SHIPPING.

**NO C.O.D. SHIPMENTS OR ORDERS ACCEPTED.**

**MAIL ORDERS TO:**

**Beckian Enterprises**

**P.O. Box 3089**

**Simi Valley, CA 93063**

**WRITE FOR LARGE QUANTITY DISCOUNTS. DEALER INQUIRIES ARE WELCOME.**

**WE ARE CONNECTOR EDGE CARD SPECIALISTS. IF YOU DO NOT SEE WHAT YOU NEED IN THIS ADVERTISEMENT, PLEASE WRITE US. WE WILL**

**REPLY.**

**TERMS:** Minimum Order $10.00. Add $1.25 for handling and shipping. All orders over $25.00 in USA and Canada WE PAY THE SHIPPING.

**NOTE:** CA residents please add 6% sales tax.

**NO C.O.D. SHIPMENTS OR ORDERS ACCEPTED.**

**MAIL ORDERS TO:**

**Beckian Enterprises**

**P.O. Box 3089**

**Simi Valley, CA 93063**

**Circle 30 on inquiry card.**
Circle 11 on inquiry card.

**MICROBYTE Z80-I-O**
- A complete single board Z80A CPU and software system
- Fully S-100 Bus compatible, IMSAI, ALTAIR
- Z80A CPU (eMS memory version of the Z80)
- 156 instructions — support of and upward compatible from the Z80’s 78 instructions
- 1K (2108), 2K (2716), or 4K (2723) PROM on board with Z80 Monitor program
- On board EPROM can be hard
- ware and software deselected
- 4K or 8K operation is switch selectable
- 6 or 1 wall slots for all cycles is switch selectable
- Full vectored interrupt capability (8 data with NMI 1 bit)
- 2 RS-232C serial ports with 8251 UARTS
- Serial baud rates switch selectable
- 1 8-bit parallel port with 2 control lines with Z80A-PIC
- Gold Contacts for higher reliability
- Power requirements: + 5.0 V @ 800mA, + 16V @ 50mA
- Operating temperature 0°-55°C
- Will operate with or without IMSAI/ALTAIR front panel
- Low power shottky n-state buffers on all address and data lines
- Fully warranted for 120 days from date of shipment

**MICROBYTE 16K STATIC RAM BOARD**
- Fully S-100 Bus Compatible, IMSAI, SOL, ALTAIR, ALPHA MICRO
- Uses National’s Low Power 5257
- 4K x 1 Static RAM
- 2 MHz or 4 MHz operation
- On board single 5 amp regulator
- Thermally designed heat sink
- Board operating temperature 0°-70°C
- Inputs fully low power Shottky Schmitt Trigger buffered on all address and data lines
- Phantom jumper selectable to pin 0
- Each 4K block addressable to any 4K slot with in a 64K boundary
- 4K hardware or software selectable
- Selectable port address
- 4K banks can be selected or dis
- abled on power on clear or reset

**MICROBYTE 32K STATIC RAM BOARD**
- Fully S-100 Bus Compatible, IMSAI, SOL, ALTAIR, ALPHA MICRO
- Uses National’s Low Power 5257
- 4K x 1 Static RAM
- 2 MHz or 4 MHz operation
- On board single 5 amp regulator
- Thermally designed heat sink
- Board operating temperature 0°-70°C
- Inputs fully low power Shottky Schmitt Trigger buffered on all address and data lines
- Phantom jumper selectable to pin 0
- Each 4K block addressable to any 4K slot with in a 64K boundary
- 4K hardware or software selectable
- One on board 8-bit output port enables or disables the 52X in 4K blocks
- Selectable port address
- 4K banks can be selected or dis
- abled on power on clear or reset
- Will operate with or without front panel
- Compatible with ALPHA MICRO, with extended memory management for selection beyond 64K
- No DMA restriction
- Low power consumption 2.3 — 2.5 amps
- Fully warranted for 120 days from date of shipment

**8251 PROGRAMMABLE/U-ART**
- TESTED @ 4 MHZ
- $6.00 each

**SA400**
- DISK DRIVE INCLUDES CABINET, NO PWR SUPPLY
- CUTOUTS FOR SWITCH, FUSE, & INTERFACE CABLE
- Mfg. By Lobo Drive
- $325.00

**TRS - 80**
- FLOPPY DISK DRIVE WITH CABINET & PWR. SUPPLY
- COMPATIBLE WITH RADIO SHACK INTERFACE ASSEMBLED & TESTED WITH 1 YR. WARRANTY
- ON PARTS & LABOR
- Mfg. By Lobo Drive $385.00

**REGULATORS**
- 450 NS $340.00
- 300 NS $300.00

**MM 5257**
- 4K X 1 STATIC RAM
- 1-16 17-49 50 up
- 320 T-5 .90 .85 .75
- 320 T-9 .90 .85 .75
- 340 T-5 .85 .80 .70
- 340 T-12 .85 .80 .70
- 78 H05 6.50 6.00 5.50

**SOCKETS—LO PROFILE**
- 450 NS $650.00
- 300 NS $600.00

**MICROBYTE DISK CONTROLLER**
- IBM 3740 Soft Seleceted Competitive
- Z80 or 6809 compatible on S-100 Bus
- Single density runs both mini and full size drives, runs CP/M, on Shugart, Perci, Memorex etc.
- Selectable portaddress
- On board 27082716 for bootstrap or monitor program
- No hardware jumpers, uses plug in modules for different drives
- Uses 1771B01 controller chip
- Assembled and tested

**MICROBYTE MOTHERBOARD**
- Active Diode termination
- Slot for IMSAI front panel
- Terminal block connector for easy hookup

**CALL FOR INFO ON OUR NEW PROM/PROGRAMMER**
- PROGRAMES 2708 / 2716 / 2732

**SHUGART 801-Disk Drive**
- WITH CABINET & PWR SUPPLY
- ASSEMBLED & TESTED
- 1 YR PARTS & LABOR
- Mfg. By Lobo Drive $585.00

**ORDERING INFORMATION:**
- Name, Address, Phone
- Ship by: UPS or P.P., with or without PROM/PROGRAMMER
- Shipping Charge: Add $2.50 up to 5 lbs., all excess shipping charges will be refunded. Credit cards will be charged appropriate freight.

**TERMS:**
- We accept cash, check, money orders, Visa, and Master Charge cards.
- COD’s on approval only
- Open Acct’s: companies may inquire for net terms.
- Tax: add 6% for Calif. residents only

**$250.00**

**$135.00**

**$200.00**

**$9.00**

**$69.00**

**$9.00**

**$69.00**

**$3.25 each or 10 / 2.75 ea.**

**$45.00**

**$360.00**

**$9.00 each**

**8 for $69.00**

**$325.00**

**$45.00**

**Limited Qty.**

**$585.00**

Circle 11 on inquiry card.
**WAMECO**

**THE COMPLETE PC BOARD HOUSE**

**EVERYTHING FOR THE S-100 BUSS**

- **FPB-1 FRONT PANEL BOARD**
  Hex Displays, IMSAI Replaceable ...........$54.95
- **FDC-1 FLOPPY DISC CONTROLLER BOARD**
  Controls up to 8 Discs ......................$45.00
- **MEM-1A 8K BYTE 2102 RAM Board ..........$31.95**
- **MEM-2 16K BYTE 2114 RAM Board ..........$31.95**
- **CPU-1 8080A CPU Board**
  With Vector Interrupt ........................$31.95
- **EPM-1 4K BYTE 1702A EPROM ...............$29.95**

**FUTURE PRODUCTS: 80 CHARACTER VIDEO BOARD, IO BOARD WITH CASSETTE INTERFACE.**

**DEALER INQUIRIES INVITED, UNIVERSITY DISCOUNTS AVAILABLE AT YOUR LOCAL DEALER**

---

**COMMERCIAL GRADE PERIPHERALS FOR THE MICROCOMPUTER**

**PRINTER TERMINALS**

- **ASCII SELECTRIC PRINTER/TYPewriter:** Why settle for less than letter-quality printout from your computer? Refurbished IBM Model 725 can be used as off-line typewriter or on-line printer. Complete with solenoids, power supply, case and ASCII interface card (TTL to CPU parallel port). Interface includes programmable ASCII translation table on EPROM with up to 8 tables for use with various type faces. Feedback signals on completion of each print cycle insures fastest printing speed (15 cps).
  Price: programmed w/3 translation tables (one type sphere) ..............................$695.00

- **SELECTRIC I/O TERMINALS** (by GTE/Information Systems). Both ASCII & IBM code versions with microcomputer interface software & hardware (RS-232 connector). Cassette drive models permit up to 2400 baud data transfer rate as well as off-line data storage, use as memory typewriter, & use as data entry device for office personnel familiar with Selectric typewriters but not computers. Wide-carriage, interchangeable type spheres; optional built-in modem. All units cleaned, adjusted & warranted.
  - Model 5541 (IBM Correspondence code) ..................................................$695.00
  - Model 5550 (correspond code, built-in cassette drive) .................................$1195.00
  - Model 5560 (ASCII code, built-in cassette drive) ......................................$1295.00

- **IBM SELECTRIC 725 TYPWRITER I/O w/solenoids switches & magnet driver PCB (from GTE/IS terminal) plus instructions for 8080 printer-driver interface hardware & software.**
  - a) Typewriter mechanism complete, cleaned & adjusted .................................$375.00
  - b) Case from terminal & power supply (+24V, ±12V, ±5V 95A) ................................$75.00

- **DIABLO HYTYPE I Model 1200 PRINTER MECHANISM:** used, complete and tested. Requires power supply, case & mCPU interface. 15 day return privilege — no other warranties. LIMITED QUANTITY!
  - $750.00
  - 6-ribbon window connector for printer Main Logic PCB ...........................................$10.00
  - 14-pin Winchester connector & 18" power supply cables ...........................................$5.00
  - "A4-4" spare printer PCB's for parts (Logic, Heat Sink, Control) ea.$30.00
  - New Pin-feed Plates (14") $55 if bought w/printer; separately .....................$100.00

- **QMB-12 12 SLOT MOTHER BOARD**
  Terminated ..................................................$40.00
- **RTC REALTIME CLOCK**
  Programmable Interrupts .......................$27.95

**MODems**

- **POS 103/202 "Mix or MATCH" MODEM:** BELL 103 and/or BELL 202 CONNECTIONS: Unique POS control design permits use in one housing of both Bell-compatible 103 (0 - 300 baud) and 202 (0 - 1200 baud) modem modules originally made by GTEIDC Corp. for a telephone company subsidiary. Features RS-232 serial interface, auto-answer, auto-dial, LED display, telephone line interface via acoustic coupler, manual DAA, or auto-answer DAA (sold separately). FULLY ADJUSTED: no special tools required.
  - Price: $199.95
  - POS 103 MODEM (with Auto Answer, Auto Dial) ..............................................$199.95
  - POS 202 MODEM (Half-Duplex with Reverse Channel) ......................................$249.95
  - POS 202 MODEM (Half-Duplex w/Rev. Ch., Auto-Answer) ...................................$279.95
  - POS 103/202 MODEM (Auto-Answer, Auto-Dial) ..................................................$399.95

- **POS-100 NRZ1 TAPE DRIVE CONTROLLER/FORMATTER:** Designed as interface between S-100 bus mCPU and 9-track, 800 BPI NRZ1 tape drive. Allows microcomputerist to read and write IBM-compatible magnetic tapes. Software provided for 8080 or Z-80 systems. Requires modification for drives of various mfrs.
  - Price: (Included S-100 card, controller card, 10' cable, software listing) ............$750.00
  - NRZ1 TAPE DRIVE by WILLARD LABS. 9-track, 800 BPI, NRZ1 normal, 12" tapes, 1200 ft. reels (10-megabyte capacity) Fully tested and warranted $599.00
  - FORMS TRACTOR, Moore Variable width "Form A-Liner" for print terminals: 3-modal 565P for 15" Carriage IBM Selectrics (new) ......................$50.00
  - 3-modal K81 for QUME or DIABLO Hytype I or II printers (new) .............$50.00
  - POWER SUPPLIES for Disk Drive, mCPU, tested under load shown:
    - No. 519 (with & without AC card): ±5V reg., ±12V reg., ±24V, ±4A (10 lb.) ....$29.95
    - DIGITAL CASSETTE DRIVE (from GTE/IS Terminal): 1800 baud, 6"/sec. AC motor; ok rewound circuitry plus tape head, no read/write electronics $20.00
  - FULLY WELDED ELECTRIC INTERFACE BETWEEN S-100 BUS & CPU ..........................$20.00

All units cleaned, adjusted & warranted. LIMITED QUANTITY!

**TAPE DRIVES**

- **QMB-12 12 SLOT MOTHER BOARD**
  Terminated ..................................................$40.00
- **RTC REALTIME CLOCK**
  Programmable Interrupts .......................$27.95

---

Full documentation included PLUS interface instructions where indicated. All equipment is shipped insured FOB Palo Alto within 14 days after check clears or COD order is received. Prices may change without notice.
POWER TRANSFORMERS (WITH MOUNTING BRACKETS)

<table>
<thead>
<tr>
<th>ITEM NO.</th>
<th>USED IN</th>
<th>PR. WINDING TAPS</th>
<th>SEC. WINDING OUTPUTS</th>
<th>SIZE W x D x H</th>
<th>UNIT PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>1</td>
<td>0V, 110V, 120V</td>
<td>2 x 9A</td>
<td>3¾&quot; x 4½&quot; x 3½&quot;</td>
<td>19.95</td>
</tr>
<tr>
<td>T2</td>
<td>2</td>
<td>0V, 110V, 120V</td>
<td>2 x 12.5A</td>
<td>3¾&quot; x 4½&quot; x 3½&quot;</td>
<td>25.95</td>
</tr>
<tr>
<td>T3</td>
<td>3</td>
<td>0V, 110V, 120V</td>
<td>2 x 2.5A</td>
<td>3¾&quot; x 4½&quot; x 3½&quot;</td>
<td>27.95</td>
</tr>
<tr>
<td>T4</td>
<td>4</td>
<td>0V, 110V, 120V</td>
<td>2 x 2.5A</td>
<td>3¾&quot; x 4½&quot; x 3½&quot;</td>
<td>19.95</td>
</tr>
</tbody>
</table>

POWER SUPPLY KITS (OPEN FRAME WITH BASE PLATE, 3 HRS. ASSY. TIME)

<table>
<thead>
<tr>
<th>ITEM</th>
<th>USED FOR</th>
<th>@+8 Vdc</th>
<th>@-8 Vdc</th>
<th>@+16 Vdc</th>
<th>@-16 Vdc</th>
<th>@+28 Vdc</th>
<th>SIZE W x D x H</th>
<th>UNIT PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>KIT 1</td>
<td>18 CARDS SOURCE</td>
<td>18A</td>
<td>2.5A</td>
<td>2.5A</td>
<td>12&quot; x 6&quot; x 4½&quot;</td>
<td>46.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KIT 2</td>
<td>SYSTEM SOURCE</td>
<td>25A</td>
<td>3A</td>
<td>3A</td>
<td>12&quot; x 6&quot; x 4½&quot;</td>
<td>54.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KIT 3</td>
<td>DISC SYSTEM</td>
<td>18A</td>
<td>1A</td>
<td>2A</td>
<td>14&quot; x 6&quot; x 4½&quot;</td>
<td>62.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KIT 4</td>
<td>DISC SOURCE</td>
<td>8A</td>
<td>1A</td>
<td>8A</td>
<td>10&quot; x 6&quot; x 4½&quot;</td>
<td>44.95</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

EACH KIT INCLUDES: TRANSFORMER, CAPACITORS, RESIS., BRIDGE RECTIFIERS, FUSE & HOLDER, TERMINAL BLOCK, BASE PLATE, MOUNTING PARTS AND INSTRUCTIONS.

REGULATED POWER SUPPLY "R1" ASSY. & TESTED, OPEN FRAME, SIZE: 9" (W) x 5" (D) x 5" (H) ....... $49.95

SPECs: +5V ±1%, @ 5A, OVERCURRENT PROTECTION, 5% ADJ. FOR +5V. +24V UNREG. @ 5A FOR PRINTERS OR DISCS.

REMARK: IDEAL FOR ROCKWELL AIM-65 MICROCOMPUTER. ALSO UNREG. -8V @ 8A ATTAINABLE FOR USE IN S-100 BUS.

SHIPPING FOR EACH TRANSFORMER: $4.75. FOR EACH POWER SUPPLY: $5.00 IN CALIF. $7.00 IN OTHER STATES. CALIF. RESIDENTS ADD 6% SALES TAX. OEM WELCOME.

COMPUCOLOR II IS HERE!!

HERE IS A SURPRISINGLY AFFORDABLE COMPUTER THAT MAKES THE COMPETITION LOOK TWICE!!

STANDARD FEATURES

- 13" COLOR CRT
- SPECIAL GRAPHICS PKG.
- EXTENDED DISK BASIC
- MINI DISK DRIVE
- 8K RAM MEMORY
- 72 KEY KEYBOARD

PRICE & OPTIONS

MODEL 3 - 8K USER RAM-1495.00
MODEL 4 - 16K USER RAM-1695.00
MODEL 5 - 32K USER RAM-1995.00
2nd DISK DRIVE - 400.00
EXPANDED KEYBOARD - 135.00
FORMATTED DISKETTE - 5.00
MANY PROGRAMS AVAILABLE *

TO ORDER

SEND CHECK OR MONEY ORDER
CALIF. RES. add 6% TAX
shipping 1% all orders

CATALOG - 50¢
FOR SALE: Radio Shack ASCII keyboard, oscillator/monitor. Freq. 80, 5V, 1A supply, 5V, 2A +12V, 1A. Data can be entered and retrieved but program will not run. $200. CFI add-on memory for IBM system III, mod 6 or 10, 16K. Working condition, with cables, $200 or best offer. Norm Doty, 53 Kaufman Rd, Chestnut Grove NY 14225, (161) 922-8289.

FOR SALE: KIM system KIM-1 Computer, Encyclopedia. Samsung RS-200 terminal, 2L202D. TV-5 video interface, surplus video monitor. Board has adequate ASCII keyboard, oscillator/holder driver board and speaker, I/O (input/output) connector block, 5 V, 1 A supply, 5 V, 2 A +12 V, 1 A supply. All for $450. Ron Kehnman, 3108 Addison Ct, Cornelius Heights PA 19020, (215) 757-3057.

FOR SALE: Eight 4.2 K 8-bit microcomputers, one disk drive, VDM-1, 3P + S, Cherry Switch keyboard, monitor and cassette recorder. All in excellent condition, with cables, $2000 or best offer. No reserve. Hendrington St, Jersey City NJ 07302, (201) 441-6858.

FOR SALE: Two MITS Altair 4K memory boards, model 8840MC, assembled and in service, no bad bits. Includes original documentation. I need the 2K. Printed circuit is well wired and insulated. Money order or certified check, or allow three weeks for personal check to clear. Lewis Mosley Jr, 2576 Glendale Ct NE, Conyers GA 30092.

FOR SALE: IMSAI microcomputer with 2K programable memory and 32K static memory board, Tarbell cassette interface, floppy video board, keyboard, monitor, and cassette tape recorder. All working, $1900. Otis TEN 801 S, Santa Monica CA 90404, (213) 829-2843 or 829-7411.


FOR SALE OR TRADE: 5 D SEales, 16K Expandoram (has sockets for 32 K). This board will not work with DMA or any application that requires static memory. I will sell for $200 OBO. Wayne Millar, 905 Fairmont Blvd, Jefferson City MO 65101.


FOR SALE: Assembled Cromemco D7A analog I/O (input/output) board. Ribbon cable and edge connector included. I will include all driving and applications software that I have written to date. Excellent condition, only $12. John Peterson, 1820 Camino Dr, Forest Grove OR 97116.


FOR SALE: A limited number of BYTE. Volume 1 #1, in mint condition. Never been opened. Highest bids can have them while they last. Joe Hanan, 607 Painters Xing, Chadds Ford PA 19317, (215) 358-3346.

FOR SALE: Digital Group Z-80 26 K system, keyboard, dual Phi-Decks, printer. All working, in dress cabinets; lots of software. No reasonable offer refused. Scott Bishop, 2221 Charlotte Dr, Maitland FL 32751, (305) 869-4203.
SMART FOXY

Venus 2001 Video Board
Assembled and Tested $259.95 • Complete Unit with 4K of Memory and Video Driver on Eprom assembled and tested $339.95

kit $199.95

OPTIONAL: • Sockets $10.00 • 2K Memory $30.00 • 4K Memory $60.00 • Video Driver Eprom $20.00 • Text Editor Eprom (Includes Video Driver $75.00)

S-100 Plug-In • Parallel Keyboard Port
On board 4K Screen Memory (Optional). On board Eprom (Optional) for Video Driver or Text Editor Software.

Up and Down Scrolling through Video Memory
Reverse Video, Blinking Characters.

Display: 128 ASC11 Characters 64 X 32 or 32 X 16 Screen format (Jumper Selectable). 7 by 11 Dot Matrix Characters.
To get further information on the products advertised in BYTE, fill out the reader service card with your name and address. Then circle the appropriate numbers for the advertisers you select from the list. Add a 15 cent stamp to the card, then drop it in the mall. Not only do you gain information, but our advertisers are encouraged to use the marketplace provided by BYTE. This helps us bring you a bigger BYTE.
Now you can put your S-100 system solidly into a full-size, single/double density, 600K bytes/side disk memory for just $1149 complete.

DISCUS/2D™ single/double density disk memory from Thinker Toys™ is fully equipped, fully assembled, and fully guaranteed to perform perfectly.

DISCUS/2D™ is a second generation disk memory system that's compatible with the new IBM System 34 format. The disk drive is a full-size Shugart 800R, the standard of reliability and performance in disk drives. It's delivered in a handsome cabinet with built-in power supply.

The S-100 controller utilizes the amazing Western Digital 1791 dual-density controller chip... plus power-on jump circuitry, 1K of RAM, 1K of ROM with built-in monitor, and a hardware UART to make I/O interfacing a snap.

The DISCUS/2D™ system is fully integrated with innovations by designer/inventor George Morrow. Software includes BASIC-V™ virtual disk BASIC, DOS, and DISK-ATE™ assembler/editor. Patches for CP/M™ are also included. CP/M™, MicroSoft Disk BASIC and FORTRAN are also available at extra cost.

DISCUS/2D™ is the really solid single/double density disk system you've been waiting for. We can deliver it now for just $1149. And for just $795 apiece, you can add up to 3 additional Shugart drives to your system. Both the hardware and software are ready when you are.

Ask your local computer store to order the DISCUS/2D™ for you. Or, if unavailable locally, write Thinker Toys,™ 5221 Central Ave., Richmond, CA 94804. Or call (415) 524-2101 weekdays, 10-5 Pacific Time. (FOB Berkeley. Cal. res. add tax.)

*CP/M is a trademark of Digital Research.

The S-100 controller utilizes the amazing Western Digital 1791 dual-density controller chip... plus power-on jump circuitry, 1K of RAM, 1K of ROM with built-in monitor, and a hardware UART to make I/O interfacing a snap.

The DISCUS/2D™ system is fully integrated with innovations by designer/inventor George Morrow. Software includes BASIC-V™ virtual disk BASIC, DOS, and DISK-ATE™ assembler/editor. Patches for CP/M™ are also included. CP/M™, MicroSoft Disk BASIC and FORTRAN are also available at extra cost.

DISCUS/2D™ is the really solid single/double density disk system you've been waiting for. We can deliver it now for just $1149. And for just $795 apiece, you can add up to 3 additional Shugart drives to your system. Both the hardware and software are ready when you are.

Ask your local computer store to order the DISCUS/2D™ for you. Or, if unavailable locally, write Thinker Toys,™ 5221 Central Ave., Richmond, CA 94804. Or call (415) 524-2101 weekdays, 10-5 Pacific Time. (FOB Berkeley. Cal. res. add tax.)

*CP/M is a trademark of Digital Research.
OHIO SCIENTIFIC DOES IT AGAIN

Ohio Scientific has taken its standard C3 computer and married it to the new Shugart 29 Megabyte Winchester Drive. The result is the C3-C. This new microcomputer now fills the vacuum that existed for computer users who need more mass storage capability than floppies can offer—yet until now, could not justify the additional cost of a larger capacity hard disk computer such as our C3-B 74 Megabyte disk system.

Winchester Technology
Winchester hard disk drives offer small business and professional computer users the logical solution to mass storage problems that are beyond the capability of floppy disks. In addition, Winchester disks feature a track seek-time that is much better than floppies and because they spin at eight times the rate of floppies, Winchesterers have a shorter latency. Both of these points reflect one remarkable speed advantage Winchester disks have over floppies.

Coupled to the C3 Computer
Ohio Scientific's award winning C3 computer is a classic. It is the only computer series that utilizes the three most popular microprocessors - 6502A, 68800 and Z-80. This tremendous processor versatility enables one to utilize a seemingly endless selection of quality programs available from Ohio Scientific's software library as well as from many independent suppliers.

And Advanced Software
For instance, there are single user, multi-user and network operating systems. A complete turnkey small business package, OS-AMCAP provides accounts receivable, accounts payable, disbursements, cash receipts, general ledger, etc. OS-CP/M offers a complete FORTRAN and COBOL package. And there is WP-2, a complete word processing system. For information management, OS-DMS, features an advanced file handling system and program library that simplifies information storage and recall and routinely performs tasks which usually require special programming on other systems.

Yields the Microcomputer of the Future
With an eye toward the future, the C3-C, like all other C3's was designed with provisions for future generation 16 bit microprocessors via plug-in options. There are ten open slots for lots of I/O and multi-user operation. Truly, the Ohio Scientific C3-C is a computer with a future.

The new C3-C computer with 29 Megabyte Winchester Hard Disk.

S9340 with 48K static RAM and OS-65U operating system

600K byte Dual 8" floppys

Easy to configure and service. Rack slide mounting on all subassemblies. 10 open slots for expansion.

Shugart SA-4008 29 Megabyte Winchester Disk (23 Megabytes of formatted user space under OS-65U).

OHIO SCIENTIFIC
1333 S. CHILLICOTHE RD., AURORA, OHIO 44202 (216) 562-3101

OEM pricing available

Circle 290 on inquiry card.