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In This Issue

This month we talk about voices — computer voices, that is — and several other topics as well.

Consulting Editor Mark Dahmke speaks out on speech in the editorial "Computer Speech: An Update." We also have two theme articles: "An Extremely Low-Cost Computer Voice Response System," which shows how to computerize your vox humana for very little money, and "Articulate Automata," which looks at the physiology of speech.

Also in this issue is Steve Clarcia's do-it-yourself computerized Big Trak; everything you've always wanted to know about dynamic memory; inexpensive AID and D/A conversion; and much more, including reviews of the new Radio Shack Daisy Wheel Printer II, the Heath H-14 printer, not to mention Zork and IRV.

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Editorial

Computer Speech: An Update

Guest Editorial by Mark C. Dahmke

In 1972 I saw an advertisement in Scientific American for the Votrax speech synthesizer — a multiple-board system that produced fairly intelligible speech. Although digital speech synthesis has been with us for more than a generation, it wasn’t until the early seventies that relatively low cost, compact synthesizers were available for use in industry. At the time, I became very interested in the concept and wanted to experiment with a synthesizer, but the price was still too high for my budget.

Finally, in August 1976, BYTE published an issue on speech synthesis. The article “Friends, Humans, Countryrobots: Lend me your Ears” described in detail the Computalker CT-1 speech synthesizer designed by Computalker...

Photo 1: The author of this month’s guest editorial, Mark Dahmke (left), demonstrating the special speech-generating computer system, “The Bionic Voice,” he developed for his friend Bill Rush. The Computalker-based system allows Bill, a quadriplegic, to “speak” with the aid of a head stick. Mark and Bill were the subjects of a feature story in Life magazine last year that was later condensed in the Reader’s Digest. Hollywood is interested, too: a movie is being produced for television that will tell their story and show how personal computers can make a profound difference in people’s lives. Mark is a Consulting Editor for BYTE, and has had a continuing interest in computer speech for many years. His forthcoming book, Microcomputer Operating Systems, will be published by BYTE Books later this year....CM (Photo courtesy Brian Lanker).
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Consultants of Santa Monica, California. The CT-1 was an S-100 board, consisting of a formant-based synthesizer, driven by nine parallel output ports. The data rate required was only 100 bytes per control parameter per second, or 800 bytes per second for normal speech.

Several software packages were provided: the CTMON program and later CTEDIT, allowing the user to enter and edit parameter data. Another package called CSR1, the Computalker Synthesis by Rule Program, accepted as input a character string of phonemes from the International Phonetic Alphabet and generated fairly good speech. During the mid-1970s, several other single-board speech synthesizers became available, allowing hobbyists and researchers to experiment with state-of-the-art hardware and software without going into debt.

It was not until early in 1979 that I obtained a Computalker board for experimentation. The project was to design a "Bionic Voice" for my friend Bill Rush, a student at the University of Nebraska who has cerebral palsy. (See my article, "A Voice for Bill," in the Winter 1979 issue of onComputing.) I used the CSR1 package and wrote a dictionary handler program to make the system easy to use (since Bill does not have full control of his limbs, he types hunt-and-peck style using a stick attached to a band around his forehead).

More recently, I attended a VOCA (Voice Output Communication Aid) Conference in Berkeley, California, in May 1980. It is obvious from such conferences and discussions that voice output for the nonvocal and nonverbal (and talking terminals for the blind) are high on the list of potential applications of voice input/output technology.

On the consumer electronics front, VIO (voice input/output) technology seems to be the trend setter of the eighties. This becomes immediately apparent when one walks through consumer electronics shows, the West Coast Computer Faire, or numerous other product shows. Instead of just flashing lights and color video displays, products are now talking at, about, and with you.

Some recent developments in speech synthesis include the Votrax SC01 single-chip formant synthesizer mentioned in "Articulate Automata" in this issue. Texas Instruments has been at the forefront of LPC (linear predictive coding) approach. One of its most successful products, Speak & Spell, shows what can be done in the consumer products market.

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Editorial

As VIO technology has become more readily available, there is a natural tendency to make everything from washing machines to automobiles talk back. Although the concept is a novel one, I have enough noise pollution to contend with without adding anonymous electronic voices. The real problem with voice output is that it is omnidirectional. If you’re surrounded with devices that spontaneously vocalize, it’s not always easy to determine where the voice came from. Picture the executive who has three or four telephones on his desk all ringing simultaneously, all sounding the same. Just as high-density video displays can cause sensory overload, multiple voice-output devices can also overload the aural channel to the brain.

Voice recognition has taken longer to develop because of the many differences between speakers and the different shades of nuance inherent in contextual information. Factors such as the emotional content of the speaker's voice, the accent or dialect, and (the biggest problem) continuous recognition, have slowed the evolution of voice input technology. Continuous recognition means that the computer must be able to determine the beginning of one word and the ending of the last — not a trivial project. For example, the machine may have to distinguish between “I speak” and “ice peak.” The problem is further compounded by regional accents and other variables. While great strides have been made in this area, it will probably be many years before generalized continuous voice recognition systems become available. Isolated word recognition is a much simpler problem, and systems are now available with better than 90 percent accuracy when working with a limited vocabulary.

With any new or evolving technology, the challenge is to use it effectively, efficiently, and with imagination. Voice input/output promises to open a whole new dimension to the man-machine interface, one that can be sensed without needing to be seen.

At the end of my onComputing article, “A Voice for Bill,” I wrote, “I cannot even begin to imagine what uses Bill will find for his new voice. But if past accomplishments are any indication of things to come, I want to be around in five or ten years to see the results of the seeds we have planted.” A year and a half later, my sentiments haven’t changed a bit.

Photo 2: The TMS5200 LPC (linear predictive coding) speech-synthesizer chip from Texas Instruments.

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New Computer Speech Developments

Scott Instruments of Denton, Texas, recently announced the VET/2 — a speech-recognition interface for the Apple II. It will run with any existing software because, once loaded, either keyboard or voice input may be used. The program will handle forty-word vocabularies, with the option of overlaying other vocabularies to double or triple the number of words.

Street Electronics of Anaheim, California, has announced the Echo series of speech synthesizers. Versions are being designed for the Apple II and the TRS-80. The units use the Texas Instruments TMS5200 LPC synthesizer chip mentioned in the editorial. The software driver runs in about 900 bytes of memory. Individual vocabulary words take between 10 and 20 bytes, depending on the length of the word....MCD
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Katching Up with Khachiyan

I would like to commend the authors of "Khachiyan's Algorithm" (G.C. Berresford, A.M. Rockett, and J.C. Stevenson) published in the August and September 1980 BYTEs (pages 198 and 242, respectively). Their presentation illustrated the essentials of the algorithm without getting bogged down in its derivation. However, now that I understand it (I hope), it is somewhat disillusioning to realize that the "amazing shortcut" appears to be only a nonpractical mathematical curiosity.

I have some observations regarding the algorithm. First, the huge initial volume subsequently requires the incredible precision. Hadamard's initial volume is much smaller, and this should reduce the precision requirements; but by how much? Also, if upper bounds are defined for all $x_i$, would this be helpful?

Even if the precision problems are solved, the total number of arithmetic operations to solve a large linear-programming problem still appears to be intractable. The upper bound for the number of iterations is $16L^2$, and each iteration uses $O(n^2 \times m^2)$ multiplications for the matrix inner products. Presumably, if a solution exists, the number of iterations will be much less than $16L^2$ (but by how much?), and the number of multiplications per iteration can be reduced to $O(n^2 m^2)$ via Strassen's algorithm. However, both of these appear to be greater than those required by the usual revised Simplex algorithm. While the Simplex algorithm can require $O(2^n)$ iterations, it usually finds the optimal solution in $O(nm)$. Also, each iteration needs only $O(mn)$ multiplications (revised Simplex).

Memory requirements also seem to put Khachiyan's algorithm at a disadvantage. The giant $A$ array (see statement 430, listing 1, September 1980 BYTE, page 246) can be reduced to negligible size using linked lists, and the $Q_1$ and $W$ arrays could use the same space, but this still leaves three $(m+n)$ by $(m+n)$ arrays for Khachiyan's algorithm. In contrast, the only large array for the revised Simplex is the $m$ by $m$ array.

The problem of solving large linear-programming problems looks more promising if array-oriented hardware is used. For example, a clocked matrix multiplier can read in, compute, and write out the inner product of two $n$ by $m$ matrices in $5n$ clock periods. This would be an immediate benefit for the revised Simplex as well as a help to Khachiyan's algorithm, if the precision problem can be overcome.

William J. Butler Jr
44 Dees Cr
Warwick RI 02889

Berresford, Rockett, and Stevenson Reply

We are happy that you found our articles on Khachiyan's algorithm so informative. Our purpose was to encourage such experimentation with the algorithm. As the articles explained (and, incidentally, earlier than any other journal as logged in the February 1980 issue of Abstracts of Papers Presented to the American Mathematical Society), Khachiyan's algorithm is not capable of immediate practical application largely because of the incredible precision required.

In fairness to Leonid Khachiyan, it is clear from his paper that he never intended his result as a practical method for solving linear-programming problems. In fact, linear programming is only mentioned in one sentence in the introduction, the rest of the paper being devoted to the consistency problem for linear inequalities. His purpose was a purely theoretical one: to prove that linear consistency and, therefore, linear-programming problems could be solved in polynomial instead of exponential time. It was the American and European press (with the exception of BYTE) that erroneously construed the result as one of practical rather than theoretical importance. (In fact, many other journals have had to issue retractions or corrections of earlier ill-considered statements.)

As to your specific questions, there is little we can say except to answer "yes": your suggestions would doubtless improve the algorithm. Dr. Philip Wolfe of IBM (Yorktown Heights, New York) has been serving as a clearinghouse and evaluator for the numerous improvements to the algorithm that have been suggested, but none so far seem to accelerate the algorithm by as much as one order of magnitude. Thus, it is far from competitive with the revised Simplex algorithm. While the Klee-Minty example shows that the Simplex method is an exponential-time algorithm, problems similar to Klee-Minty rarely occur in practice, and when they do, standard
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tricks (such as rescaling) usually greatly reduce the time needed for solution. In fact, experience seems to indicate that the revised Simplex method is almost linear in the number of variables, thus making it hard to beat.

A more complete answer to your questions about improving Khachiyan's algorithm will have to await large-scale experimentation by IBM and others.

Comments on the Heath H-89

In regard to Mark Dahmke's review of the H-89 (see "The Heath H-89 Computer," August 1980 BYTE, page 46), I agree with him until he starts talking about the "disadvantages." The text editor is not that hard to operate, and, if he thinks it is, he can get a different one from HUG (Heath User's Group) or other sources in BH. He also mentions the lack of a RUN "FNAME" command in BH (Benton Harbor) BASIC, but, in version 1.6, which is the version Mr Dahmke worked with, you can say CHAIN "FNAME" with the same results.

All of Mr Dahmke's other observations are true, but there are cues. For example, to keep the disk head from dropping up and down, change the HS jumper to open and the HM jumper to closed in the disk unit on the "programming plus." Then the heads stay loaded as long as the motor stays on, about a minute after the last operation. Of course, you could time-delay the load signal.

The last, and probably more important, point is how not to need the HDOS system on every disk. On version 1.6, the command SET HDOS STAND-ALONE is available, and, after the warning message, the command RESET SY0: will be honored. This might mess up versions earlier than 1.6; and, if you land on a disk while not in PIP or ONECOPY, the SYSMD.SYS will load. If the verions differ, you might get a FATAL SYSTEM ERROR, but, all in all, it is a good trade-off. Be sure to LOAD LP; and other DUDs before RESETing after BOOT up.

Bill Pinkston
Saltillo MS 38866

If I may add a few things to Mr Dahmke's review of the Heath H-89: Heath's BH BASIC is neither fast nor high in precision (my Ohio Scientific C3 will run circles around it), but it does have one great advantage for the debugging phase of programming. While other BASICS will null all variable and array values upon a revision of any line of a program, however trivial, BH BASIC does not. Thus you can stop execution, fix up a defective line, and restart in mid-program, rather than having to re-run from the beginning—a real advantage for long programs, and for programs requiring many INPUTs to go through.

A detail I like about the H-89 is its ability to take commands in lowercase, converting input to uppercase as needed. That's very nice if you spend a lot of time in the word-processing mode.

Oddly, Mr Dahmke had little to say about the display and keyboard. I have to cope daily with a Televideo 912, an industrial-grade terminal which will cause you to appreciate the superior quality of the H-89 display and keyboard. The 912 is susceptible to false key contacts, which usually cause the display to do truly weird things, thereby forcing you to abandon your input and to refresh the entire display. It also gives no audible confirmation of key contact; and the 80-character line is limited to perhaps two-thirds of the screen width, wasting the rest of the screen. The H-89 terminal runs at 9600 bps (bits per second)—some have been pushed to 19,200 bps—a difference especially noticeable in word-processing and financial programs, for which execution time is limited by the display, rather than by computation.
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Letters

I have to disagree with Mr Dahmke’s assertion that the Heath text editor is useless. I use it as a word processor, for hours every day, with no difficulty; however, I’m not hampered by familiarity with any other text editors. Mr Dahmke’s statement that the H-89’s reading of error messages from disk takes “several seconds” is, frankly, an exaggeration. The actual elapsed time is under one second, though it certainly seems longer. Also, the disk head does not touch down for “each and every sector”; it reads the sectors in pairs, touching down for every other sector, which is noisy and slow enough.

If you want a sophisticated machine, or a fast, high-precision computer, the H-89 isn’t it. The H-89 is a fine word-processing and financial computer, right for the user who doesn’t want to get deeply involved in computer hardware and software.

Jack McKay
3200 19th St NW
Washington DC 20010

Mark Dahmke Replies

I thank Mr Pinkston and Mr McKay for their comments about my review and for bringing the various “fixes” to my attention and to that of BYTE’s readers. My philosophy for reviewing equipment is that I am reviewing essentially what comes out of the box. Any updates from readers are greatly appreciated, but I feel I must give potential buyers an accurate indication of what the product is like as it comes from the manufacturer. As for the other comments regarding the editor, I will stand by my statements in the review.

Dissecting the Speak & Spell Article

The article published in the September 1980 BYTE concerning the TI (Texas Instruments) Speak & Spell (see “Dissecting the TI Speak & Spell,” by Michael P Rigsby, page 76) contains a number of serious errors that must have upset staff scientists Richard Wiggins and Larry Brantingham at TI’s Central Research Laboratory in Dallas, Texas.

To suppose that the TMC0281 device used in the Speak & Spell is the same as the SN76477 is to greatly underestimate Texas Instruments’ achievement. The TMC0281 is, in fact, a complete speech-synthesizer device fabricated in metal-gate depletion-load p-channel technology and contains an entire digital-signal processor, with timing and decoding circuits, a ten-stage digital-lattice filter, and a D/A (digital-to-analog) converter. The system is based upon the relatively new voice-compression technique known as linear predictive coding. This technique can generate high-quality speech from low data rates (less than 2400 bits per second). Linear predictive coding is so called because of the way in which the coefficients that characterize the digital filter are predicted from a linear combination of the previous coefficients. This requires a great deal of number crunching—in the case of the TMC0281, 160,000 additions and 160,000 10- by 14-bit multiplications every second. TI confounded the many skeptics who said it couldn’t be done. To get around the speed problem, Wiggins transformed all the calculations into a fixed-point format and Brantingham designed a pipeline processor that is contained within the TMC0281.

The coded speech data for the synthesizer device is stored in the TMC0351’s read-only memory. These are 16,384 by 8-bit devices (ie: 128 K bits) having an internal 18-bit address counter/register and two 8-bit output buffers. Fourteen of the address bits go to the memory array directly, while the 4 most significant bits are used in a 1-of-16 chip select.

The controller chip, the TMC0271, is a slightly modified calculator chip, a member of the Texas Instruments TMS1000 family. It has been modified to enhance its BCD (binary-coded decimal) arithmetic and expand its instruction set. Also, there is an output multiplexer to reduce the pinouts needed for the Speak & Spell application.

Contrary to the implications in the article that the “operation of the Speak & Spell involves many unknowns,” TI has, in fact, published full details of its three-chip synthesizer system (see Electronics, August 31, 1978, pages 109 thru 116) and many other articles have appeared. A letter to TI brings (at least in my case) a set of reprints.

Tim Spracklen
23 Butlerrmere, Greenways, Spennymoor Durham, DL16 6UD, England

De Facto of De Matter

This is a plea for order in what could be the next standards chaos: Sol Libes mentioned a Massachusetts company planning to use home VTRs (videotape recorders) for hard-disk backup. (See “Back Up Winchesters” in “BYTELINES” October 1980 BYTE, pages 188 and 189.) Corvus also plans such a system. Our company, D C Crane Inc, is planning one using the Digital Graphic Systems CAT-100 videodisplay board.

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restoring hundreds of megabytes. It will also establish de facto interchange standards. Could we learn from the past? Just this once? Please?

I would like to hear from anyone interested in helping develop or use such a standard with a view toward documenting the problem and the solutions in an article for BYTE. If a formal standards commission is interested, so much the better. Please write me at the address below. I will put you in contact with each other and contribute my ideas toward a solution.

David C Crane
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Have You Tried onComputing?

For fifteen years I have dreamed of using a computer for my one-man busi­ness. I have tried to find the right one in BYTE, on and between the lines. The result of my search is the feeling that, to become "computerized." I must become an expert in mathematics (Boolean and otherwise), electronics, hardware, software, semiconductors, integrated cir­uits, languages, and all the rest of the stuff. Oh, my aching head! Help, help! The computer train is rolling so fast and I am unable to climb aboard.

When I first became "motorized," I didn't have to be an expert in mechanics, thermodynamics, aerodynamics, electricity, tire structure, fuel chemistry, etc. I simply sat in the car and—without any help—taught myself the rules of the road. Who can, for a moderate price, link together and harmonize some of the wonderful programs advertised in BYTE to make a system coherent, practical, and flexible?

R E Gilbert
Jozef Hermansen 41
B-2510 Mortsel
Belgium

Of course, a computer is much more complex than any automobile, but the analogy is still valid. People should be able to get what they want from a computer with a minimum of fuss. Until then, Mr Gilbert, guides are necessary: enjoy the complimentary copy of onComputing; she's our sister publica­tion for the layman.

Marc H Bruna
Abrikosenstraat 31
2504 VK Den Haag
Netherlands

Tree Is Root of Problem

As a fellow member of the University of Oklahoma, I feel it necessary to point out some of the areas where I disagree with Dr Bill Walker's article "Sorting With Binary Trees" (October 1980 BYTE, page 96). These areas will be dealt with in the same order as they appear in the article.

First, Dr Walker gives the impression that a tree sort is both fast and allows deletion of nodes in an efficient manner. As he says, a tree sort is faster than a bubble sort, but almost any serious sort routine will be faster than a bubble sort. Likewise, deleting a node from a tree is faster than deleting an element from a bubble-sorted list, but deleting nodes from trees, except in the special cases of AVL; B; and 2-3 trees, is not particularly fast. (See The Design and Analysis of Computer Algorithms, by Alfredo Aho and Jeffrey D Ullman. Reading MA: Addison-Wesley, 1974.)

Second, students of graph theory tend to define a tree as an acyclic graph. (See Graph Theory, by Frank Harary. Reading MA: Addison-Wesley, 1969.) By this definition, the object presented in Dr Walker's figure 1 is not a tree, but a rooted graph.

Third, Dr Walker states that one way of scanning a sorted tree (a binary­search tree) would be to first visit the leftmost node in each branch, then the parent, and finally visit the rightmost node, repeating this sequence until finished. He proceeds to say that this is "tough for computers." However, the C-language routine in listing 1, page 24, performs Dr Walker's suggested algorithm.

Next, the algorithm used to search a tree can be cleaned up considerably, as shown in listing 2. The algorithms used to delete and add nodes are excellent, and rewriting those in C would serve no other purpose than to expose the defi­ciencies of Pascal.

We now have nice, short algorithms to do everything that Dr Walker wanted to do to the tree, except to delete nodes

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Letters

from it. As far as I know, the algorithm he used cannot be improved upon to any great extent. This point is the basis for my statement that it is not relatively easy to delete nodes from a tree.

To achieve the operations Dr. Walker wants (easy insertion and deletion, while maintaining a sorted list, plus easy searching), I would recommend a double-linked list. The algorithms for dealing with this structure can be found in any good data structures or algorithms text.

Mike Meyer, Student
University of Oklahoma
POB 1749
Norman OK 73070

I thoroughly enjoyed Dr. Walker's article on binary-tree sorting in the October BYTE. He presented a subject that often receives a boring and confusing treatment in an interesting and clear manner. Since the amount of data I must sort daily has recently doubled, the article came at the right time.

Time after time I have seen the subject of trees presented in magazines and books. Each time I lacked the incentive to actually implement a tree structure on my system. The whole thing seemed too complicated for the results obtained. However, Dr. Walker provided the push I needed to get it going.

Although some of the coding is redundant, by the author's own admission, and is slightly inefficient in some areas (due mostly to the direct conversion from FORTRAN and his desire to keep the program portable), the program makes sense. That sounds simple, but many programs don't make any sense at all—they just work "somehow."

Because of the use of highly structured subroutines and "standard" BASIC, I easily translated the program of his listing 1 into Oasis BASIC and modified it for operation on strings. This later change is simple if the BASIC used dimensions a string-array length rather than a string length. The modification to sort strings requires changing P in lines 200 and 205, KEY, and ALPHA to string variables. It works well and fast.

I did, however, find one major design problem. It is associated with the deletion of a right terminal node that is not the last node in the sorted sequence. Both the coding of line 3090 and the logic of table 1, Case II, Group B, Subcase I call for setting the right link pointer of the parent Q to NIL (setting RLINK(Q)=NIL). This tells the tree-traversal routine that this parent is the last item in the tree. Often it is not.

The proper logic is to set RLINK(Q) equal to RLINK(P). In this way, the parent Q of the deleted node P will point back to the ancestor node, the one that follows it in the sorted sequence. If the deleted node P was the terminal node of the entire tree, its parent, Q, will assume this property when the node P is deleted. That is the only problem I found.

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Listing 1

struct node {
  int info;
  struct node *leftson, *rightson;
}

visit(root) struct node *root;
{
  if (root == NULL) return;
  visit(root->leftson);
  printf("%d ", root->info);
  visit(root->rightson);
}

Next, the algorithm used to search a tree can be cleaned up considerably, as shown:

search(root, item) struct node *root;
{
  while (root != NULL) {
    if (root->info == item) return(root);
    if (root->info > item)
      root = root->leftson;
    else
      root = root->rightson;
  }
  return(NULL);
}

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Many thanks to Dr Walker. It was a great article; I would enjoy seeing more articles from him in the future.

Jack Dolby
335 D-1 Hiddlenwood Dr
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Screen Print for TRS-80

In the October BYTE, Teri Li's "Technical Forum" talks about some of Radio Shack's modifications for the TRS-80. (See "Radio Shack's Modifications to the TRS-80," page 182.) The screen-print problem created by the lowercase modification has a simple solution. Run the program shown in listing 1.

Listing 1

10 CLS
20 FOR A = 15360 TO 15391
30 FOKE A,B
40 B = B + 1
50 NEXT A
60 PRINT
70 END

Listing 2

5000 P$ = 15360
5010 FOR V = 1 TO 15 : FOR H = 0 TO 63
5020 IF PEEK(P$) < 32 THEN P$ = CHR$(PEEK(P$) + 64) ELSE P$ = CHR$(PEEK(P$))
5030 LPRINT P$ ; ; P = P + 1 ; NEXT H
5040 LPRINT " "
5050 NEXT V
5060 RETURN

Pain In the Exhaust

The article "FCC Regulation of Personal- and Home-Computing Devices," by Terry Mahn (September 1980 BYTE, page 180) has consequences for buyers and sellers of microcomputer systems that are far-reaching and not widely realized.

Compliance with the new FCC (Federal Communications Commission) regulations and the associated paperwork, testing, and certification are expensive. Personal- and business-computer systems will be more expensive after the first of January, 1981, because the consumer will be paying for compliance with these regulations.

Let me first point out that, as a licensed radio engineer, I must agree that restricting radio emissions from personal home-computing devices is both neces-
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Radio Shack's Daisy Wheel Printer II

Yvon Kolya, POB 22, Peterborough NH 03458

In August of 1980, Radio Shack introduced a series of new products, including a daisy-wheel printer capable of producing high-quality print for word-processing systems. Radio Shack named the device the Daisy Wheel Printer II.

I was fortunate enough to be among the first to receive one of the new Daisy Wheel Printer IIs. I picked it up at the store only a week after ordering it.

Physical Appearance

As I expected, the printer had an attractive appearance, using the standard Radio Shack colors black and silver. However, much to my surprise, I found the printer to be constructed entirely of heavy-gauge cast aluminum. The only nonmetal parts were the miscellaneous knobs and switches, which were brought out to the surface of the cover for the user to manipulate, and a rubber platen. Upon opening it up, I discovered that the metal exterior was well supported by a cast aluminum interior frame, with a layer of foam rubber sandwiched between the two for sound absorption. Everything else seemed to be made of steel or chrome, except the pulley wheels, which were nylon. All in all, the printer appeared to be very solidly constructed. It was a bargain to get all this excellence for hundreds of dollars less than an equivalent letter-quality printer.

Connecting It

As soon as I had unpacked the printer from its shipping box, I plugged the carbon ribbon cartridge into place, a very simple operation, and then I pressed the print wheel into position (also a very simple operation). When I connected the printer to my TRS-80 Model II and tried it out, it worked perfectly.

I borrowed a friend's TRS-80 Model I Disk System and tried it out with the printer. It also worked perfectly the first time.

Next I connected it to an Apple II-Plus computer, using its Parallel Printer Interface Card. Unfortunately, it did not work. After a little experimentation, I discovered that the problem was with the ROM (read-only memory) software on the parallel card. Normally, the Apple's software leaves the eighth bit of the data bus set high. When it's set low, the characters on the video display flash on and off. On the Centronics printers, and their look-alikes, this bit is ignored. On the Radio Shack printer, however, the eighth bit is used for the special characters. To correct this problem, I grounded the line for the eighth bit, and the printer then worked correctly with the Apple II-Plus. I could have used a software routine to correct this problem, but I felt this method would be quicker.

Printer Controls

There are two control switches on the front of the printer, an on-line/off-line switch and the pitch-control switch. There are three modes of pitch control: 10 cpi (characters per inch), 12 cpi, and proportional spacing. The pitch control depends upon the type font mounted in the printer. For example, if the Courier 10 font daisy wheel is in place, this switch should be placed in the 10 cpi position. If the Prestige Elite font is used, the switch setting should be 12 cpi. The Madeleine font requires that the switch be set to proportional spacing. To some minor degree, the 10 and 12 fonts can be used at either the 10 or the 12 cpi switch setting, although using
ZORK™ is more than an adventure.

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Zork, The Great Underground Empire, was created by Infocom, Inc., and is available for 32K Apple II and II Plus and 32K TRS-80™ Model I Level II disk systems.

Also new from Personal Software is MONTY™ Plays Monopoly, which lets an Apple or TRS-80 play America's favorite board game with the family.

Arcade Classics is a new TRS-80 action game featuring Cosmic Raiders, Pinball, Ricochet and Blockade™. A great way to have fun without feeding quarters into the machines.

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PERSONAL SOFTWARE

Zork is a trademark of Infocom, Inc.; Apple is a registered trademark of Apple Computer Inc.; TRS-80 is a trademark of Radio Shack Division of Tandy Corp.; MONTY is a trademark of R.G.C. Monopoly is a trademark of Parker Brothers, Inc.; Blockade™ is a registered trademark of Gemtex Industries, Inc.
the 10 font at the 12 setting will make the letters appear cramped.

At the top of the printer are two levers, one on the right for releasing the grip of the platen on the paper, and one on the left for controlling the number of carbon copies (from 1 to 7) to be run through the printer.

At the rear of the printer are, once again, two switches. One switch is directly above the power cable, and it is used to turn the machine on and off. The other is over the interface connector; it is the self-test switch. The self-test switch print outs a series of characters to test both the printer and the print wheel.

Inside the printer, to the right of the cabinet, there is a three-position impression intensity control switch. It allows you to adjust the amount of energy used by the strike-hammer when printing.

Printer Attributes

This printer does not require special software for use. If you have the proper printer cable for your computer, you can use the printer immediately. While in BASIC, you can use it to print listings, or you can use it from within a program to deliver hard-copy information. If you have a word processor, such as Radio Shack's Scripsit or Michael Shroyer's Electric Pencil, you are really ready to go.

Unfortunately, both Electric Pencil and Scripsit are incapable of using all the features of this printer. For example, not all of the control codes accepted by this printer are used by these two word processors. The codes accepted by the Daisy Wheel Printer II are given in table 1.

Unfortunately, Scripsit will access only the carriage-return-with-linefeed code (decimal 13) of this printer. The rest of the codes are not used.

Electric Pencil is only a little bit better in that it accesses the backspace feature (to perform underlining) in addition to the carriage-return-with-linefeed code.

Fortunately, BASIC is capable of accessing all of these codes (using the function CHR$(X)); the printer's manual provides several example lines of BASIC code that can be used to do this. Listing 1 shows the first step of a maze generated on the Apple II-Plus printed by this printer. A word of caution: if your BASIC program uses the top-of-form code (decimal control code 12), you will need a special driver program for this printer. This special program is available from Radio Shack free of charge.

Although BASIC can access all of the characters and control codes used by the printer, the TRS-80 in command mode is incapable of accessing either the special control codes or about thirty characters on the print wheel because the keyboards of the Tandy Corporation computers do not generate the necessary ASCII (American Standard Code for Information Interchange) codes.

The complete character set produced by the printer is shown in listing 2. Notice that there are several foreign-language characters, as well as special nonalphanumeric

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**At a Glance**

<table>
<thead>
<tr>
<th>Name</th>
<th>Audience</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daisy Wheel Printer II—catalog number 26-1158</td>
<td>Computer owners desiring letter-quality printout instead of dot-matrix</td>
<td>1. Print speed: 43 cps; carriage-return speed: 300 ms/13½ inches (34.5 cm); linefeed speed: 4 ips; printing pitch choice of ¼ inch, ½ inch, or proportional spacing; linefeed pitch: ¼ inch or ½ inch; fonts: 124 character positions on double-daisy print wheel; wheels: Courier 10 (supplied), Prestige Elite 12 (not supplied; catalog number 26-1421), Madeleine P5 (not supplied; catalog number 26-1422); characters per line: 136 characters at 10 pitch, 163 characters at 12 pitch; impression control: high, medium, low; interfaces (physical): eight parallel and one strobe; code: Modified ASCII; paper-feed mechanism: pinch-feed platen; power requirements: 120 VAC, 50/60 Hz, 141 W 220 VAC, 50 Hz (for European operation)</td>
</tr>
<tr>
<td>Use</td>
<td>Letter-quality printer</td>
<td></td>
</tr>
<tr>
<td>Manufacturer</td>
<td>Radio Shack</td>
<td></td>
</tr>
<tr>
<td>Dimensions</td>
<td>20.45 by 62.5 by 39.5 cm (8½ by 24½ by 15½ inches)</td>
<td></td>
</tr>
<tr>
<td>Price</td>
<td>$1960</td>
<td></td>
</tr>
<tr>
<td>Hardware Required</td>
<td>TRS-80 Model I, II, or III computer, or any computer capable of driving a standard Centronics-interface parallel printer; requires a printer-computer cable, available from Radio Shack, for whichever Radio Shack computer the printer is to be used with.</td>
<td></td>
</tr>
<tr>
<td>Software</td>
<td>None (if used with appropriate configuration of a Radio Shack computer)</td>
<td></td>
</tr>
<tr>
<td>Hardware Options</td>
<td>Tractor feed, $249 extra</td>
<td></td>
</tr>
<tr>
<td>Documentation</td>
<td>38-page manual, 22 by 28 cm (8½ by 11 inches), includes schematics</td>
<td></td>
</tr>
</tbody>
</table>

---

Listing 1: A test pattern to check registration. This pattern, which is made from vertical bars and underline characters, demonstrates the printer's capabilities of great printing accuracy.

```
Listing 2: The character set of Radio Shack's Daisy Wheel Printer II. Some of the special characters can be printed only by sending special-character codes to the printer.

```

Circle 24 on inquiry card. 

February 1981 © BYTE Publications Inc
How to tell if it's a White Computer.

You see, it isn't always white. Until now, if you bought a White Computer it was dressed up as someone else's system. Now the White Computer is available under its own nameplate.

And the features that make the White Computer the choice of many system builders also make the White Computer an excellent choice for you. Features like White's guarantee to ship replacement parts within 24 hours of your telephone call. CP/M® and MP/M™ operating systems. Full upgrade routes to multi-user and hard-disk performance. (Like the 3-user 35 megabyte system shown.) And 8-bit or 16-bit configurations.

Features that make the White Computer the reliable, high performance system you need for business, or software development, or industrial control uses.

So if you buy a computer that's not white, it might still be White. But make sure. Because if it's not White, chances are you're paying more, for less computer.

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The print-wheel mechanism. The print wheel is a double-daisy wheel (i.e., each prong of the wheel contains two or more characters, one closer to the center than the other). The mechanism is shown tilted back, which is the position used for changing the print wheel.

Characters. Careful study of the type font indicates that the Courier 10 print wheel supplied with the printer is capable of printing both the French and German alphabets. That's a really nice feature, if your software will allow you to generate the required ASCII codes from the keyboard.

Another worthwhile feature of this printer is a printer optimizer. If a series of linefeeds, either positive or negative, are received by the printer within 10 ms of each other, they are temporarily stored until a character code or control code is received, after which they are all performed at once. That is, if ten linefeed codes are received at less than 10 ms intervals, they are automatically stored. Upon receipt of the eleventh code, which in this example is not a linefeed, the printer moves the paper the full distance of ten linefeeds, rather than the distance of one line ten times, as other printers do.

As a last note, the documentation says that the printer uses a multistrike carbon ribbon. This means that the ribbon is advanced very slowly, with each key striking on almost the same place as the previous keystroke. Unfortunately, when the end of the cartridge is reached, you cannot rewind it and reuse the ribbon unless you disassemble the cartridge and rewind the ribbon from the take-up reel to the supply reel by hand. This is a very tedious and messy process. (I did it once when I desperately needed a printout and did not have an extra cartridge available.)

Summary
- Radio Shack's Daisy Wheel Printer II is a full-featured printer capable of providing high-quality print; it is totally suitable for use in word processors.
- The printer accepts the Centronics-standard parallel connector; thus it can be driven by any computer capable of driving a Centronics-type parallel printer (although some modification may be necessary to prevent the printing of special characters that use the eighth bit high).
- The print wheel supplied provides 124 different characters, not all of which can be produced from the standard ASCII keyboard unless a special software-driver routine is written and used.
- The printer is constructed of heavy-gauge metal and should be capable of heavy-duty use for a very long and useful life.
- According to a label on the back, the printer was made in Japan for Radio Shack. If someone had told me that Radio Shack would be selling a word-processor printer as solidly built as an NEC (Nippon Electric Company) printer or a Diablo Spinwriter, only much cheaper, I wouldn't have believed it. Now I do.
Adapter for TRS-80* computer eliminates disk read errors

Garland, Texas — Harold Mauch, president of Percom Data Company, announced that the company is marketing a simple plug-in adapter for TRS-80* computers that corrects a design deficiency in the disk controller circuit.

The problem, which causes disk read errors, has been traced to Tandy’s reliance on a circuit internal to the FD1771 controller IC to perform the function of separating clock and data pulses.

As explained in the Backgrounder, use of the internal chip circuit for reliable data-clock separation is a design shortcoming which the manufacturer of the controller IC wants against.

The Percom solution, a PC card adapter called the SEPARATOR™, eliminates the problem by substituting an explicit data separator circuit — one which has been used reliably in Percom disk controllers since 1977 — for the internal IC separator circuit. The SEPARATOR™ is installed without modifying the host system. The user merely removes the FD1771 IC from the host controller, installs the IC in the DIP socket on the SEPARATOR™ card, and plugs the adapter into the expanded socket of the host controller.

Percom cautions that opening the Expansion Interface of the TRS-80* computer, which is required to install the SEPARATOR™, may void the computer’s limited 90-day warranty.

The SEPARATOR™, which sells for $29.95, may be purchased from Percom dealers or ordered direct from the factory. The Percom toll-free order number is 1-800-527-1592.

Payment for mail orders may be made by certified check, cashier’s check or money order, or charged to a Master Card or VISA account. Texas residents must add 5% sales tax.

Backgrounder

This problem started while we were studying an annoying problem with the TRS-80* computer. Disk drives sold by Percom are realigned and tested before shipment. We noticed, however, that some disk drives would pass the Percom inspection but just would not work reliably on the inner tracks with a TRS-80* computer. These drives were within the manufacturer’s specifications, and would function perfectly on other disk systems Percom manufactures — “perfectly” here meaning more than 50 million bytes read without error!

The disk read data separation arrangement in the TRS-80* computer Expansion Interface uses an internal data separator of the FD1771 disk formatter/controller IC. Use of the FD1771 internal data separator is not recommended by Western Digital, the IC manufacturer. The following note appears on page 17 of the FD1771 data sheet:

Internal data separation may work for some applications. However, for applications requiring high data recovery reliability, WDC recommends external data separation be used.

The Percom data separator circuit fixes the mini-disk controller of the TRS-80* computer. The type of drives being used is irrelevant; the circuit eliminates disk read errors resulting from the inability of the Tandy controller design to reliably separate clock and data signals when reading high density inner tracks.

Percom Mini-Disk Drives Store More, Cost Less.

Percom mini-disk drives store more data, are more reliable, yet a 40-track Percom drive costs $100.00 less than a 35-track Tandy drive.

You can store over 102 Kbytes per disk on Percom TFD-100™ 40-track drives, over 197 Kbytes per disk on TFD-200™ 77-track drives. A patch — supplied free on minidiskette — upgrades TRSDOS* for operation with the newer 40- and 77-track drives. Both TFD-100™ and TFD-200™ models are available in one-, two- and three-drive configurations.

Prices start at $399 for a single-drive TFD-100™ $675 for a single-drive TFD-200™. Drives are supplied with heavy-duty power supplies. Metal enclosure is finished in compatible silver enamel.

See your nearby Percom dealer or order direct by calling toll-free 1-800-527-1592.

Five-Inch Disks Store More Than Eight-Inch Disks!


Harold Mauch, president of Percom, made that announcement here today, saying that disk storage capacity using the adapter and double-density disk operating system is included — can be increased to as much as 354 Kbytes per minidiskette.

By comparison, the maximum storage for larger eight-inch disk systems used with the TRS-80* Model I computer is about 290 Kbytes.

We suspected the data separator because the problem was most severe on disk inner tracks where storage density is highest and data separation is most critical.

To prove our point, a technician breadboarded a standard Percom data separator circuit, and configured it to plug directly into the FD1771 IC socket of the TRS-80* computer controller.

When connected to the TRS-80* computer, a troublesome drive functioned perfectly! We ran a BACKUP utility many times and never got a track lockout. Before we added the external data separator circuit to the computer, this same drive would always lock out tracks, and would have difficulty reading from the inner (higher number) tracks.

The Percom data separator circuit fixes the mini-disk controller of the TRS-80* computer. The type of drives being used is irrelevant; the circuit eliminates disk read errors resulting from the inability of the Tandy controller design to reliably separate clock and data signals when reading high density inner tracks.

Radio Shack Corporation which has no relationship to Percom Data Company.
An Extremely Low-Cost Computer Voice Response System

James C Anderson
c/o MIMIC Electronics
POB 921
Acton MA 01720

A computer speech-output system can be built which requires no A/D (analog-to-digital) or D/A (digital-to-analog) converters, no multiple-pole filters, no complex hardware, very little software, and yet produces speech which is quite intelligible even to untrained listeners.

A data rate of 9600 bps (bits per second) produces speech quality and intelligibility acceptable for most hobbyist applications. This means that a 400-word vocabulary can be stored on one side of a single-density 8-inch floppy disk, the average word duration being 0.5 seconds. Similarly, the 16 hexadecimal digits, 0 thru F, can be spoken from the data stored in only 8 K bytes of memory, the average word duration for these digits being 0.4 seconds. The memory need not be high quality, and slow memory devices or components with a few random bit failures can be used. Thus, for limited vocabularies, the MIMIC speech processor may be the lowest-cost computer speech-processing system available. Other applications include:

- two-tone telephone-signal decoding
- alarm signal
- automatic word recognition by computer (using software pattern matching against stored speech samples)
- sound effects
- computer-generated musical tunes
- metronome
- rhythm generator

There are basically two reasons why speech-storage memory can be inexpensive:

- The manufacturer's yield on perfect circuits plus slightly defective circuits (those with 1% of the bits bad) will be higher than the yield on perfect circuits alone.
- Memories with slow access times can be used. An access time of 10 ms is more than adequate, and circuits of this sort can be purchased at prices far below those of standard semiconductor memories.

Hardware

The technique to be used here is called differentiated, infinitely clipped, and integrated speech. Figure 1 on page 38 is a diagram of the essential hardware. Model speech is input through a microphone and a preamplifier (IC1). The unprocessed analog-speech signal is then used as input to a compressor consisting of an operational amplifier (or op amp, IC2), two diodes, and two resistors. The compressor has a pseudo-logarithmic characteristic and greatly amplifies low-level signals while somewhat attenuating high-level signals. In this system, the compressor acts as a simple automatic gain control, making the amplitude of the speech signal at the compressor output less dependent upon such things as the human speaker's voice loudness and distance from the microphone.

The output of the compressor goes to a simple R/C (resistor/capacitor) differentiator which has a pole at approximately 8 kHz. The differentiator performs quite well over the entire range of speech frequencies from 100 Hz to 5 kHz (300 Hz to 3 kHz is considered "telephone quality" bandwidth for speech signals).

The differentiated analog-speech signal is then applied to a comparator (IC3) which acts as a zero-crossing detector, or infinite clipper, and turns the analog speech into a digital bit stream. A resistor is in series with the noninverting input to compensate for the input bias current of the comparator, thus preventing distortion due to "center clipping" of the signal. Only a small amount of DC offset potential in the comparator produces a large degradation in speech intelligibility.

This would complete the speech data-input path except for one problem: when no speech is present, the...
Speech Processing

Many techniques now exist for speech processing or digitization (the encoding, storage or transmission, and subsequent decoding of data for speech signals). Some techniques have definite advantages over others depending upon the application.

For example, phoneme synthesizers, which are essentially electrical analog models of the human vocal tract, can produce speech from very low data rates (600 bps (bits per second) or less) and are often used in systems where bandwidth or memory is at a premium. By contrast, time-domain techniques such as delta modulation require greater bandwidth (9600 bps or more) and are popular when a mass-storage device (e.g.: a disk drive) is available. Time-domain techniques simply record speech-signal parameters as a function of time, and may or may not make use of human-vocal-tract characteristics to help reduce memory or bandwidth requirements.

Cost constraints often determine which type of speech processor will be used in a system. Synthesizers can be costly both in terms of the initial hardware investment and in the programming and testing time required to convert words into phoneme strings. Neither of these costs is likely to be reduced significantly. It is often more cost-effective to invest in equipment of general utility, such as a floppy-disk drive, and use a low-cost time-domain speech processor. Many forces are acting to drive down the cost of mass storage. For example, optical recording technology has produced a 30 cm disk with storage capacity of 10 billion bits and data access times compatible with speech-processing requirements. Assuming the speech data has been sampled at a rate of 16,000 bps, such a disk can store enough data to produce speech continuously for more than a week.

Many of the time-domain techniques for speech processing have significant drawbacks. Pulse code modulation, as used in telephone-quality systems, requires a high data rate (64,000 bps) and is therefore seldom considered for present-day computer speech applications. CVSD (continuously variable slope delta) modulation produces good-quality speech from a 16,000 bps data stream, and several manufacturers have recently introduced CVSD integrated circuits (MC3417 by Motorola, HC-55516 by Harris Semiconductor, and FX-209 by Consumer Microcircuits of America are examples). However, all the CVSD units are sole-sourced (i.e.: non-interchangeable with other units).

Each of these components requires a considerable amount of support circuitry for operation, including a power supply, microphone preamp, audio power amp, and complicated filters which use precision (1%) capacitors and resistors. Perhaps the greatest drawback to CVSD is the fact that the speech data stream which a CVSD chip produces is meaningful only to another CVSD chip.

For example, if the highly encoded CVSD speech data is to be used for automatic word recognition, it must first be decoded by some rather time-consuming software before any operations such as frequency analysis can be performed. CVSD data also proves to be difficult to “conference” (mix) in communication networks, when several users are talking simultaneously to a single listener. When time-domain techniques are used to store a large vocabulary in memory, it often becomes a difficult and time-consuming task to reproduce the words in the vocabulary at the same volume level. This occurs because it is nearly impossible to hold the microphone in the same manner and to speak always at the same volume level when originally recording the vocabulary. It is also difficult to add new words to an existing vocabulary for the same reason. A similar problem arises when attempting automatic speech recognition with a computer, since variations in volume produce variations in the speech data pattern. Such variations must usually be eliminated by a lengthy amplitude-normalization process in software.

The MIMIC Speech Processor presented in this article is a low-cost time-domain system which has a relatively low bit rate. Using only standard components, the MIMIC Speech Processor requires minimal external hardware for operation. The data produced is not highly encoded, and is therefore easy to analyze and use in communication networks. The MIMIC Speech Processor automatically normalizes the amplitude of all audio input signals, and is therefore not subject to the problem of volume variation.

Speech Intelligibility

A common method for evaluating speech intelligibility is the “articulation test.” Typically, a person reads a list of syllables or unrelated words to an “untrained” group of listeners (recognition ability improves with practice), and the percentage of items identified correctly is taken as the articulation score. By choosing test material representative of the sound statistics of a language, a realistic test of the system can be made. Word-articulation scores for speech which has been differentia ted, infinitely clipped, sampled at a 10 kHz rate, and integrated (in that order) are in the neighborhood of 90% for trained listeners.

When words are used in sentences, contextual information is present which leads to considerably higher articulation scores. To test your system, try recording the sentences “Joe took father’s shoe bench out,” and “She was waiting at my lawn.” Together, these sentences contain all of the fundamental sounds in the English language that contribute toward the loudness of speech.
Figure 1: Speech-processing hardware. Model speech information is input through a microphone and preamplifier. The analog signal is processed by compressor and differentiator circuits, and is then applied to a zero-crossing comparator. The result is a serial data stream in which the bit width is modulated to reflect the input frequency. A squelch circuit is provided to disable the processor output when no speech signal is present.

The comparator (IC3) puts out unpleasant high-frequency noise. This problem is overcome by controlling the processed speech-data signal with a squelch signal. The squelch circuit uses amplitude information to shut off the data stream through IC4a. When the overall magnitude of the unprocessed input signal is above a certain threshold value, the circuit quickly enables the data to pass. Op amp IC5, diode D1, and the R/C output filter form an envelope-detector system which follows the positive peaks of the unprocessed speech signal. A comparator with hysteresis (IC6 and its voltage-divider feedback network) is used to give the squelch circuit a fast attack response, but a slow decay characteristic. Thus, the differentiated and infinitely clipped digital speech data stream is created, and squelched when necessary.

The processed speech, in the form of a bit stream, may then be sampled by a computer or other digital hardware at a rate of approximately 10 kHz. The information may be stored in some type of memory, and used later to produce speech.

To reproduce stored speech, the information is dumped at a 10 kbps rate. The speech-output hardware is a filter consisting of IC4c and an R/C network which has a pole at approximately 16 Hz. The buffer (IC7) feeds an AC-coupled power amplifier (IC8) with volume control. The speech produced by this digital recording system has essentially been differentiated before storage, then integrated upon playback.

Quality

Although the storage requirement is typically 10,000 bits for each second of speech, the effective amount of storage required can be reduced somewhat by using phoneme concatenation. For example, the spoken word "seven" can be stored as an "s" sound plus an "eh-vun" sound. The same "s" sound can also be used in other words such as "six" ("s" plus "ick" plus "s"). Similarly, one recording of the word "teen" will allow you to generate "seventeen" with a simple program which outputs "s" plus "eh-vun" plus "teen."

This method, unfortunately, will not always produce acceptable speech. When "dog" is broken up into "duh" plus "aw" plus "guh," the
resulting audio does not sound like the intended word. This is due to the fact that in natural-sounding speech, the end of one phoneme often blends into the start of the next (but not always, as was shown in "seventeen"). If all of the phonemes are recorded separately, some method is needed to blend them together—a formidable task.

The speech quality of this system is similar to a single-sideband radio signal which is not quite tuned in. The speech produced is quite intelligible yet rather "mechanical" sounding. However, upon listening to speech produced by this system, several people have remarked that it "sounds just like you'd expect a computer to sound when it talks." Thus, it seems to have good public acceptance as far as quality is concerned.

Theory

Why does such a simple system work? The answer is not particularly simple. However, an understanding of the theory can point to methods for improving the speech quality and can also give a feel for the system's limitations. During World War II, it was discovered that a large amount of peak clipping could be impressed on a speech signal with the speech remaining at least moderately intelligible.

Infinite clipping is a process which preserves only the zero-amplitude axis-crossing information of the speech waveform (ie: the process tells us whether the signal is positive or negative). The intelligibility of an infinitely clipped speech signal can be dramatically improved if the clipper is preceded by a differentiator circuit. A simplified conceptual diagram of the hardware is presented in figure 2, which omits the squelch circuit. The system input $f(t)$ in figure 2 corresponds to the compressor output (IC2) of figure 1.

The spoken word "seven" can be stored as an "s" sound plus an "eh-vun" sound.

Mathematically, taking the derivative of a function and equating it to zero yields the local maxima and minima (peaks and valleys) of the original function. For example, assume that the system input in figure 2 is a sine wave, $f(t)$, as shown in figure 3a on page 40. This sine wave is differentiated so that the cosine wave, $f'(t)$, of figure 3b is present at the input to the comparator. Notice that whenever $f'(t)$ equals zero, as at $t = \pi/2$, the original function $f(t)$ is at a peak or a valley.

In the next step of processing, the comparator acts as an infinite clipper. The comparator output is high when $f'(t)$ is greater than zero, which means that the original function $f(t)$ has a positive slope and is rising from a valley to a peak. Similarly, for $f'(t)$ less than zero, the comparator output is low, which means $f(t)$ is going from a peak to a valley. When $f'(t)$ equals zero, a critical point is occurring and the comparator output is changing. The comparator output is an infinitely clipped version of $f(t)$ as shown in figure 3c. This may be sampled and stored as digital information.

An approximation to the original function $f(t)$ can be obtained by integrating the stored digital information (see figure 3d). Note that only a triangular-type waveform can be obtained at the integrator output because the input to the integrator is always a bivariate (two-level) waveform. However, a triangle wave is a close approximation to a sine wave. In fact, the triangle wave of figure 3d is given in Fourier-series form as:

$$\frac{4}{\pi} \left[ \sin t - \frac{1}{9}\sin 3t + \frac{1}{25}\sin 5t - \frac{1}{49}\sin 7t + \ldots \right]$$

The components other than the fundamental ($\sin t$) can be considered as contributions to distortion and can be reduced by filtering. In general, a DC offset may also be present, but any offset can easily be eliminated in the actual implementation simply by using AC-coupled amplifiers. In summary, the system of figure 2 will provide a triangle wave which can only approximate the original sine wave.

Amplitude Decoding

In the system of figure 2, the frequency of the "reconstructed" waveform (at the output) will be the same as the original input frequency. However, the output waveform's

![Figure 2: Diagram of the processing concept. This simplified diagram omits the squelch and compressor stages of figure 1. The process is easy to follow: any analog input is differentiated and clipped before storage as a digital bit stream; upon playback, the bit stream is simply integrated to recover the original waveform information.](image-url)
Figure 3: The basic process is illustrated on the first four waveforms. If a sine wave \( f_1(t) = \sin t \) is fed to the processor, the wave will be differentiated to produce a cosine wave \( f_1'(t) = \cos t \). Notice that the cosine wave crosses zero whenever the sine reaches a peak. This is also reflected in the output of the infinite clipper stage \( f_3(t) \) where the waveform may be expressed as \( f_3(t)/|f_3(t)| \). At this point, the information may be stored digitally. An approximation of the original signal \( f(t) \) can be obtained by integrating the stored information to produce \( f_4(t) \):

\[
\int \frac{f_3(t)}{|f_3(t)|} \, dt
\]

Although the output waveform has the same frequency, the amplitude is not always accurately reproduced, since the comparator has a constant amplitude output regardless of input signal level. If the signal shown in (e) is fed to the speech processor \( f_5(t) = \sin 6.5t \), the differentiator will produce the wave of (f) \( f_6(t) = 6.5 \cos 6.5t \). The zero-crossing comparator produces the square wave of (g) \( f_7(t)/|f_7(t)| \), which may be recorded quite accurately. When this information is played back, the wave of (h) will be produced:

\[
\int \frac{f_7(t)}{|f_7(t)|} \, dt
\]

The amplitude is reduced because the integrator stage is essentially a low-pass filter. The same process is performed on more complex waveforms as shown:

(i) \( f_8(t) = \sin t + \frac{1}{6.5} \sin(6.5t + 2.3) \)

(j) \( f_9(t) = \cos t + \cos(6.5t + 2.3) \)

(k) \( f_{\text{stipped}}(t) = \frac{f_9(t)}{|f_9(t)|} \)

(l) \( \int f_{\text{stipped}}(t) \, dt = \int \frac{f_9(t)}{|f_9(t)|} \, dt \)

Note that the overall wave shape and relative amplitudes are well preserved.

amplitude will diminish as the frequency increases; and it will do so regardless of the input amplitude. For example, assume that the input to the system is \( f_1(t) = \sin 6.5t \), as shown in figure 3e. The output of the differentiator is then \( f_2(t) = 6.5 \cos 6.5t \), which is a large-amplitude sinusoid (see figure 3f). This signal is applied to the comparator and the square wave of figure 3g results, with an
amplitude independent of the input-signal amplitude.

The square-wave signal is now run through an integrator, which drastically diminishes the amplitude of the signal (see figure 3h). This is so because an integrator acts as a low-pass filter, and causes a signal's amplitude to diminish in inverse proportion to its frequency (i.e. it attenuates higher frequencies by 20 dB per decade of increase in frequency). Thus, the amplitude of $f(t)$ was not preserved in the reconstruction, even though the frequency was.

We can get an accurate reconstruction of both frequency and relative amplitude only if we guarantee that the input waveform will diminish in amplitude as a function of its frequency. For example, $(1/\alpha)\sin(\alpha t)$ is such a signal, when $\alpha$ is an arbitrary real (nonzero) constant. Thus, if we had applied $(1/6.5)\sin 6.5t$ to the system (instead of just sin $6.5t$ as in the previous example), the output would have been a reconstructed waveform of both proper frequency and amplitude.

The system of figure 2 is therefore limited to reconstruction of signals which fall off in amplitude by 20 dB/decade. Figures 3i, 3j, 3k, and 3l show what the system does to a more complicated signal which meets the restriction. The important thing to note is that the wave shape (and hence the frequency content) of the original signal is faithfully reproduced, and the relative amplitudes are maintained.

Speech signals (e.g.: a voltage waveform produced by a microphone whose output is linearly proportional to pressure) generally have amplitude components which drop off as a function of frequency by about 20 dB/decade. This is true for both short-term (125 ms) and long-term (a minute or so) measurements. Hence, one would expect the system of figure 2 to be capable of reproducing fairly natural-sounding speech which, indeed, it does.

Actually, differentiated-clipped speech is just as intelligible as differentiated-clipped-integrated speech (i.e.: no new information is produced by simply integrating the bivariate waveform at the comparator output), but it is very unpleasant to listen to. Some types of music can also be recorded using this system, with recognizable melodies and harmonies.

**Distortion**

Distortion may come from several different locations in this system of speech recording and playback. If, for example, the input signal does not have components which fall off in amplitude by exactly 20 dB/decade, there is no hope for an "exact" playback using the circuit of figure 1. This situation arises when several persons are speaking simultaneously at different levels of loudness. The voices tend to mask or distort each other. A similar situation occurs when one person talks in a noisy environment. Another source of distortion comes from the fact that the system can produce only ramp-type
waveforms at its output, no matter what the input looks like.

With additional hardware and software, these problems can be greatly overcome, resulting in an improvement in speech quality. If, instead of a simple squelch circuit, the slowly varying amplitude-envelope signal is sampled with an A/D converter, and if this data is used to amplitude-modulate the constant-level clipped speech signal when it is reproduced for output, the quality of the signal is improved. However, the overall data rate required is approximately 15,000 bps, and requires additional hardware. The system of figure 1 is about the best we can do in terms of simplicity and cost when it comes to low-bandwidth speech processing.

Sample Rates
If one is to use clipped speech as a digital recording technique, distortion due to a finite sampling rate must be considered. Figure 1 shows a typical system for recording a vocabulary of selected words which may later be used for computer voice response. Experiments have shown that highly intelligible speech can be obtained with a sampling rate of about 10 kHz. Note that this sampling rate is an experimental result and has nothing to do with the well-known sampling theorem, which states that the rate of sampling must be at least twice the highest frequency to be recorded, in order to ensure an accurate reproduction. Here we are essentially sampling a square wave, which is not a band-limited signal.

To understand why the 10 kHz sampling rate is adequate, consider the fact that the human ear loses resolution at high frequencies. For example, the note A above middle C has a fundamental frequency of 440 Hz. The next note above it (A sharp) has a frequency of $440 \times \frac{1}{2}$, or approximately 466 Hz. The highest A on the piano, which is 3 octaves above 440 Hz, has a frequency of $2^3 \times 440$ or approximately 3520 Hz. Similarly, the highest A sharp has a frequency of $2^3 \times 466$, about 3720 Hz.

The difference between 440 Hz and 466 Hz sounds the same as the difference between 3520 Hz and 3729 Hz, even though the actual frequency difference is 26 Hz versus 209 Hz. Thus, our ability to resolve frequencies deteriorates rapidly with increasing frequency. In the case of clipped speech, time quanta of about 0.1 ms are adequate and the ear cannot easily discern errors introduced in the frequencies which are reproduced. Sampling clipped speech at rates much higher than, say, 20 kHz merely wastes computer memory while offering no appreciable improvement in speech quality.

Final Note
It appears that clipped speech techniques can be used in cases where a limited-vocabulary computer voice response is needed. In terms of simplicity, ease of implementation, and low cost, it is probably optimal. For persons on limited budgets such as students, hobbyists, and even professional electrical engineers (who see applications for computer speech output but would have trouble justifying a large investment), the clipped-speech approach presents an alternative to more complex and costly systems.

References

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My guess is that when you first scanned the title of this article and a few of the photos, you immediately recognized Milton-Bradley's Big Trak. Perhaps it was one of the gifts your children received during the holidays.

Big Trak, shown in photo 1, is a computer-controlled, motorized toy tank. Commands to move, to turn, and to fire the "photon cannon" are programmed by a user (via a keypad) into the tank's control system. After the user presses the "Go" key, Big Trak takes off, executing the stored command sequence.

Big Trak's keypad contains a key for each command. Some commands are completed with a single keystroke, while other commands require multiple keystrokes for the entry of parameters. A list of command functions appears in table 1.

Commands may be chained and carried out sequentially. For example, pressing the sequence: Forward, 2, Left, 3, 0, Hold, 1, 0, Fire, 3, Go, causes the tank to drive forward 2 feet, pivot 180°, wait 1 second, and then fire three cannon blasts. This se-

Photo 1: The Big Trak microprocessor-controlled, user-programmable tank, sold by the Milton-Bradley Company.
quence is four commands. Big Trak can hold sixteen commands.

Considering this month’s Circuit Cellar title and the description thus far, you may think this article is about Big Trak and the microcomputer control system it employs. You are half right. Big Trak is indeed the tank mentioned in the title. However, the word “Computer” in “Computer-Controlled Tank” refers to your personal computer, rather than the microprocessor inside the tank!

For a long time I have been interested in robotics. I have always fantasized about building a robot to do simple tasks. I am sure that many others have similar interests. Unfortunately, due to the high expense and the mechanical expertise required, most of us never get beyond the idea stage.

Playing with Big Trak is a tease. It is not a robot, nor can it be converted into one. However, it has features that are fascinating as well as aggravating for robot-building procrastinators like myself. Big Trak has a control system that memorizes commands and coordinates a mechanical drive. It converts simple keystrokes into complex movements combined with light and sound effects.

While the microprocessor program that controls the tank is interesting, it is the price/performance ratio of the mechanism that is impressive. Big Trak incorporates a two-wheel/two-motor gearbox. The wheels turn synchronously for forward or backward motion and contrariwise for turns. Left and right turns are precisely definable (to a resolution of 1 part in 60). This drive mechanism would take many hours to fabricate if you were building it from scratch.

For die-hard robotics types, this is kid stuff. EXACTLY! But, to someone with just a passing interest, the capabilities of this $50 toy are fascinating. With a little ingenuity, it could serve as a test bed for robot enthusiasts on a tight budget. It could also serve as a school project combining programming and actual control of a mechanical device.

If only it could be linked with a larger computer and remotely controlled!

This idea sounded like a fun project, so I decided to write an article on converting Big Trak to remote control. The result is an interface that allows complete wireless control of the tank’s operation from your computer keyboard. Virtually no modification is required to your computer if it already incorporates a serial I/O (input/output) port and 300 bps (bits per second) modem.

Writing the control program isn’t hard. Commands are communicated as LPRINT CHR$(X) statements in BASIC. (For example, an LPRINT CHR$(81) fires the photon cannon.) A program which demonstrates this is included. (See listing 1.)

At the other end of the link, a circuit is installed in the tank to receive control commands from your computer and simulate the user pressing the keypad. This is not a specialized interface applicable only to Big Trak; the receiver has useful applications elsewhere. It is designed in two sections: a tank interface specifically for this application and a general-use wireless receiver/demodulator. The receiver/demodulator can easily serve as a wireless serial RS-232C extension for your computer in other applications. Don’t care to string wires for a printer located in another room? Use this receiver interface up to 200 yards from the computer.

All this will be explained in detail, but first, back to Big Trak.

**Inside Big Trak**

Big Trak gets its control capability from a 4-bit microprocessor. This single 28-pin CMOS (complementary metal-oxide semiconductor) integrated circuit contains programmable user memory, ROM...
The “wireless extension cord” can be used with other peripheral devices besides Big Trak. 

Figure 1: Pin usage of the TI TMS1000 4-bit microprocessor. The TMS1000-series processors all have the same instruction set, differing in the number of pins used for I/O and in the amount of memory contained in the package.

Figure 2: Schematic diagram of the Big Trak’s keypad matrix. The column lines are connected to the R-series output pins on the TMS1000, and the row lines are connected to the K-series input pins. The physical structure of the keypad can be seen in photo 4.

(read-only memory), and I/O capability. The low cost (under $1 in large quantities) makes this the product of choice for many simple applications such as computer games and appliance controls.

The TMS1000 microprocessor series is actually a family of fifty-odd devices. They all share a common instruction set. The differences are the number of I/O pins and the amount of on-board memory. The package of Big Trak’s 28-pin microprocessor, shown in photo 2, is marked only with a “house” number. It is most likely either a TMS1000 or a TMS1100. The only difference between these two components is the amount of memory they contain. The TMS1000 has 1 K bytes of ROM and 32 bytes of programmable memory, while the TMS1100 has twice as much of each memory.

As shown in figure 1, the microprocessor has four dedicated input lines and nineteen dedicated output lines (O0 thru O7 and R0 thru R10). The eight data outputs, O0 thru O7, are wired in an unusual way and can be set to only 32 out of the usual 256 values possible with an 8-bit code. This is because the O-series outputs receive only the 4-bit values from the accumulator and the status flag (1 bit) as inputs. The enabled range of the 32 values (out of the 256) is mask-programmed during manufacture of the circuitry on the silicon chip.

The R-series output lines, on the other hand, are treated as eleven control outputs. Each R output line can be set or cleared individually.

The Big Trak uses these lines to read input data from the keypad, generate sound effects, light up the “photon cannon,” and coordinate the operation of the two motors.

Because the TMS1000 is a low-power device (about 90 mW), it cannot directly drive a motor. A second integrated circuit (an SN75494) and a few transistors facilitate the connection. The 75494 is a hex digit driver primarily intended to interface CMOS devices to common-cathode-configured LEDs (light-emitting diodes). While the tank uses no LEDs, the 150 mA drive-current capability of the 75494 makes it particularly suitable in this application.

Connection of the keypad (shown in photo 3) to the microprocessor is straightforward. The keypad is actually a matrix of processor I/O lines. Outputs R0 thru R5 and inputs K1, K2, K4, and K8 form a 4 by 6 matrix (only twenty-three keys are functional—the In key has no contacts) as shown in figure 2. The K signals are the rows, and the R signals are the columns.

Such a keypad operates on a scanned-matrix principle. The processor alternately places a signal on each R line and reads the four inputs for any completed circuit (which shows a key being pressed). Entering a command, therefore, is simply a
The Big Trak can serve as a test bed for robot enthusiasts on a tight budget.

The keypad has no springs, magnets, or raised buttons. It is nothing more than two photo-etched plastic sheets with conductive traces, separated by a thin insulator. At the cross points of the matrix, the insulator has a cutout. Any pressure on the keypad surface over this point flexes the plastic and shorts the two contacts, completing the circuit. Photo 4 shows the structure of the keypad.

Practically speaking, any connection between a column and a row of the matrix will be perceived as a valid data input to the processor. For example, if you use a clip lead to connect pins 8 and 26 on the processor package, it will accept this as a Go command and commence operation. This concept is the premise of my remote-control circuit.

External Keyboard Control
Remote control of Big Trak starts with an interface that attaches to the processor and functions in place of the keypad. Figure 3 shows the schematic diagram of a circuit that does this. The prototype is shown installed over the processor board in the tank. (See photo 5.) Its location with respect to the tank layout is better shown in photo 6.

The integrated circuits IC2 and IC3 are 8-channel type-CD4051 CMOS multiplexers. The 6 matrix column lines are attached to IC2, and the 4 row lines are connected to IC3. The selection of 1 of the 6 column lines and 1 of the 4 row lines is determined by the address-input lines A, B, and C on each integrated circuit. A total of 5 address bits are required. While a six-conductor cable (5 bits of data and ground) strung between the computer and the tank for parallel communications would work, it is hardly efficient as remote control. Serial communication is better, for a number of reasons.

The components IC1, IC4, and IC5 function as a 300 bps serial-to-parallel converter which operates on 9 V (note the use of the General Instrument AY-3-1014A UART, a universal asynchronous receiver/transmitter). Data comes into pin 20 of IC3 at 300 bps where it is reconverted to parallel format. Bits 0 thru 2 (D0 thru D2) go to IC2, and bits 4 and 5 (D4 and D5) go to IC3. The choice is not arbitrary. By selecting these particular bits as the address inputs, the CMOS switches can be set by binary codes that correspond to ASCII (American Standard Code for Information Interchange) characters. This makes the interface more flexible, since its functions can be exercised directly through characters output by use of the CHR$(X) function in the BASIC language. The necessary codes are common, printable characters and will not interfere with machine operation. (In some BASICS, the CHR$(X) function can cause strange things to occur, depending upon the value of X. In my computer system, sending a CHR$(127) clears the screen and resets the cursor.) Choosing printable codes also aids troubleshooting. Table 2 lists the twenty-three codes...
used in this interface. For example, sending an "R" (with the output statement LPRINT CHR$(82)) tells the tank to make a right turn.

Oscillator IC5 (a 555 timer) is tuned for 4800 Hz. This sets the communication data rate at 300 bps. A rate of 110 bps is set by changing the oscillator frequency to 1760 Hz.

Operation is straightforward. The UART is hard-wired for 8 bits of data, no parity bit, and 1 stop bit. When a character is received, the data-output line becomes active and the DAV (data available) line goes high. One section of IC4 serves to delay the reset pulse to the RDAV (reset data available) input. This produces a 10 ms strobe signal which closes the CMOS switches. (While the data rate may be 300 bps, time must be allotted between characters to allow the tank control system to respond. The effective data rate is more like five commands per second.) Whatever points were addressed on IC2 and IC3 will be electrically connected. The tank will then either store or execute the command, depending upon what it is.

Functionally speaking, you could stop right now. If you don't mind a two-wire cord running from your computer to the tank, you can control it with just the circuit so far described. Simply set your serial output port at 300 bps and feed its signals directly to pin 9 of IC4 in the interface. This, in fact, was the way I had to test the circuit before I went on to the next step.

Constructing a "Wireless Extension Cord"

The next step is, of course, the real fun part of this project. Since we can now command the tank through serial-character transmissions, it is only natural to consider eliminating the wire and using wireless communication.

Let's take stock. We have a tank that for all practical purposes is remote-controlled. All we have to do is send TTL (transistor-transistor logic)- or CMOS-level serial characters to it. These characters, in turn, come from BASIC LPRINT CHR$(X) statements, the output of which is transmitted serially. On the computer side, we have a serial output, and on the tank side we have a serial input. Connecting the two requires an "extension cord," either physical or ethereal.

One method, shown in the block diagram of figure 4, uses radio transmission. The approach is not as strange as it might initially seem. The serial output from your computer is FSK (frequency-shift keyed) modulated and transmitted. Somewhere at a remote location, a receiver picks up this transmission and demodulates it. The reconstructed serial data is fed into the remote device, in our case, the Big Trak control interface.

Please note the following: because this interface uses standard serial-data rates and voltage levels, any wireless communication device we design to accommodate computer/Big Trak communication will also work for any other similar-rate communication. The computer doesn't know whether it is "talking" to a tank
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Figure 3: Schematic diagram of the Big Trak remote-control interface. This circuit is installed inside the tank, replacing the function of the manual keypad. The address-input lines on each of the two CD4051 8-channel multiplexers select the rows and columns of the keypad matrix.

The AY-3-1014A UART is a product of General Instrument Corporation, Microelectronics Division, 600 W John St, Hicksville NY 11802.

Figure 4: Conceptual block diagram of a typical wireless communications link.

or to a remote printer. The “wireless extension cord” depicted in figure 5 can just as easily be attached between the computer and any output peripheral device.

Figure 5 outlines a simple way to accomplish this communication. At the computer, an FSK modulator converts the 1 and 0 levels to 2025 Hz and 2225 Hz tones. These tones are transmitted using an inexpensive 49.86 MHz walkie-talkie. At the receiving end (in this case, the Big Trak), another walkie-talkie receives the tones and a demodulator reconverts the tones to logic levels which are fed to the UART/control interface.

Figure 6 is a schematic diagram of an answer-type modem modulator. The assembled circuit is shown in photo 7. Serial data from the computer is fed into pin 1 of IC2, as shown. A logic 1 input produces a 2225 Hz tone, and a logic 0 input produces a 2025 Hz tone. These tones are amplified by IC3 and are directly fed to the walkie-talkie transmitter, through a connection across its speaker.

Figure 7 is a diagram of the circuit required at the receiving end. It consists of an originate-type modem demodulator and a walkie-talkie receiver. The guts of the walkie-talkie are removed from its case and mounted in the same enclosure with
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the modem board. Photo 9 shows the receiver mounted in the bottom of the box. The modem board is mounted on stand-offs over the receiver, and batteries are placed along the edge and under the board, as shown in photo 10.

The audio output of the walkie-talkie is tapped from speaker leads; a 10-ohm resistor should be substituted for the speaker if you don't wish to hear the tones. This audio signal is connected to the modem preamplifier input. It is next sent through a band-pass filter and limiter, which maximizes the signal level yet keeps it under the saturation point of the demodulator. The demodulator, IC3, is an XR2211 monolithic PLL (phase-locked loop). It is set to work at 2025 and 2225 Hz. The output of the demodulator is a logic signal that is compatible with the UART in the tank controller.

The basic circuits shown in figure 6 and 7 were originally presented in the Circuit Cellar article titled "A Build-It-Yourself Modem for Under $50" (BYTE, August 1980, page 22). I refer you to that article for a more complete explanation of modem communication. (See also "BYTE's Bugs," BYTE, October 1980, page 332, and November 1980, page 112.)

Wireless remote control in an automated-house application was discussed in "Handheld Remote Control for Your Computerized Home," BYTE, July 1980, page 22.

The printed-circuit boards shown in photos 7 and 10 are the production modem boards originally offered as a kit with components for those people interested in constructing their own modems from the August article. These circuit boards are still available and were used to construct the interface described in this article. A text box at the end of this article tells how to order one of these boards.

The completed interface is a fairly neat package. While it is large in comparison to the five-integrated-circuit assembly inside the tank, it can still be toed along behind Big Trak by using the Big Trak Transport, the tank's cargo trailer. A cable and jack connect the receiver to the controller in-

Photo 6: Big Trak undergoing modification. The interface circuit of figure 3 may be seen inside, in front of the keypad.

Photo 7: The modulator section of an answer-type modem. The serial data output from the computer is modulated according to an FSK scheme into audio tones with frequencies of 2025 and 2225 Hz.

Photo 8: The output of the modem modulator is connected by a cable to this walkie-talkie (a Radio Shack number 60-4001) for transmission to the receiver on the Big Trak. The connection to the transmitter section of the walkie-talkie is made across the speaker terminals, with a 10-ohm resistor inserted in the circuit in place of the speaker. A phono jack installed on the front of the walkie-talkie facilitates the connection.
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Figure 5: Block diagram of the wireless remote-control system described in this article. FSK modulation is employed along with inexpensive walkie-talkies to create a "wireless extension cord.

Figure 6: Schematic diagram of the modulator section of an answer-type modem. The assembled circuit is shown in photo 7.

In this FSK-modulation scheme, a logic 1 input produces an output frequency of 2225 Hz, while a logic 0 produces an output frequency of 2025 Hz. The output is connected across the speaker (which also serves as a microphone) in the walkie-talkie, which is connected to the transmitter section. Capacitors marked with an asterisk (*) should be Mylar type parts.

Programming Big Trak from Your Computer Keyboard

Now that you have a remote-controlled tank, you have to write a suitable control program. The complexity of the program depends upon the level of sophistication you desire. The interface was designed for simple interaction, and it doesn't require much. Complete direction can be accomplished with as little as the following BASIC program:

100 INPUT A
110 LPRINT CHR$(A);
120 GOTO 100

In this program, the value of the variable A should be one of the 23 decimal values listed in table 2. The operator must keep track of the entry sequence, and Big Trak and the communication link must be powered at all times, because commands are entered singly and stored only in the tank's control system.

A much more sophisticated BASIC program is shown in listing 1. This program allows the operator to assemble a command sequence offline with functional entries (Hold, Fire, etc) rather than coded inputs. In addition, the time needed to develop a command sequence becomes less of a problem, since power to the tank

Text continued on page 58
Listing 1: A program in BASIC that allows the operator to assemble a Big Trak command sequence using functional entries. The command sequence is stored within the host computer and is transmitted in its entirety to the Big Trak when the operator gives the Go command.

100 REM *********** BIG TRAK REMOTE CONTROL PROGRAM ***********
110 REM
120 REM
130 REM
140 REM Clear enough memory space for possible 16 command sequence
150 FOR Q=25000 TO 25048 : POKE Q, 0 : NEXT Q : REM Clear Memory Table
160 REM
170 REM Load conversion table for ASCII 0-9 to tank code
180 DATA 38,53,37,85,52,36,84,51,35,83
190 FOR W=0 TO 9 : READ B(W) : NEXT W
200 REM
210 REM Command list to be repeated each time (Y or N):"; INPUT C$ 
270 IF C$="Y" THEN C=1 ELSE C=0 : GOSUB 990 : GOTO 300
280 REM
290 REM
300 IF C=1 THEN GOSUB 990 ELSE GOTO 310
310 PRINT:PRINT:PRINT:PRINT"COMPUTERIZED REMOTE CONTROL":PRINT ...
820
380 IF A$="D" THEN GOTO 890 
390 IF A$="G" THEN GOTO 920 
400 IF A$="L" THEN GOTO 1290 
410 GOTO 310 
420 REM
430 REM ------- Move Command -------
440 PRINT"(F)orward,(B)ackward,(L)eft,or (R)ight":INPUT B$ 
450 IF B$="F" THEN X=33 :GOTO 500 
460 IF B$="B" THEN X=34 :GOTO 500 
470 IF B$="L" THEN X=50 :GOTO 550 
480 IF B$="R" THEN X=82 :GOTO 550 
490 GOTO 300 
500 PRINT"How many feet (1 to 99)"; INPUT Q1 
510 IF Q1<0 THEN 500 
520 IF Q1>99 THEN 500 
530 GOSUB 980 
540 GOSUB 1090 
550 PRINT"Turn how many degrees (0 to 360)"; INPUT Q1: Q1=INT((Q1/360)*60) 
560 GOSUB 980 
570 GOSUB 1090 
580 REM
590 REM ------- Clear Command -------
600 Q=0 :S=0 :T=25000 :FOR Q=25000 TO 25048 : POKE Q,0 : NEXT Q
610 PRINT"Stored sequence cleared --- Start Again":POKE T,65 :T=T+1
620 GOSUB 990 : GOTO 310
630 REM
640 REM ------- Hold Command -------
650 X=49 :PRINT"Hold how many seconds (total time .1sec)"; INPUT Q1 
660 IF Q1<0 THEN 650 
670 IF Q1>99 THEN 650 
680 GOSUB 980 
690 GOSUB 1090 
700 REM
710 REM ------- Repeat Command -------
720 X=67 :PRINT"Repeat how many steps"; INPUT Q1 : GOSUB 980 
730 GOSUB 1090 : GOTO 300
740 REM
750 REM ------- Test Command -------
760 IF T<25001 THEN 770 ELSE 790
770 LIST CHR$(68):PRINT:"TEST COMMAND TRANSMITTED"
780 GOSUB 990 : GOTO 310
790 PRINT:PRINT:"CAN NOT EXECUTE EXCEPT AS FIRST COMMAND" : GOTO 300
800 REM
810 REM ------- Fire Command -------
820 X=81 :PRINT"How many shots (1 to 99)"; INPUT Q1 
830 IF Q1<0 THEN 820 
840 IF Q1>99 THEN 820 
850 GOSUB 980 
860 GOSUB 1090 : GOTO 300 
870 REM
880 REM ------- Dump (OUT) Command -------
890 X=86 : GOSUB 1090 : GOTO 300
900 REM
910 REM ------- Command Transmitter -------
920 X=70 :PRINT"COMMAND CONTROL SEQUENCE IS BEING TRANSMITTED TO TANK" 
930 PRINT : PRINT
940 GOSUB 1200
Listing 1 continued on page 58
Introducing 7 data-shielding improvements from Verbatim for greater disk durability, longer data life.

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Circle 31 on inquiry card.
Listing I continued:
950 PRINT PRINT "Retransmit Same Control Sequence (Y or N)" ; : INPUT $Q
960 IF $Q = "Y" THEN LPRINT CHR$(70); : GOTO 920
970 IF $Q = "N" THEN 220 ELSE 950
980 $A = INT($Q/10) : $A = $Q - $A*10 : RETURN
990 REM
1000 PRINT "COMMANDS :"
1010 PRINT "(M)ove (F)ice"
1020 PRINT "(C)lear (D)ump"
1030 PRINT "(H)old (G)o"
1040 PRINT "(R)epeat (D)ump"
1050 IF $T <= 25000 THEN PRINT "(T)est"
1060 RETURN
1070 REM
1080 REM Store Command Code in Memory Table
1090 POKE $T,%$X : $T = $T + 1 : $X = $X + 1
1100 REM A = $X + $A * 10 : RETURN
1110 IF $A = $A THEN 1300
1120 POKE $T,$( $A) : $T = $T + 1
1130 POKE $T,$($A) : $T = $T + 1
1140 PRINT "Command Stored";
1150 IF $K >= 15 THEN GOTO 1160 ELSE 1170
1160 PRINT "NEXT COMMAND MUST BE GO!" : RETURN
1170 RETURN
1180 REM
1190 REM LPRINT Command Sequence from Memory Table
1200 POKE $T,%$X
1210 FOR $E = 25000 TO $T
1220 LPRINT CHR$(%$E);
1230 FOR $C = 0 TO 100 : NEXT $C
1240 NEXT $E
1250 PRINT "TRANSMISSION COMPLETE"
1260 RETURN
1270 REM
1280 REM Display codes stored in memory table
1290 FOR $N = 25000 TO 25048 : PRINT PEEK($N); " " : NEXT $N
1300 GOTO 300

<table>
<thead>
<tr>
<th>Command Name</th>
<th>ASCII Character</th>
<th>Hexadecimal Code</th>
<th>Decimal Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward</td>
<td>!</td>
<td>21</td>
<td>33</td>
</tr>
<tr>
<td>Backward</td>
<td>#</td>
<td>22</td>
<td>34</td>
</tr>
<tr>
<td>Right</td>
<td>R</td>
<td>52</td>
<td>82</td>
</tr>
<tr>
<td>Left</td>
<td>L</td>
<td>32</td>
<td>50</td>
</tr>
<tr>
<td>Clear (all)</td>
<td>A</td>
<td>41</td>
<td>65</td>
</tr>
<tr>
<td>Clear (last)</td>
<td>B</td>
<td>42</td>
<td>66</td>
</tr>
<tr>
<td>Hold</td>
<td>C</td>
<td>31</td>
<td>49</td>
</tr>
<tr>
<td>Repeat</td>
<td>E</td>
<td>43</td>
<td>67</td>
</tr>
<tr>
<td>Check</td>
<td>Q</td>
<td>46</td>
<td>69</td>
</tr>
<tr>
<td>Fire</td>
<td>O</td>
<td>51</td>
<td>81</td>
</tr>
<tr>
<td>Out</td>
<td>V</td>
<td>56</td>
<td>86</td>
</tr>
<tr>
<td>Test</td>
<td>D</td>
<td>44</td>
<td>68</td>
</tr>
<tr>
<td>Go</td>
<td>F</td>
<td>46</td>
<td>70</td>
</tr>
<tr>
<td>0</td>
<td>&amp;</td>
<td>26</td>
<td>38</td>
</tr>
<tr>
<td>1</td>
<td>%</td>
<td>35</td>
<td>53</td>
</tr>
<tr>
<td>2</td>
<td>$</td>
<td>25</td>
<td>53</td>
</tr>
<tr>
<td>3</td>
<td>#</td>
<td>33</td>
<td>51</td>
</tr>
<tr>
<td>4</td>
<td>S</td>
<td>23</td>
<td>35</td>
</tr>
<tr>
<td>5</td>
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</tr>
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<td></td>
</tr>
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<td>9</td>
<td>57</td>
<td>87</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>58</td>
<td>88</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Correspondence of ASCII characters to the twenty-three Big Trak command codes. The decimal values of the ASCII characters are sent to the transmitter using the BASIC statement LPRINT CHR$(%$).

Text continued from page 54:

and communication interface need to be turned on only when the sequence is to be executed. The Go command transmits the entire repertoire to the tank in one stream of data.

The data sent to the tank can in fact be seen in the sample run of listing 2. I used the same serial port designated for the wireless communications link to list the program. You'll note the string of extraneous characters after "COMMAND SEQUENCE IS BEING TRANSMITTED TO TANK". "Al % 1 % Q$25$15% QT C % F" is the string sent to the tank by the CHR$(%$) function. It ended up on the listing (inadvertently) because both devices (printer and tank) use the same I/O-port address. If you compare these characters to those in table 2, you will see that it represents the
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<thead>
<tr>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>5000 labels $2.50/1000</td>
<td></td>
</tr>
<tr>
<td>1000 labels $2.00/1000</td>
<td></td>
</tr>
<tr>
<td>2000 labels $1.50/1000</td>
<td></td>
</tr>
<tr>
<td>4000 labels $1.25/1000</td>
<td></td>
</tr>
<tr>
<td>8000 labels $1.00/1000</td>
<td></td>
</tr>
</tbody>
</table>

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<tr>
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<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epson MX 80</td>
<td>CALL</td>
</tr>
<tr>
<td>Okidata Microline 80</td>
<td>$550</td>
</tr>
<tr>
<td>Okidata Microline 90</td>
<td>$650</td>
</tr>
<tr>
<td>Okidata Microline 100</td>
<td>$750</td>
</tr>
<tr>
<td>Okidata Microline 200</td>
<td>$850</td>
</tr>
</tbody>
</table>

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</tr>
</thead>
<tbody>
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<td>Microsoft Basic Compiler</td>
<td>$250</td>
</tr>
<tr>
<td>Microsoft Excel</td>
<td>$350</td>
</tr>
<tr>
<td>Microsoft Worksuite</td>
<td>$450</td>
</tr>
<tr>
<td>Microsoft Worksuite Pro</td>
<td>$550</td>
</tr>
<tr>
<td>Microsoft Worksuite Premier</td>
<td>$650</td>
</tr>
</tbody>
</table>

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Photo 9: A second walkie-talkie is used in the receiving section of the remote-control hardware. The working parts of the walkie-talkie have been placed in the same enclosure that will shortly house the demodulator circuit. Here again, the speaker has been removed from the walkie-talkie and a 10-ohm resistor substituted.

Photo 10: The originate-type modem demodulator of figure 7 has been constructed on a printed-circuit board and placed in this box over the walkie-talkie circuit. The modulator section of the circuit board is not used in this application; therefore the integrated circuits used only by the modulator have been removed. The circuit board is mounted on stand-offs and is powered by two 9 V batteries. A shielded cable and a phono jack connect it to the tank-controller interface, mounted inside the Big Trak.
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Listing 2: An example of the user interaction produced by the program of listing 1. The coded command-specification characters transmitted to the tank show up in this print-out on the next-to-last line, because the same I/O-port address was used for both the remote-control transmitter and the printer interface.

run

COMPUTERIZED REMOTE CONTROL

Command list to be repeated each time (Y or N)? N

COMMANDS :
- (M)ove
- (F)ire
- (C)lear
- (D)ump
- (R)epeat
- (T)est

Command? M
- (F)orward, (B)ackward, (L)eft, or (R)ight

? F

How many feet (1 to 99)? 2

Command Stored

Command? H

Hold how many seconds (total times .1sec)? 20

Command Stored

Command? F

How many shots (1 to 99)? 5

Command Stored

Command? M

- (F)orward, (B)ackward, (L)eft, or (R)ight

? L

Turn how many degrees (0 to 360)? 90

Command Stored

Command? M

- (F)orward, (B)ackward, (L)eft, or (R)ight

? F

How many feet (1 to 99)? 10

Command Stored

Command? F

How many shots (1 to 99)? 6

Command Stored

Command? R

Repeat how many steps? 2

Command Stored

Command? G

COMMAND CONTROL SEQUENCE IS BEING TRANSMITTED TO TANK

A1%1%&Q$25$!5&QTC%FTRANSMISSION COMPLETE

Retransmit Same Control Sequence (Y or N)?

Photo 11: When the electronic hardware has been built and is fully operational, the Big Trak Transport (a cargo trailer) provides a convenient method for dragging the wireless communication interface along.
THE SOLUTION STORE

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MicroAge Computer Stores sell solutions to your professional, business and household-management problems, not just hardware. That's what makes the MicroAge difference! From systems integration to easy-to-understand application software, research and development to warranty service and repair, systems consulting to training and installation. In all these, we offer the latest, most innovative approaches. That's why we are the forerunners...the pioneers in the microcomputer industry.

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Figure 7: The demodulator section of an originate-type modem. This is required at the receiving end of the computer/Big Trak link to decode the 2025 Hz and 2225 Hz tones received by the walkie-talkie. See photos 9 and 10 for views of the receiving system. The XR2211 phase-locked loop is produced by Exar Integrated Systems, POB 62229, Sunnyvale CA 94086. Capacitors marked with an asterisk (*) should be the type made from Mylar.

Text continued from page 60:
ics community, but neither will it go unnoticed by those of us who like to play with toys. I hope you will recognize the independent capability of the wireless serial-communication link and use it in another application.

As regards extensions of the control concept, a few more ideas came to mind while I was writing. The wireless communication method described in this interface is a one-way link, computer to remote peripheral device. However, the modem boards used in the prototype have full-duplex capability, even though only half of each unit is used. Furthermore, within the tank-controller interface, I did not use the transmit portion of the UART.

If two more walkie-talkies operating on a different frequency are added, or if the two existing units are switched back and forth between send and receive, we could conceivably receive data sent back from the tank. The required interface components are presently available in the hardware (the other halves of the two full-duplex modem boards) but are not utilized.

What data might the tank send back? Do you remember that article I did a while back on the Polaroid Ultrasonic Ranging System? (In case you don't, see "Home In on the Range! An Ultrasonic Ranging System," BYTE, November 1980, page 32...RSS]

I'm sure you get the picture, but unfortunately I didn't have enough time to add that feature now. However, if you don't mind looking at Big Trak once more at a future time, I'd like to consider adding "eyes" and demonstrating control programs that exhibit more machine intelligence.

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TM
A Beginner's
Guide to Spectral Analysis
Part 1: Tiny Timesharing Music

We live in two worlds that co-exist in space and time; they touch each other and interpenetrate at every point and at every moment. In fact, each world contains the other within it.

One is a world of forms, of colors, of sounds; the other is a world of complex numbers, of mathematical functions. Most people aren't aware of this second world, but that doesn't make it any less valid as an expression of reality. It's not hard to peek into this "alternate universe": this article and the accompanying programs will attempt to aid you in doing so. If a student devotes some time to the concepts suggested here, he'll find himself rewarded with a set of extraordinarily useful tools. Some facts which aren't obvious in one world are obvious in the other; some tasks which are slow, laborious, and expensive in the first world become quick and cheap in the second.

My description may sound a bit like Oriental mysticism, but it's not! This article will try to sketch an introduction to Fourier analysis, one of the most powerful developments in modern mathematics. It will emphasize the feel of the subject, not the complicated algebraic formalisms. No advanced mathematical training is required, but it may help to have access to a small computer for some parts of the discussion. The programs that I've written for illustrative purposes are in either BASIC or 6502 assembly language, and were specifically designed for the 8 K-byte Commodore PET. It should be a fairly straightforward process to adapt these programs to comparable machines.

The first part of this article will introduce the one-dimensional Fourier transform, and emphasize its importance to music and human perception of sound. Included is a "tiny timesharing" program that is both educational and enjoyable. It generates simple musical themes using the building blocks of intervals, and varies these themes via a series of inversions. New musical elements are introduced pseudo-randomly, so the patterns never repeat, and the tone quality is also constantly varied. All of this uses only about 0.1% (yes, one-tenth of one percent!) of the computer's time, which allows other programs to be run simultaneously with no noticeable loss of speed.

In the second part of this article, I will outline the simple extension of a one-dimensional problem into a two-dimensional plane. The program that illustrates this process uses pictures drawn on the PET's video-display screen and transforms them by a process similar to that of making a hologram with coherent light.

The references at the end of each part should be useful for anyone who wants more information on the topics encountered. You may also find it helpful to consult your neighborhood Fourier guru, who has probably chosen to be reincarnated as an electrical engineer or radio astronomer.

The Frequency Domain
The central idea of Fourier (or spectral) analysis is quite simple. One of the best ways to understand it is to think about a musical chord, produced by simultaneously hitting several keys on a piano. Suppose you play a chord and want to record it—how can you do that?

One way to preserve a chord for posterity would be to record it on a tape deck or (if you collect antiques) on a gramophone wax cylinder. In either case, the method of recording is essentially the same: the sound impulses are translated into magnetic field patterns, or into the wiggles of a groove, and stored just as your ear/microphone perceives them. If you had an oscilloscope, you could display the sound on a screen and photograph it.

But there's also a completely different way to save the chord. You can draw a musical scale and write down the notes that are hit. This scale doesn't show the moment-by-moment variations of air pressure against your eardrums; instead, it relates something about the frequency of these pressure waves, and the set of frequencies that is being created by the vibrating piano strings.

A recording method that stores a sound as a function of time is said to work in the time domain. A method that breaks a sound up into its constituent frequencies and records the amount of each frequency component that went into the original sound is said to work in the frequency domain.

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notes on a scale doesn’t give enough information to completely reconstruct the original chord. Even if each piano key produces a pure tone with no harmonics or distortions, you should still specify more than which keys were punched. You must say precisely how loud each note in the chord was played and the precise time that each note began (ie: the amplitude and the phase of each pure note in the chord). Given that amount of data, the original sound can be reproduced exactly. The frequency-domain method of recording then contains as much information as the conventional time-domain recording technique.

That’s really all there is to Fourier analysis. There are, of course, precise mathematical formulas for translation from the time to the frequency domain, and back. There are also modern improvements on these formulas, such as the fast Fourier transform, which can do the same job in much less time than the old-fashioned method. But the basic ideas remain the same: the Fourier transform is a technique for changing notation from one way to another in order to record the same information.

There are many references (see references at the end of this article) that explain the mathematics of the Fourier transform. I’d like to avoid these, and try instead to explain the meaning of the transform, and the uses to which it can be put.

Why Transform?
I have already mentioned the application of Fourier analysis to music, and I’ll return to this topic later. There are numerous other uses for the transform concept. Almost any wave-like phenomenon can show interesting behavior when looked at in the frequency domain. Light, when spread into a spectrum, reveals information about the source that produced it: that’s how astronomers determine the composition of distant stars. (The word “spectrum” is the source of the term “spectral analysis.”) Radio signals, grouped at different frequencies, carry hundreds or thousands of simultaneous telephone calls, TV broadcasts, etc. A receiver simply performs a partial Fourier analysis in order to separate one program from the crowd. Ocean waves can be resolved into frequency components, each traveling with its own speed. This approach helps, for example, in understanding how tsunamis (tidal waves) are created by undersea earthquakes and travel thousands of miles across the water before cresting on a shore.

Fourier analysis is also applicable to things that aren’t functions of time. In calculating the heat distribution within a nuclear reactor core, one useful method involves breaking up the spatial dependence of the temperature into pieces that vary with different spatial frequencies. Similar techniques work to explain the shape of a soap film over a bent wire loop, the electrical field patterns inside a microwave cavity resonator, or the air density and pressure variations inside an organ pipe. (In the latter two cases, time dependences also exist as a part of the problem; the time dependences can be easily solved once the spatial Fourier analysis problem is understood.)

In recent years, myriad practical applications of spectral analysis have been developed, particularly in electrical engineering. If a signal is first transformed into the frequency domain, it often becomes easy to filter out noise and interference. On the other hand, by scrambling frequency components you can make a voice incomprehensible (unless the scrambling pattern is known) and allow relatively secure communications over a channel that is not secure. Quite often, it’s most efficient to manipulate a signal by transforming it into the frequency domain, working it over, and then transforming back; the cost of transforming is more than repaid by the speed and convenience of many operations when applied to the frequency components of a function.

In the field of computing, Fourier analysis concepts have proved to be extremely helpful. The invention of faster algorithms as an aid in multiplying large numbers got its start from fast Fourier transform theories. The spectral test for random number generators, one of the most powerful tests known for detecting non-random biases, is a Fourier technique. Even before electronic computers existed, mechanical “calculating engines” were built to do Fourier analysis because of the importance of the subject.
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Music and the Fourier Transform

Unlike the other senses, the ear seems to work naturally in the frequency domain. Physiologically this may result from the structure of the cochlea in the inner ear; sounds of different frequencies stimulate different spatially separated areas (so that the motion of the eardrum is Fourier transformed!). It is both interesting and educational to experiment with sounds of various frequency spectra. A microcomputer can be a great aid to this kind of experimentation, since it can reliably generate precise, easily modified waveforms, as well as perform the mathematical work required to calculate the spectrum of any particular wave. Both the pitch and the tone quality are variable.

The program RMS Spectrum Plot (see listing 1) was designed for just this kind of experiment. The mathematical parts can be run on any computer that understands BASIC; on the PET, the spectrum is graphically plotted on the video display, but a numerical output would be an acceptable alternative. This program makes use of the recirculating shift-register in the MOS Technology 6522 VIA (Versatile Interface Adapter) integrated circuit in the PET. The VIA has an output to pin CB2 of the PET's port edge connector. Any trivial amplification circuit (see figure 1) can be used to amplify and isolate this output to give an audible tone. Many other microcomputers have similar tone-generation capabilities; otherwise, a separate waveform generator may be used to study the sounds that are being Fourier analyzed.

RMS Spectrum Plot performs a straightforward N-bit power-spectrum analysis. For use on the PET and most other microcomputers N=8 is the case of interest, but there is no harm in making a more general program and allowing for an arbitrary N. (Note that for N not equal to 8, the tones produced by the PET's shift register are not the same as the tones being analyzed by the program. Also note that for N greater than 16, PET BASIC will not correctly handle the array look-up operations for arrays TS and TC, which would need to have more than 256 elements.) I won't go into the mathematical operations that are being performed in the course of the spectral analysis; some of the references cited later do that in great detail. Instead, I'll try to explain the results, the physics and the physiology that the program helps explore.

Earlier I mentioned that in order to describe a sound completely in the frequency domain, you must provide more than just the list of frequencies that went into the original sound. A complete specification also requires the amplitude of each frequency component and its phase. By phase, I mean a measure of where a sinusoidal signal is in its cycle of 0° to 360° at some moment of time. (For example, the functions \( \sin(t) \) and \( \cos(t) \) look very similar, but one is 90° out-of phase with the other.) Two sounds with the same set of component frequencies and the same amplitude can look completely different when displayed on an oscilloscope, and they make completely different wiggles in a phonograph groove (see figure 2).

So, phase information is crucial for the accurate reconstruction of the original sound. High-fidelity amplifier and speaker advertising emphasize this—you must spend lavishly in order to get really good, precise sound reproduction. Or must

---

This text seems to be a part of a larger document, possibly a scientific or technical paper, discussing the Fourier Transform and its applications. The text includes code listings and diagrams related to the synthesis of audio signals using a microcomputer. The focus is on how to analyze and generate sounds in the frequency domain, with a specific example using the Commodore PET computer. The text touches on the importance of phase information in sound reproduction and the technical details of implementing such a system.
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shapes are made up of the same component frequencies, but with a variation in phase. You are shown to see the difference that phase information makes in perceived tone.

left, right, or in front of a listener, but that too is unclear.

Read on the subject. The human ear is unbiased technical references I've read on the subject. The human ear is a marvelous Fourier analyzer as far as uncomented frequencies, but the ear seems to throw away almost all data about the phase of the sounds. (Perhaps some phase information helps to determine whether sounds are coming from the left, right, or in front of a listener, but that too is unclear.)

Even without phase information, sounds of the same fundamental frequency produced by RMS Spectrum Plot can reveal an interesting variety of textures as their bit patterns are separated. This agrees with most of the results. These notes are composed of a fundamental frequency component, called f, plus varying amounts of sound energy at frequencies 2f, 3f, 4f, ..., the harmonics of the fundamental tone. After line 170 is executed, for each frequency Kxf, the variables C and S contain the amount of the Kth harmonic of the signal which looks like a cosine (in C) or like a sine (in S). A = SQR(C x C + S x S) is the amplitude of the Kth harmonic (the thing that the ear is sensitive to); it is this amplitude A which is plotted on the screen (see photos 1a, 1b and 1c for examples).

The best thing to do now is to stop reading and to experiment a bit with frequency = (62,500 Hz)/(NT + 2)

For example, NT=140 closely approximates the standard frequency of 440 Hz, the note A above middle C. Once the frequency of the note is chosen, RMS Spectrum Plot allows you to hear what an arbitrary bit pattern sounds like, while the machine does a spectral analysis of the pattern and displays the results.

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Sample runs of RMS Spectrum analysis of the sound. The program "plays" an arbitrary bit pattern while displaying a power-spectral analysis of the sound.

But there are other ways in which two bit patterns can be equivalent. Consider the patterns 11111101 and 00000010. If you graph these patterns, you can see that the waveforms to which they correspond are exactly the same, except for a shift of the zero-voltage level and a change of polarity. The power spectra of these patterns are also the same, except for the zero-frequency component which the ear can't hear and which isn't plotted by RMS Spectrum Plot. (The zero-frequency component is just the average of the bits, e.g., $\frac{1}{8}$ for the pattern 11111101.) Since these patterns are the same as far as the ear is concerned, they should also be called equivalent. In binary arithmetic, the relation between these patterns is that each is the 1's complement of the other: all 1s are changed to 0s, and vice versa. Since the 1's complement of a binary number $I$ is just $11111111-I$ (if $I$ has 8 bits), it's easy to program in BASIC. We can call this operation INV for inverse, and add it to the list of operations that transform bit patterns into other equivalent patterns.

### Distinctive Voices

The bit patterns that produce distinct frequency spectra are the basic building blocks for generating shift-register-type music. You can certainly find all seventeen different 8-bit voices by trial and error or long and tedious searching, but such an approach becomes much more difficult as the number of bits increases. In any case, there is a better way to find the set of interesting bit patterns: use a computer! The program Music Generator (listing 2) uses a technique that is simple, yet interesting, and applicable to many other problems.

In setting up the problem of finding all distinct voices, the first thing is to determine how two bit patterns can be “equivalent.” (This is involved with the mathematical concept of a group, and is actually a good introduction to that subject.) First, it is obvious that patterns like 00000001 and 00001000 and 10000000 are all equivalent since they look the same (a single 1 and seven Os) once they've started cycling around in the shift register. Similarly, 00101101 and 10100101 are equivalent: the second pattern results from applying five rotate-left operations to the first. We can call the operation which takes the leftmost bit of a bit pattern and moves it to the right end ROL for rotate-left. Any patterns which can be converted into each other by a series of ROL operations are equivalent.

The program. Try to discover which bit patterns are indistinguishable to the ear; see which ones you like best. (My favorite is 00101101, which has no even harmonics and sounds rather like a clarinet.)

### Listing 2: Music Generator for the PET

When used to generate music waveforms, this program will produce audibly distinct tones based on 8-bit patterns in the PET's shift register. Qualities are constantly modified through the application of symmetry operations (inversion, rotation, etc) to produce interesting variations.

```plaintext
10 REM BIT PATTERN GENERATOR (C) 1979 MARK ZIMMERMANN
20 DIM V%(7): REM ARRAY FOR BIT PATTERN DISPLAY
100 FOR I=1 TO 127 STEP 2: REM TRY ALL POSSIBILITIES THAT DO NOT OBVIOUSLY FAIL
200 Z=I: FOR K=1 TO 7: GOSUB 5000: REM ROTATE BITS OF Z LEFT
220 IF Z<I GOTO 1000: REM REACHED TO A PREVIOUS CASE IF Z<I
240 NEXT K: REM PASSED FIRST TEST IF REACH HERE
300 X=255-I: REM INVERT BIT PATTERN (1's COMP.),(J's COMP.) - X>I, SINCE LOOP WAS I TO 127
320 Z=X: FOR K=1 TO 7: GOSUB 5000: REM ROTATE BITS
340 IF Z<I GOTO 1000: REM REACHED TO PREVIOUS CASE...
360 NEXT K: REM IF HERE, A SUCCESSFUL!
400 GOSUB 6000: REM REVERSE BIT ORDER OF I, RESULT RETURNED IN X
500 IF Z<1 GOTO 1000: REM FAILED AGAIN
600 Z=X: FOR K=1 TO 7: GOSUB 5000: IF Z<1 GOTO 1000
620 NEXT K
660 Z=255-X: FOR K=1 TO 7: GOSUB 5000: IF Z<1 GOTO 1000
680 NEXT K: REM IF HERE, A SUCCESSFUL!
800 X=I: FOR K=0 TO 7: V%(K)=X-2*INT(X/2): X=INT(X/2): NEXT K: REM GENERATE BITS
900 PRINT I:TAB(10): FOR K=7 TO 0 STEP -1: PRINT V%(K): NEXT K: PRINT
1000 NEXT I
2000 GOTO 9999
5000 REM ROTATE BITS OF Z LEFT
5020 Z=2*Z: IF Z>255 THEN Z=Z-255
5040 RETURN
6000 Y=I: X=0: FOR K=0 TO 7: X=2*X: IF Y>2*INT(Y/2) THEN X=X+1
6020 Y=INT(Y/2): NEXT K: RETURN: REM RETURN WITH X THE REVERSED VERSION OF I
6999 END
```
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I've only been able to think of one more symmetry operation to apply to bit patterns. (If you find others that leave the voice that the ear hears unchanged, please let me know.) This final operation is to reverse the bit order. For example, reversal changes 11010000 into 00010111. Physically, reversal corresponds to playing a bit pattern backwards, or to reversing the flow of time. I abbreviate this operation REV.

Now there are three symmetry operations: ROL, INV, and REV. Applying any one of them to any bit pattern leaves the sound that the ear hears unchanged. By repeatedly applying these operations, it's easy to discover sets of bit patterns that change into each other (the patterns 00110011, 01100110, 10011001, and 11001100 make up one such set).

How does this theoretical knowledge help you to determine which bit patterns are distinctive voices and which are redundant among the 256 possibilities? A crude way would be to apply various combinations of ROL, INV, and REV to a candidate pattern, and consider it new if it is never transformed into an already-known or old pattern. A slightly better method would be to systematically apply a series of the symmetry operations that would guarantee that no possible transformations were missed. For example, it's clear that you need never apply more than seven consecutive ROL operations to a pattern, since the eighth application brings you back to the original pattern. It's also clear that applying INV (or REV) twice in a row makes no sense, since it just flips the bits back again. There are many possible sequences of operations that will find all possible transformations of a pattern. One simple sequence is: ROL seven times, INV, ROL seven times, REV, ROL seven times, INV, and ROL seven times. After each operation, a potentially new equivalent bit pattern is produced. Applying the sequence to the pattern 00010111 will generate all thirty-one other equivalent patterns, with no repetition; applying it to a pattern like 01010101, which has only one equivalent (10101010), will, of course, produce many repetitions.

The program of listing 2 essentially goes through this process in order to find the set of seventeen distinct voices, but with a few refinements to speed it up. First, the program works exclusively with the decimal number corresponding to each bit pattern, not with the pattern itself. This allows the program to use simple BASIC arithmetic operations to perform ROL, INV, and REV. Only when a number is discovered to be a new voice is it converted into a bit pattern for display. Second, no time is wasted in checking even numbers, or numbers greater than 127. Every even number corresponds to a bit pattern ending in a 0, and a single rotation right (or seven rotations left) will always produce a pattern corresponding to a smaller binary number. Any number greater than 127 can always be reduced to a number less than 127 by an INV operation. Third, Music Generator doesn't bother storing a list of already-discovered old patterns with which to compare the result of each transformation. Instead, it uses a neat yet trivial mathematical trick, one that should be part of every alert programmer's repertoire. Let me introduce it to you with a short story:

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Each test subject is asked to make a pot of tea.

The engineer fills the kettle with water from the pitcher, puts it on the stove, brings the water to a boil, and makes the tea. When the physicist encounters the same situation, he thinks for a while, puts the tea into the cold water, etc., but eventually hits upon the solution. The mathematician takes a little longer, but finally he too solves the problem.

For the second part of the test, each subject is led into another room. In this room, again, there is a stove, a table with a pitcher of water, and a box of tea. The difference is that the tea kettle is now sitting on the floor.

When the engineer enters the room and is asked to make tea, he picks up the kettle, fills it with water, puts it on the stove to boil, and so on, as before. The physicist stops and thinks for a short time, then figures it out, and does essentially the same.

But the mathematician, as soon as he encounters the puzzle, simply takes the kettle from the floor and sets it on the table. Then he stops. He has reduced the problem to a previous case—one he has already solved.

As far as he's concerned, nothing more need be done.

This trick of reducing a problem to a previous case may be funny or obvious, but it's also exceedingly valuable in computing, and in other fields. When calculating the factorial function \( n! = n \times (n-1) \times (n-2) \times \cdots \times 3 \times 2 \times 1 \), once you know how to calculate \( n! \) you can easily get \( (n+1)! \) by reducing the calculation to a previous case. When trying to find the prime factorization of the numbers from 1 to \( n \), once a single factor of a number is found, no more work need be done since the remaining number has already been factored, and is therefore a previous case.

These are many other examples.

Music Generator uses this "reduction to a previous case" technique. After each transformation of a candidate bit pattern, the result is checked to see if it is smaller than the original candidate under consideration. If it is smaller, you know that it has been previously handled, and the program immediately skips on to the next candidate (specifically, it branches to line 1000 which is a NEXT I statement). By starting with the smallest candidate, 00000001, and working upward, the program produces a complete list of all the
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Circle 50 on inquiry card.
Choices for actual locations:

- \( P = 0 \)
- \( Q = 1 \)
- \( R = 2 \)

**P,Q,R** occupy “USR(X)” storage area!

- **RNDPTR** = DD (hexadecimal)
- **RNDNUM** = DE (hexadecimal) :random numbers in PET’s RND(X) location
- **D** = EC (hexadecimal) :in PET’s “EOT character” area
- **V** = F3 (hexadecimal) ; in PET’s “EQT character” area
- **N** = F4 (hexadecimal) ;V,N in tape buffer pointer area

M1 = 033A (hexadecimal) = 826 (decimal)
M2 = 036C (hexadecimal) = 876 (decimal)
I = 03D8 (hexadecimal) = 984 (decimal)

Music table occupies 03D9 thru 03E0 (hexadecimal) = 985 thru 992 (decimal).

INTRVTAB = 03E1 = 993
Interval table occupies 03E1 thru 03E8 (hexadecimal) = 993 thru 1000 (decimal).

NOTETAB = 03E8 = 1000
Note table occupies 03E8 thru 03FF (hexadecimal) = 1000 thru 1023 (decimal). Note overlap with interval table.

**Contents of tables:**

<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>
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<tr>
<td>03E0:</td>
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<td>00</td>
<td>00</td>
<td>04</td>
<td>F9</td>
<td>07</td>
<td>FS</td>
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<td>C7</td>
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<td>03F0:</td>
<td>9D</td>
<td>94</td>
<td>8C</td>
<td>84</td>
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<td>4D</td>
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</table>

**Algorithm Description**

**M1.** (Initialize) Point PET hardware interrupt vector to M2.
- SET Q, R, and N to 8; zero music table I(1), I(2),..., I(8).
- Set P, V, and D to 1.

**M2.** (Interrupt enters here) Decrement note duration counter D; if result is nonzero, go to PROCEED below.

**M3.** (Next note) Reset D to 4 (or other chosen length of note to be played, in units of 1/8 second). Look up interval I(P) and add that to note N, staying in allowed range (0 to 23). Decrement pointer P; if result is nonzero, go to step M6.

**M4.** (A measure of eight notes has been completed) Reset P to 8. Decrement voice V (bit pattern making sound) by 4 (or other choice), and if result is negative, reset V to maximum (=85). Change voice of note (POKE 59466, V). If counter Q is nonzero, invert interval I(Q) by negating value of I(Q), decrement Q and go to step M6.

**M5.** (All eight inversions have been completed) Reset Q to 8. Replace interval I(R) by another “randomly” chosen interval from the allowed table of intervals (in musical notation, table contains thirds, fifths, octaves, etc).

**M6.** (Play next note) Play new note NOTETAB(N), looked up in notetable. (POKE 59464, NOTETAB(N).)

**PROCEED.** Jump to PET’s normal interrupt-handling routine (E685).

To use Tiny Timesharing Music give command SYS(826) to turn music on and off. (You must turn it off before tape operations, since the PET uses the same interface chip when reading/writing tapes,...)

---

distinct-tone-quality bit patterns. (Patterns 00000000 and 11111111 are not included, since they’re inaudible.)

When written as binary numbers, the legal (irreducible) bit patterns have some interesting resemblances to the set of prime numbers (numbers that have no positive factors except themselves and 1). They are quite dense at the lower end of the range of available numbers, but become fewer and farther between as the candidate numbers get larger. There’s a simple reason for that: if a large number is chosen at random, it’s likely that some combination of the operations ROL, INV, and REV will be able to transform it into a smaller number, a previous case. (Similarly, there is a good chance that a large integer chosen at random has a factor among the many smaller integers between itself and 1, so the density of prime numbers decreases.) However, even as you go to higher numbers, an occasional pair of distinctive bit patterns appears, separated by a single even number. Among the 8-bit musical patterns, the pair 43=00101011 and 45=00101101 is a good example of such a “musical-pair”; if you look at 16-bit patterns, which potentially range from 1 thru 65535, pairs such as 11059, 11061 can be found. Prime numbers can also come in such pairs; as far as I know, however, there is no proof that an infinite number of prime pairs exist. There may be other analogies between the theory of primes and the distinct-voice musical bit patterns—I’d be interested in hearing about your discoveries.

From Tones to Music

I began this discussion with a look...
Listing 3: Tiny Timesharing Music. This
interrupt-driven program runs concur­
tently with other PET programs, and uses
their changing data to update its tone-
parameters (see the text box “Algorithm
Description”). The interrupt occurs every
\( \frac{1}{60} \) of a second to cause the PET to check
the keyboard for closed keys.

at Fourier analysis, and have
wandered through a bit of group
theory in looking at shift-register-
generated tones and what they sound
like. I’d like to close with a practical
application of this material.

I often run fairly long programs,
and it can be boring to stare at a static
video screen, waiting for the results
to appear. Then, too, I sometimes
become paranoid and suspect that the
machine has crashed, leaving me to
wait forever. Well, I thought, why
not put a little musical theory to
work? Why not have music while I’m
waiting for the programs to finish?

The more I thought about it, the
better the proposal sounded. The PET
is always interrupted sixty times per
second, to scan the keyboard and up-
date the internal clock. (This happens
as long as the interrupt-disable flag
hasn’t been set in the 6502 micropro­
cessor; the flag is rarely set during
normal operation.) At each interrupt,
the microprocessor branches to the
address stored in memory locations
0219,021A. Normally, these ad­
dresses point to hexadecimal location
E685, but by changing the address
pointed to, I could take control once
every \( \frac{1}{60} \) second—and play music!

The requirements that a good
interrupt-driven music-generation
program must meet are rather severe:

1. It must produce interesting
musical patterns, neither too
repetitious nor too chaotic.
2. It must be fast so that the main
program does not slow down ap­
preciably while music is playing.
3. It must be small; the main pro­
grams must not be squeezed out of
memory or restricted by the music
generator.

The program shown in listing 3
resulted. Tiny Timesharing Music
meets the third requirement by occu­
pying only the memory at locations
826 thru 1023 (second cassette
buffer), plus five locations on page
zero. It satisfies the second require-
ment by being fast; running at normal
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speed it uses about 18 µs every \( \frac{1}{10} \) second—only 0.1% of the machine's time. (Changing notes at top speed uses less than 0.4% of the time.) As for whether or not it meets the first criterion, you'll have to judge for yourself: "interesting" is in the ear of the beholder. I enjoy it, although it's certainly nowhere near Bach's Art of Fugue...then again, nothing is.

The algorithm description which accompanies this listing (see the text box "Algorithm Description") should make its method of operation clear. The theory of music is beyond the scope of this article (and me!), but in brief, the program works as follows: first it generates eight intervals, chosen from a musically "nice" set of possibilities (see Arthur Benade's book, and other references, for more details). Beginning with a base note, eight notes are played, each related to the previous note by one of the chosen intervals. After a measure of eight notes is completed, the bit pattern (voice) being used by the shift register is changed, one of the eight intervals is inverted, and another measure is played. (Inversion simply amounts to a sign change: an interval of +7 (a fifth) is inverted to −7.) After all eight intervals have been inverted, one is replaced by a new, randomly-chosen interval, and the whole process is repeated. The "random" numbers are influenced by the contents of page zero, so if the user is doing something, or running any program, the musical patterns produced will never repeat for long.

As always, I will be delighted to learn of any improvements that readers make in this musical program. The best way to test ideas for musical pattern generation is to run them as non-timeshared BASIC programs. Then they're easily modified and debugged, and if they sound good, they can be coded in assembly language. In Tiny Timesharing Music as presently written, it's easy to change the tempo of the notes: just POKE 881,X where X is the length of the notes in units of \( \frac{1}{10} \) second (values of X between 4 and 16 seem to work best). The contents of memory location 918 govern the changes between one voice and the next: the number there (and in location 922) may be changed to vary the sequence of bit patterns used. The table of musical intervals in locations 993-1000 can be varied according to taste, as can the table of notes (1000-1023; note that one table entry is in common, to save space). I use a digital approximation to a well-tempered scale, but you may prefer another choice.

References
3. BYTE magazine, September 1977. Several interesting and useful articles, especially one by Hal Chamberlin, page 62.
7. Kinnard, J. R. "Generating square waves with the PET," PET User Notes, Volume 1, Number 3. Published by Gene Beals, POB 371, Montgomeryville PA 18936.
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Tens of thousands of satisfied customers have purchased this volume. It is one of our three most popular volumes and has been for the last four years. While containing only eight programs with an average program length of 12K Bytes they have proven to be real winners! The Billing, Inventory and Payroll programs are designed to be used with non-disk computer systems and just as most such systems can be upgraded to disk operating, modification details are already included in this volume so that at the same time you upgrade your system you may convert these programs for disk usage. Sold for $1500 each, nationally, for several years before inclusion in our software library, these programs will print paychecks, customer bills, mailing labels, tabulated reports and allow over a dozen different modes of operation. To assist the businessman in making some costly decisions we have some very special programs that will help — schedule shipments of goods based on different demands, assign resources and people power efficiently; based on your priorities, analyze the risk factors for certain capital investments, compute the intrinsic value of stocks and lastly to compute the effects on bond yields when planning a switch. All of the programs contained in this volume are modular in structure (comprised of subroutines for each main function) allowing you to use the subroutines separately or to link them together to generate more highly specialized programs.

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Almost every single program included in these volumes will run in every Computer system that operates in Basic. A few changes may be required for some Basics but most of these changes are covered in one of the Tables and Appendices included in Volumes III, V, VI, VIII, and X.

Volume VI — Disk programs are compatible with TRS-80 disk basic. The disk programs in Volumes VI, VII and X are written in (CP/M) M Basic and Disk Extended Microsoft Basic. Other programs written in 8K Basic.

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Converting Pitch to Frequency

Robert Katz, 248 E 90th St, #3B, New York NY 10028

This program converts pitch to frequency and can use either the piano tuner’s scale (based on a perfect fifth interval), or the scientific, or “just,” scale (based on a perfect octave interval). The scales are equally tempered in either case.

The program is written in RPN (reverse Polish notation) for a Hewlett-Packard calculator. Step 8 includes a GTO instruction. If your calculator has labels instead of step numbers, use a label at steps 8, 10, 32, and 35.

To use the program, place a number from 1 to 7 in the x register. This represents one of the notes from C to B in the 12-note scale. To indicate the standard “whole” tones, use a whole number (such as 1 for C, 6 for A, etc). To indicate an accidental, use an integer plus 0.5 (6.5 for A#, 2.5 for D#). If the tones are to be in the octave of middle C, make sure a 0 is contained in the y register. Otherwise, the number in the y register should be an integer representing the number of octaves above or below middle C. For example, 5.5, -2 represents G#, two octaves below the octave of middle C. Once the pitch has been entered, all you have to do is press R/S. For example, enter (6, 0) and press R/S. This will display 440, which is the pitch of A in the octave of middle C.

The formula is:

\[ 261.25 \times \left( \frac{2}{\sqrt[12]{2}} \right)^{p+1/2} \]

Listing 1: A program to convert pitch to frequency. This listing is in the RPN (reverse Polish notation) for a Hewlett-Packard calculator. If your calculator uses labels instead of step numbers, a label must be used at steps 8, 10, 32, and 35. In a calculator with continuous memory, steps 15 thru 21 and steps 24 thru 29 can be replaced with a constant recalled from memory.

1. \( \text{fix } 0 \)
2. \( 1 \)
3. \( - \)
4. \( 2 \)
5. \( \times \)
6. \( 5 \)
7. \( \text{int } y \)
8. \( \text{GTO } 32 \)
9. \( i \)
10. \( x-y \)
11. \( 1 \)
12. \( 2 \)
13. \( \times \)
14. \( + \)
15. \( 1 \)
16. \( \ldots \)
17. \( 5 \)
18. \( \text{ENTER} \)
19. \( 7 \)
20. \( \text{g } 1/\text{x} \)
21. \( \text{g } y\)'
22. \( x-y \)
23. \( \text{g } y\)'
24. \( 2 \)
25. \( 6 \)
26. \( 1 \)
27. \( \ldots \)
28. \( 2 \)
29. \( 5 \)
30. \( \times \)
31. \( \text{GTO } 00 \) (or \( \text{g } \text{RTN} \))
32. \( 1 \)
33. \( \ldots \)
34. \( \ldots \)
35. \( \text{GTO } 10 \)

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Intel has adopted CIS COBOL and offers it (as iCIS-COBOL) for their Intellect and Intellec II systems. Ideal for OEM's or private label, CIS COBOL was developed entirely by Micro Focus. Send inquiries for CIS COBOL object packs and application vendor terms to MICRO FOCUS or its licensed distributors. Distributor terms also available from MICRO FOCUS.

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where \( P_1 \) is a power within the octave of middle C. \( P_2 \) is a power that will reach any octave above or below middle C. Steps 15 thru 21 compute the seventh root of \( \sqrt[3]{2} \), which is the relationship of a semitone within the piano-tuner's scale, based on perfect fifths and stretched octaves. Replace steps 15 thru 21 with the twelfth root of 2 and you will have the standard, perfect octave scale. When using the perfect octave scale, you may have to change steps 24 thru 29 to 261.63 to obtain an A 440. Steps 24 thru 29 are the frequency of middle C, on which the program is based. Note also that steps 32 thru 35 are a correction factor based on the half step between E and F in the scale.

**NSF Awards Education Grant**

The NSF (National Science Foundation) has awarded Educational Solutions Inc a grant for the development of courseware that will demonstrate new ways to teach numeration, addition, and subtraction. The New York City-based research and development organization's approach stresses learning through insight and practice rather than rote memorization. Feedback from the instructor helps guide and refine the student's growing insight. According to Educational Solutions's hypothesis, perceptual activities, feedback, and practice eventually teach the student practical skills.

Under the provisions of the grant, Educational Solutions must first produce a prototype of the courseware, then test it on public school students. After analysis, the courseware will be revised and prepared for distribution.

**OSU's TABS Project**

The College of Education at OSU (Ohio State University) is busily at work on project T ABS. The purpose of this project is to develop and disseminate curricular materials in which high technologies are used to teach basic mathematical skills such as problem solving, estimation, and computer literacy. Funded by the US Department of Education, project T ABS's goal is to collect and evaluate existing educational software for microcomputers and select the highest quality programs for distribution. The programs are to be field tested and distributed nationally.

Individuals or groups who have developed mathematics software for the upper elementary-school level are invited to submit their work for possible inclusion in the project. To have materials considered, send a cassette tape or floppy disk with a printout, machine documentation, and any related information to Dr Suzanne K Damarin, TABS Project, Arps Hall 202-A, 1945 N High St, Columbus OH 43210, (614) 422-1257.
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Software Review

Infinite BASIC and Infinite Business

Scott Mitchell, 346 S Taylor St, Manchester NH 03103

Infinite BASIC is a software-utility package for the Radio Shack TRS-80 sold by Racet Computes. The package has a suggested retail price of $49.95, with an optional Infinite Business package available for $29.95.

The purpose of these packages is to add extra commands to either your disk BASIC or Level II cassette system. Infinite BASIC adds eighty commands to your BASIC vocabulary, so if you thought the Level III add-on for your cassette system was a good deal, you'll consider this a steal for the same price. Level III BASIC (from Microsoft Consumer Products, Bellevue, Washington) always consumes 4 K bytes of memory, even if you use only one or two of its features in your program. Infinite BASIC lets you take only the features you want and put them on a system tape or disk file, thereby saving memory space. Also, you can place the resulting object code in memory anywhere you wish. These two features make Infinite BASIC a versatile package for both disk and tape users.

Infinite BASIC—Matrix and Strings
Infinite BASIC is the foundation of the program set.

At a Glance

<table>
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<tr>
<th>Name</th>
<th>Infinite BASIC and Infinite Business</th>
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<tbody>
<tr>
<td>Type</td>
<td>BASIC extension software system with independent application modules</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>Racet Computes</td>
</tr>
<tr>
<td></td>
<td>702 Palmdale</td>
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<tr>
<td></td>
<td>Orange CA 92665</td>
</tr>
<tr>
<td></td>
<td>(714) 637-5016</td>
</tr>
<tr>
<td>Price</td>
<td>Infinite BASIC: $49 95; Infinite Business: $29 95</td>
</tr>
<tr>
<td>Format</td>
<td>5-inch floppy disk or tape cassette</td>
</tr>
</tbody>
</table>

Language: Z80 machine language

Computer: Radio Shack TRS-80 with either disk BASIC or Level II cassette system

Documentation: Printed booklets 14 by 22 cm (5½ by 8½ inches); for Infinite BASIC, two booklets totaling 84 pages; for Infinite Business, one booklet with 21 pages

Audience: Business, game, and general programmers

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listing 1: Sample string-manipulation program and run. Note that the commands are small and compact. The program initializes string AS, performs a function on it, and prints it out. After each printout of the modified string, AS is reset to its original contents and the next operation is performed. With each command that modifies AS, the modified string is stored in JS. However, it could simply be put back into AS. The program runs quite fast.

10 CLS
11 GOSUB 1000
12 PRINT:PRINT"A$ =";:PRINT A$;:PRINT")"
20 J$ = &SLR$(A$,6);' LEFT ROTATION COMMAND
30 PRINT"LEFT ROTATE BY 6 = ("; :PRINT J$; :PRINT")"
40 GOSUB 1000
50 PRINT"RIGHT ROTATE BY 6 = (":PRINT J$; :PRINT")"
60 GOSUB 1000
70 JS = &SLR$(A$, 6):' LEFT JUSTIFICATION COMMAND
80 PRINT"LEFT JUSTIFIED = (":PRINT J$; :PRINT")"
90 GOSUB 1000
100 JS = &SRR$(A$, 6):' RIGHT JUSTIFICATION COMMAND
110 PRINT"RIGHT JUSTIFIED = (":PRINT J$; :PRINT")"
120 GOSUB 1000
130 JS = &SLT$(A$, 6):' LEFT TRUNCATION COMMAND
140 PRINT"LEFT TRUNCATED = (":PRINT J$; :PRINT")"
150 GOSUB 1000
160 JS = &SRT$(A$, 6):' RIGHT TRUNCATION COMMAND
170 PRINT"RIGHT TRUNCATED = (":PRINT J$; :PRINT")"
180 GOSUB 1000
190 JS = &SLT$(A$, 4):' LEFT SHIFTING COMMAND
200 PRINT"LEFT SHIFTED BY 4 = (":PRINT J$; :PRINT")"
210 GOSUB 1000
220 JS = &SRT$(A$, 6):' RIGHT SHIFTING COMMAND
230 PRINT"RIGHT SHIFTED BY 6 = (":PRINT J$; :PRINT")"
240 GOT0 240
1000 A$ = " ABCD EF"
1010 RETURN
9999 END

RUN
A$=( ABCD EF )
LEFT ROTATE BY 6 = (D EF ABC)
RIGHT ROTATE BY 6 = ( EF ABCD)
LEFT JUSTIFIED = ( ABCD EF)
RIGHT JUSTIFIED = ( ABCD EF)
LEFT TRUNCATED = ( ABCD EF)
RIGHT TRUNCATED = ( ABCD EF)
LEFT SHIFTED BY 4 = (BCD EF) RIGHT SHIFTED BY 6 = ( ABCD )

Listing 2: Program and run showing the packed-decimal mathematics function. The numbers must be saved into strings, then converted into packed decimal by the proper command. One may initialize precision up to 500 places; however, the more places you specify, the slower the operation will become. When the answer arrives, it is converted back to a string for printing or further normal mathematics functions. The precision of the exponent printed out in the answer is also initialized to either 10^-44 to 10^-63 or 10^-3116 to 10^-3156.

10 CLS:DEFINTC
20 CLEAR2000
30 NS = "1": XS = "3994949"
40 J = &BPRC(120,2):'SETS UP 120 DECIMAL PLACES PRECISION
50 ' + OR = 32767 EXPOI'N RANGE
60 NS = &BCP$(NS, X$: X$: &BCP$(XS, NC):CONVERTS XS + NS PACKED DECIMAL
70 AS = &BDPS$(NS, XS):' DIVIDES AS BY XS PACKED DECIMAL
80 NS = &BPCS$(AS):'CONVERT ANSWER TO PRINT
90 PRINT1/3994949 = ";:PRINTNS$: PRINTS ANSWER
99 END

RUN
1/3994949 = 2.503160866384026429373691629104651899185697385999929059899999990116822647640-00007
Threaded languages (such as FORTH) are an exciting new class of languages. They are compact and fast, giving the speed of assembly language with the programming ease of BASIC, and combine features found in no other programming languages. An increasing number of people are using them, but few know much about how they work. Is a threaded language interpreted or compiled? How much memory overhead does it require? Just what is an "inner interpreter?"

Threaded Interpretive Languages, by R. G. Loeliger, concentrates on the development of an interactive, extensible language with specific routines for the ZILOG Z80 microprocessor. With the core interpreter, assembler, and data type defining words covered in the text, it is possible to design and implement programs for almost any application imaginable. Since the language itself is highly segmented into very short routines, it is easy to design equivalent routines for different processors and produce an equivalent threaded interpretive language for other development systems. If you are interested in learning how to write better FORTH programs or you want to design your own powerful, but low-cost, threaded language specific to your needs, this book is for you.
The extra commands available handle functions that, if done as a routine in standard BASIC, would take up to fifty times longer. The commands provide capabilities for matrix and string manipulation, graphics, and data compression.

There are twenty-three commands in the matrix category. Some of the many functions that they speed up are copying, scaling, solving simultaneous linear equations, matrix inversion, and operations on a matrix from constants or another matrix.

The speed of these commands is far superior to conventional BASIC. For instance, if you want to invert a 10 by 10 matrix, the command is \( J = \text{&MINV}(A,B,C) \), where \( A \) is the matrix to be inverted, \( B \) is the array where the inverted matrix is to be stored, and \( C \) is the size of the matrix to be inverted (default is the dimension of \( A \)). \( J \) is the return argument. \( J \) is 0 if a solution is found and -1 if not. The command \( A = \text{&MINV}(A,B,3) \) is certainly much faster to execute and requires less syntax than standard BASIC commands. For another example, suppose you want to multiply matrix \( A \) by matrix \( B \). This is performed by the simple statement \( J = \text{&MELM}(A,B) \). All matrix commands are of similar format, execution time, and simplicity.

There are fourteen string-compression routines, which are extremely useful for compressing data for increased storage efficiency. However, you must know the type of data with which you are dealing and exactly what you intend to do to the data in the program. You can compress or expand in 4-, 5-, 6-, or 7-bit formats. You can use this in random-file formats but not in sequential files (since some control characters may be in the data). You can also convert data to lowercase or uppercase and remove multiple characters.

There are fourteen string-manipulation commands provided, and they handle left and right character shifting and rotating, justifying, and truncating. You can also invert a string, sort a string (multiple-key sort), delete a substring, pack string text, and more. (See listing 1, page 98, for an example.)

The graphic commands allow drawing and erasing lines between any two coordinate points. Four commands allow scrolling of the screen up, down, left, or right. There is no wraparound feature, so scrolling up and down will result in a loss of what was at the top or bottom of the screen. These commands can best be used to improve screen presentation of data, and fast execution means little time is lost.

Other available commands include the writing of matrix data onto tape and the transfer of string and variable arguments to a subroutine in the program and back again. There are decimal-to-hexadecimal conversion commands.

**Infinite Business**

Infinite Business is an add-on package giving twenty commands that, among other things, control a printer, provide multiple-precision mathematics, search string arrays for matching elements, and provide hash number generation. (The package needs Infinite BASIC before it will work.)
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Conclusions
- In checking over these packages, I saw two problems. In trying to assemble an Infinite BASIC module for use in low memory on tape, I set an upper limit of hexadecimal 7FFF and the assembler bombed out. I assume this is a result of the assembler placing its code in the same memory that I had specified during the assembly process, thus clobbering the disk operating system. It is unfortunate that the assembler cannot make the object modules in high memory and save them on tape or disk. If this were so, the object modules could then be loaded into the memory locations the user specified. As it is, the assembler will save the object code to tape, but saving to disk requires typing in a cumbersome dump command. The assembler gives everything needed to type for this dump, but it would be much easier if the user did not have to intervene (and if the disk operating system clobbering were eliminated).
- The second problem is that the setting of memory size is difficult for those BASIC programmers who are not especially familiar with machine language. The Infinite BASIC documentation spends little time with examples of how to do this with user-created object modules.
- The Infinite BASIC documentation is about as difficult to understand as the Radio Shack Level II manual. There are three manuals. Two are for Infinite BASIC—one being a general description with lots of examples, the other a definition of the command formats. The Infinite Business manual has both of these elements incorporated into one volume. All the information is there, but there are not enough examples to cover every case, so the result may be that the 100 available commands will be hard for the less experienced programmer to understand. As the command statements are fairly involved, frequent references to the manuals are necessary.
- These packages would be of great help to the more skilled business, game, and general programmer who could best understand and make use of the available power. However, in comparing these to other similar packages, almost anyone would find enough of the 100 commands useful to make it worth the price.
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The Micromodem II data communications system and the Apple II* computer. What better combination to maximize the capabilities of your personal computer!

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**Not 1985. NOW!**
A Pascal Library Unit for the Micromodem II

Thomas H Woteki
814 D Street NE
Washington DC 20002
(MicroNet 70220,165)

The Micromodem

The Hayes Microcomputer Products Micromodem II is a powerful combination of hardware and firmware that facilitates computer-to-computer communication. The onboard ROM (read-only memory) contains programs for originating and answering calls (including dialing the telephone) and an ACIA (asynchronous communications interface adapter) device for parallel-to-serial conversion. In addition, the accompanying owner's manual provides a wealth of information on how to custom program the modem for such applications as repertoire dialing, modifying hardware defaults, and dumb terminal communications. All of the examples given are in BASIC.

At the time I purchased a Micromodem for my Apple II computer, Pascal software for driving it was not available. In fact, certain parts of the modem's firmware refer to locations and routines used by the old Apple monitor; these routines are accessible from BASIC but don't exist under Pascal. Having forsaken BASIC and being faced with the modem as my only non-Pascal application, I was determined to develop a suitable library of Pascal programs. With a little help from the friendly folks at Hayes Microcomputer Products (who are about to release their own Pascal software), and through close study of the manual, I was able to do just that.

The Library Unit

The routines are housed in an intrinsic unit dubbed "micromodem" (see listing 1). Library units are a UCSD addition to Pascal; commonly used routines can be stored in a library unit that can be called by any Pascal program. Intrinsic units have the advantage that the object code of the unit is never entered into the code file of the host program, thereby maximizing disk storage space. A slight disadvantage is that the library containing the unit must be on-line (available for access) whenever the host program is executed. I have the unit stored in my system library on the boot disk.

Our interface block begins with the declaration of several constants which correspond to the addresses of certain locations in the modem's ROM and the Apple's memory. The constants are appropriate to having the modem card in slot 2 on the Apple's motherboard. This is the set-up expected by the Apple's low-level I/O (input/output) drivers, the BASIC I/O Subsystem, or BIOS. If you wish to install the card in another slot you will have to modify the addresses and the BIOS accordingly.

The values "acia" and "modem" are the addresses of the ACIA and the modem control and status words, respectively. Both of these registers (actually pairs of registers) have the property that what is written to them (the control word) is not what may be read from them (the status word). Since it is important to know what was last written as the modem control word, a copy of this data is stored in location "modemcopy" in a portion of the Apple's memory.

The value "keybde" is the address of the Apple's keyboard, and "datain" is the address where characters received by the modem can be found. The value for "outa" is the address of a routine in the modem's firmware which transmits characters; this routine expects to find the characters in "dataout". Fortunately, the output routine does not reference any "old" monitor locations.

The constants "resetflag" and "selftest" correspond to two special bits in the modem control word. Setting bit 3 of the word puts the modem into the self-test mode, wherein the modem communicates with itself. Setting bit 4 prevents the ROM from automatically applying default settings to the ACIA.

About the Author: Thomas H Woteki has a PhD in statistics and is currently developing an interactive statistics package for the Apple II. His interests include applications programming in Pascal and systems development for the Apple II.
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VAR x:0..255; (x takes integer values from 0 to 255)

memory.addrs := acia; (point to location acia)

VAR md:mode; (md", that may assume the values "low" (corresponding to 110 bps [bits per second]) and "high" (300 bps), and "answer" and "originate" respectively. Following this is a set of declarations for boolean-valued functions that report on various aspects of ACIA and modem status. The integer-valued functions "aciatatus" and "modemstatus" return a complete status report. The interface block concludes with a series of procedure declarations for setting the ACIA and modem control words and for performing such chores as dialing the phone, waiting for the other system to turn on its carrier, and sending and receiving characters. Several of these routines call external procedures declared in the implementation block.

The implementation block begins with a set of declarations that facilitate direct-money accessing from Pascal. The declarations establish the type "freeunion", a variant record, and a variable ("memory") of that type. The variable has two names (it is a free union; see Peter Grogono's Programming in Pascal, listed in the references) and will be interpreted differently depending on the name used. When referred to as "memory.addrs" it will be treated as an integer, but when referred to as "memory.pntr" it will be treated as a pointer to an array of the type "word". Thus, both the location pointed to and its contents can be manipulated from Pascal as indicated in the following fragment:

VAR x:0..255; (x takes integer values from 0 to 255)

memory.addrs := acia; (point to location acia)

x := memory.pntr[0]; (read the

Listing 1: Library unit "micromodem" for Apple Pascal system. These routines can be called for use by any Pascal program, but they are intended to drive the Hayes Microcomputer Products Micromodem II.

Listing 1 continued on page 110

PROCEDURE initacia(word:INTEGER);
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Listing 1 continued:

PROCEDURE dial(number:STRING);
PROCEDURE waitforcarrier;
PROCEDURE hangup;
PROCEDURE setmodem(word:INTEGER);
PROCEDURE sendchar;
PROCEDURE delchar(VAR ch:CHAR);

IMPLEMENTATION

TYPE word=PACKED ARRAY[0..1] OF 0..255;
freeunion=RECORD CASE BOOLEAN OF
TRUE: (addrslINTEGER);
FALSE: (value:word);
END;
VAR memory:freeunion;

FUNCTION rinsins;
( Determine whether the phone is rinsins )
BEGIN
memory.addrsl=MODEM;
rinsinsl=memory.value[OJ<128;
END;

FUNCTION carrier;
( Test for presence of carrier )
BEGIN
memory.addrsl=acia;
carrierl=memory.value[OJ MOD 8<4;
END;

FUNCTION rcvrfull;
( Check if ACIA receiver register is full )
BEGIN
memory.addrsl=acia;
rcvrfull=ODD(memory.value[OJO);
END;

FUNCTION transempt;
( Check if ACIA transmitter register is empty )
BEGIN
memory.addrsl=acia;
transempt=ODD(memory.value[OJO DIV 2);
END;

FUNCTION aciaerror;
( Check for ACIA error )
BEGIN
memory.addrsl=acia;
aciaerrorl=memory.value[OJO<3;
END;

FUNCTION aciastatus;
( Determine ACIA status )
BEGIN
memory.addrsl=acia;
aciastatusl=memory.value[OJO;
END;

FUNCTION modemstatus;
( Determine last value written to modem )
BEGIN
memory.addrsl=modemcopy;
modemstatus=memory.value[OJO;
END;

Listing 1 continued on page 112

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* From Guangzhou, China to Norwich, England. From Banphai, Thailand to Pasadena, California. A proven record of performance and reliability in installations throughout the World makes the DISCOVERY MULTIPROCESSOR the international choice in multiuser microcomputer systems.

WORLD CLASS SOFTWARE

Our Distributed Processing Operating System, dpos/2*, resides in the Service Processor, establishing a CP/M environment for each user and managing access to the shared system resources. Multiuser facilities are provided for print spooling, for interprocessor communication and for private, public and shared-update files. Several processors can be employed concurrently by a single user via the enhanced batch submit facilities. And with DISCOVERY all CP/M compatible programs will execute without modification, thus protecting your software investment.

WORLD CLASS HARDWARE

The ACE 64K Distributed Processing single board Computer, the dpc-180* gives the DISCOVERY MULTIPROCESSOR its unique architecture. One DPC is dedicated to each user providing exclusive use of the onboard Z-80, 64K ram and serial I/O. Shared storage is provided by an expanded DPC used as the Service Processor. Additional users can be added at any time by simply inserting additional DPC's into the standard S-100 bus — up to 16 in a single chassis!

Whatever your requirements, Whatever your language. No matter how you say it — DISCOVERY is THE World Class Multiprocessor.

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Listing 1 continued:

PROCEDURE initacia;
( Initialize ACIA )
VAR dummy:INTEGER;
BEGIN
memory.addr:=acia;
memory.value[O]:=3;
memory.value[CO]:=word;
REPEAT dummy:=0 UNTIL NOT carrier;
END;

PROCEDURE newmodemvalue(newbits:INTEGER);
EXTERNAL;
( Logical or the value last written to location modem (stored in modemcopy)
with the argument, store the result
in modemcopy and write it to modem.)

PROCEDURE enabletransmit;
( Turn on the modem transmitter )
BEGIN
newmodemvalue(2);
END;

PROCEDURE setmode;
( Set the mode and baud rate )
BEGIN
newmodemvalue(4*ord(md)+ord(br));
END;

PROCEDURE pickup;
( Pick up the phone, wait for dial tone )
VAR dummy:wait:INTEGER;
BEGIN
newmodemvalue(128);
( wait for dial tone )
FOR wait:=0 TO 3000 DO dummy:=0;
END;

PROCEDURE dialit(number:STRING):EXTERNAL;
( Dial the indicated number, display the digits
as they are dialed )

PROCEDURE dial;
( Dial the indicated number )
BEGIN
WRITE('Dialing .. ',');
dialit(number);
writeln;
END;

PROCEDURE waitforcarrier;
( Wait for carrier after dialing )
VAR data,wait:INTEGER;
BEGIN
wait:=0;
WHILE NOT carrier AND (wait<10000) DO
BEGIN
wait:=wait;
memory.addr:=data:
data:=memory.value[CO];
END;
END;

PROCEDURE setmode;
( Write a new value to the modem
control word )

Listing 1 continued on page 114
Our New grafixPLUS™ 80-column printer opens wide for easy servicing.

Introducing the newest members of our grafixPLUS™ family—the DP-9000 Series 80/132 column printers—built on the same tradition of quality printout, solid design and low cost of ownership established by our 132/220 column DP-9500 Series.

A Case for Serviceability
Not that is comes up often, but want to get inside? Simple. Just remove a few screws and the clamshell case swings open exposing all major components. This easy access plus built-in self-test and minimum component count yields an MTTR of one-half hour. The 9-wire print head replacement’s even simpler...two screws and it’s out. Without opening the case. And without a service call.

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The DP-9000 Series prints the full ASCII 96 character set, including descenders and underlining, bi-directionally, at up to 200 CPS. Number of columns can go up to 80 or 132, depending on character density—switch or data source selectable from 10 to 16.7 characters per inch. And all characters can be printed double width. The print head produces razor-sharp characters and high-density graphics with dot resolutions of 72X75 dots/inch under direct data source control.

Interface Flexibility
The three ASCII compatible interfaces (parallel, RS-232-C and current loop) are standard, so connecting your computer is usually a matter of plug-in and print. Also standard are: a sophisticated communications interface for printer control and full point-to-point communications, DEC PROTOCOL, and a 700 character FIFO buffer. An additional 2K buffer is optional.

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CROSS-COMPIL
FORTH!

Nautilus Systems' Forth Cross-compiler is now in use by individuals, universities, and major companies around the world.

USES:
• To produce a modified or tailored version of Forth on a host computer.
• To produce Forth systems for computers that have none.
• To produce applications that use the minimum required nucleus code.
• To do all the above in a ROM/RAM environment.

FEATURES:
• Written entirely in high level fig-Forth.
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• Cross-compiles to any screen in the host for any base address in the target.
• Cross-compiles vocabularies.
• Can produce headerless code.
• Can produce runnable code.
• Load map that shows address, type of symbol and name. The map appears in readable column format, and page width and length are selectable.
• A comprehensive list of undefined symbols is produced showing undefined CPAs, DDBS, pointers, labels and words on a vocabulary-by-vocabulary basis.

MACHINE READABLE VERSIONS FOR THE FOLLOWING SYSTEMS:

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<thead>
<tr>
<th>HOST</th>
<th>TARGET</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRS-80</td>
<td>APPLE</td>
</tr>
<tr>
<td>NORTSTAR</td>
<td>CP/M</td>
</tr>
</tbody>
</table>

Each includes an executable version of fig-FORTH model 1.0. Cross-compiler, cross-compilable source, utilities, and documentation.

(This program is not intended for newcomers to FORTH)

Price $150.00 (Includes shipping). Calif. residents please add sales tax.

---

Listing 1 continued:

BEGIN
memory.addr=modemcopy;
memory.value[0]=0;
newmodevalue(word);
END;

PROCEDURE hansup;
( Hang up the phone, turn off the modem )
BEGIN
setmodem(0);
END;

PROCEDURE sendchar;
( Get a character from the keyboard, transfer it to the modem output location dataout, and transmit the character via the modem routine located at outa )
BEGIN
sendchar;
END;

FUNCTION stchar;CHAR;EXTERNAL;
( Fetch the character stored in the modem input location datain and send it to the screen. Pass the character as a function result.)
BEGIN
char=stchar;
END;

BEGIN
setmodem(resetflag);
END.

Listing 2: The assembly-language programs called in the implementation block of listing 1. These low-level utility routines are stored as part of a file called NATIVECODE in a library unit, and may be accessed from any Pascal program.

.....
.....
.....
.....

THESE ROUTINES ARE STORED IN THE SYSTEM LIBRARY:

POKE(VALUE,ADDRS:INTEGER);
PEEK(ADDRS:INTEGER):INTEGER;
CALL(ADDRS:INTEGER);
DIALIT(STRING:INTEGER);
NEWMODEVALUE(WORD:INTEGER);
SENDCHAR;
GETCHAR;

| THOMAS H. WOTEKI |
| LAST UPDATE MAY 1980 |

,MACRO POP
PLA
STA #1
PLA
STA #1+1

Listing 2 continued on page 116
Here is THE computer from NEC. Centronics and RS232 interfaces are standard. Up to 64 K (RAM). SEND FDR PRICE AND INFO., OR CALL TOLL FREE!

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Listing 2 continued:

ENDH

MACRO PUSn
LDA @N1
PHA
LDA @N2
PHA
END

GLOBAL EQUATES

PASCAL .EQU 00
PASCAL_II .EQU 01
BIDOS .EQU 0083
BIOSOUT .EQU 008B
CONCHECK .EQU 00681
VIDOUT .EQU 007E7

; PROC POKE, 12 PARAMETER WORDS
; PROCEDURE(VALUE, ADDR: INTEGER);
; EFFECT:
; VALUE IS STORED AT ADDR

ADDR .EQU 02
ADDRSHI .EQU 03
POP PASCAL

LDY $00 ; INITIALIZE Y-REG
POP ADDR ; SAVE ADDRESS ARGUMENT

PLA ; FLSB OF VALUE
STA @ADDR,Y ; STORE VALUE AT ADDR
PLA ; DISCARD MSB VALUE
PUSH PASCAL ; BACK TO PASCAL
RTS

; FUNCTION POKE(ADDR: INTEGER); INTEGER
; EFFECT:
; THE CONTENTS OF ADDR ARE RETURNED BY POKE

ADDR .EQU 02
ADDRSHI .EQU 03
POP PASCAL

PLA ; DISCARD 4 BYTES
PLA ; OF STACK BIAS
PLA ; ASSOCIATED WITH
PLA ; FUNCTIONS

POP ADDR ; SAVE ADDRESS TO POKE

Listing 2 continued on page 118
As a serious computer user you spend much of your time editing, whether it be for program development or word processing. Make the best use of your time with the help of VEDIT, an exceptionally fast and easy to use full screen editor. VEDIT is a highly refined and proven editor which is easy enough for novices to learn and use. Yet its unequalled set of features also makes it the choice of computer professionals. And because VEDIT is user customizable, it adapts to your keyboard, hardware, applications and preferences.

In VEDIT, the screen continuously displays the region of the file being edited, a status line and cursor. Changes are made by first moving the cursor to the text you wish to change. You can then overtype, insert any amount of new text or hit a function key. These changes are immediately reflected on the screen and become the changes to the file.

VEDIT has the features you need, including searching, file handling, text move and macros, plus it has many special features. Like an 'UNDO' key which undoes the changes you mistakenly made to a screen line. And a mode which allows a programmer to enter all text in lower case and let VEDIT convert the labels, opcodes and operands, but not the comments, to upper case. The screen writing is almost instantaneous on a memory mapped display or can use your CRT terminal's editing capabilities. Disk access is very fast too, and VEDIT uses less than 12K of memory. The extensive 70 page, clearly written manual has sections for both the beginning and experienced user.

**Totally User Customizable**

Included is a setup program which allows you to easily customize many parameters in VEDIT, including the keyboard layout for all cursor and function keys, screen size (up to 70 lines, 200 columns), default tab positions, scrolling methods and much more. This setup program requires no programming knowledge or 'patches', but simply prompts you to press a key or enter a parameter.

The CRT version supports all terminals by allowing you to select during setup which terminal VEDIT will run on. Features such as line insert and delete, reverse scroll and reverse video are used on 'smart' terminals. Special function keys on terminals such as the H19, Televideo 920C and IBM 3101, and keyboards producing 8 bit codes or escape sequences are also supported.

**New Features and Support**

The new release includes disk write error recovery, indent and undent keys for structured programming, and the ability to insert a specified line range of another file at the cursor position. Versions for MP/M\(^6\) and the Apple II\(^8\) SoftCard\(^8\) are now also available.

**Ordering**

Specify the CRT version, your video board or microcomputer, the 8080/Z80 or Z80 code version, and disk format required.

Standard Package: Disk and manual

Manual: Price refunded with software purchase

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OS-9™ MULTIPROGRAMMING OPERATING SYSTEM

A true multitasking, real time operating system for timesharing, software development, database, process control, and other general applications. This versatile OS runs on almost any 6809-based computer.

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- OS-9 Level Two $495*
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Extended BASIC language compiler/interpreter with integrated text editor and debug package. Runs standard BASIC programs or minimally-modified PASCAL programs.

- Permits multiple named program modules having local variables and identifiers. Modules are reentrant, position independent and ROMable.
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- Interactive Assembler
- Macro Text Editor
- Interactive Debugger

BASIC9 and OS-9 are trademarks of Microware® and Motorola. UNIX is a trademark of Bell Laboratories. Most software is available on ROM or diskette in versions for many popular 6809 computers. Contact Microware® for specific availability.

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Listing 2 continued on page 120
MULTIUSER

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Listing 2 continued:

; THE D.C. HAYES MICROMDEM II.
; THIS ROUTINE IS CALLED BY THE PROCEDURE
; DIAL(NUMBER;STRING)
; IN THE LIBRARY UNIT MICROMDEM.
; THIS ROUTINE ASSUMES THE MICROMDEM
; IS IN SLOT 2 ON THE MOTHER BOARD.
; IT SHARES "MODEMCOPY",
; WHICH CONTAINS A COPY OF THE MODEM
; CONTROL WORD, WITH THE LIBRARY UNIT.

;=========================================

MODEM .EQU 0COA5
MODEMCOPY,EQU 067A
WAIT61 .EQU 99
WAIT39 ,EQU 7A
LOCATION .EQU 02
LENGTH •.EQU 04
HANGUP ,EQU 06
PICKUP ,EQU 07

;SAVE THE PASCAL RETURN ADDRESS
POP PASCAL

;POP THE MEMORY ADDRESS OF THE
;TELEPHONE NUMBER
POP LOCATION

;INITIALIZE LOCATIONS HANGUP

;AND PICKUP FOR PROPER DIALING
LDA MODEMCOPY
AND #7F
STA HANGUP
LDA MODEMCOPY
ORA #80
STA PICKUP

;REMEMBER HOW MANY DIGITS IN
;THE TELEPHONE NUMBER
LDY #00
LDA LOCATION,Y
STA LENGTH

;INITIALIZE TO GET THE FIRST
;DIGIT
LDY #01

NXTDIGIT TYA
PHA ;SAVE DIGIT NUMBER ON STACK
LDA BIOSIN ;SWITCH TO BIOS
LDA LOCATION,Y ;DISPLAY DIGIT
JSR VIDOUT ;ON CONSOLE

LDA BIOSOUT ;BACK TO PASCAL
PLA ;RECOVER DIGIT NUMBER

TAY
LDA LOCATION,Y ;GET DIGIT AGAIN

;CONVERT DIGIT FROM CHARACTER FORM
SEC
SBC #30
BNE START

LDA #OA ;IN CASE DIGIT IS 0

START ;INITIALIZE X TO COUNT PULSES
TAX

PULSE
LDA HANGUP
STA MODEM
LDA #WAIT61
JSR WAIT
LDA PICKUP
STA MODEM
LDA #WAIT39
JSR WAIT
DEX

BNE PULSE

;WHEN DONE WITH A DIGIT CHECK
;TO SEE IF DONE WITH NUMBER

CPY LENGTH
BEQ DONE

;IF NOT, WAIT A WHILE THEN GET
;THE NEXT DIGIT
JSR LONGWAIT
INY

BPL NXTDIGIT

DONE

PUSH PASCAL
RTS

LONGWAIT LDX #05
AGAIN LDA #OFF
JSR WAIT
DEX
BNE AGAIN
RTS

Listing 2 continued on page 122
WHY GROWING CONCERNS PICK OUr FLOPPY BASED SYSTEMS

Growing concerns require fresh ideas. Ideas that stimulate growth. Ideas that manage growth. Ideas that are designed to grow with the business.

Altos Computer Systems, a world leader in single board microcomputer technology, cultivates these ideas and delivers them in an attractive assortment of economical floppy disk based systems.

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All Altos systems are packaged with the most select features, such as the single board Z80A* CPU, quality Shugart drives, and optional DMA and floating point processors. And every Altos system must endure extensive reliability testing including 48 hours of in-process burn-ins.

Altos supports three industry standard operating systems: single/multi-user CP/M, **OASIS† and Altos' proprietary AMEX.† Seven high level programming languages are offered which are CP/M or AMEX compatible.

Pick Altos.

For specific details about pricing or performance, call or write: Altos Computer Systems, 2360 Bering Drive, San Jose, CA, 95131, (408) 946-6700, Telex 171562 ALTOS SNJ.

*Z80A is a registered trademark of Zilog, Inc. **CP/M is a registered trademark of Digital Research, Inc. †OASIS is a registered trademark of Phase One Systems, Inc. © 1980 Altos Computer Systems.

Circle 76 on inquiry card.
### Listing 2 continued:

```
WAIT SEC
WAIT2 PHA
WAIT3 SBC #01
   BNE WAIT3
   PLA
   SBC #01
   BNE WAIT2
   RTS

;=========================================;

.PROC NEWMODEMVALUE

A PROCEDURE TO CHANGE THE CONTENTS OF LOCATION $067A WHICH IS THE SLOT 2 LOCATION OF THE "MICROMODEM CONTROL WORD. THIS IS A ROUTINE WRITTEN ESPECIALLY FOR USE BY THE LIBRARY UNIT MICRODEM.

THE ROUTINE LOGICALLY ORS ITS ARGUMENT WITH THE CONTENTS OF MODEMCOPY, $067A, SAVES THE RESULT IN MODEMCDPY AND WRITES IT TO MODEM, $0CA5.

MODEMCOPY .EQU $067A
MODEM .EQU $0CA5

; Pull the value of the new
POP PASCAL

;=========================================

.PROC SNDCHAR

A PROCEDURE TO OUTPUT ONE CHARACTER THROUGH THE MICROMODEM LOCATED IN SLOT 2.

THE ROUTINE IS CALLED FROM THE LIBRARY UNIT MICRODEM.

;------------------------------------------

; Bits to be set and update
; MODEM
   PLA
   ORA MODEMCDPY
   STA MODEMCDPY
   STA MODEM

   PLA
   IDISCARD MSB OF NEWBITS

; Back to PASCAL
   PUSH PASCAL
   RTS

;==========================================

.FUNC GTCHAR

A ROUTINE TO GET ONE CHARACTER FROM THE MICROMODEM DATA INPUT LOCATION DATAIN, THE ROUTINE ASSUMES THE RECEIVER REGISTER IS FULL.

AFTER FETCHING THE CHARACTER THE ROUTINE OUTPUTS IT TO THE CONSOLE SCREEN AND RETURNS THE VALUE TO THE CALLING PROGRAM AS A FUNCTION RESULT.

 THIS ROUTINE IS PART OF THE LIBRARY UNIT MICRODEM.

;------------------------------------------

DATAIN .EQU $0CA7

POP PASCAL
```

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</thead>
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<td>$122</td>
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<td>$181</td>
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<td></td>
<td>$295</td>
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<td>$147</td>
<td>$96</td>
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</tbody>
</table>

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status of the ACIA.

memory.pntr[0] = x; (write the ACIA control word)

This technique is used in the code for several of the listed routines. Implementation of the technique may be machine dependent. The alternative is to link externally assembled machine-language programs to perform the work of BASIC's PEEK and POKE. Such programs are illustrated below.

The procedure "initacia" performs initialization of the ACIA by setting it up for characters of the length specified by the parameter value. It then waits for a no-carrier-detected signal before returning.

Several of the procedures call the external procedure "newmodem-value" which is used to set selected bits in the modem control word to logical 1 without affecting the status of any other bits. By contrast, "setmodem" sets all bits (except the selected ones) to logical 0.

Procedure "waitforcarrier" waits a period of time to detect a carrier after dialing the phone. Unloading the location "datain" in the WHILE...DO loop is necessary to satisfy the ACIA, as suggested on pages 38 and 39 of the owner's manual.

The procedures "sendchar" and "getchar" are Pascal hosts for calling the external procedures "sndchar" and "gtchar" which are the workhorses for simple modem I/O. "Getchar" passes the character it gets to the calling program via the variable parameter "ch" in case the user wishes to process "ch" further (say, by sending it to the system printer). I have done this to retain printed copy of terminal sessions.

The statement "setmodem (resetflag);" in the body of the unit will be executed as an initialization step when the host program is executed. Setting the reset flag informs the ACIA that default initializations are not to be applied when the ACIA is first called for input or output.

The External Procedures
The assembly-language programs called in the implementation block of the unit (see listing 2) are part of a file called NATIVECODE. I have stored these and other low-level utility routines, such as the PEEK and POKE routines, in a library unit. Therefore they can be called from any of my

Listing 2 continued:

```
PLA IDISCARD 4 BYTES OF FUNCTION
PLA ITION BIAS
PLA PLA
LDA BIOSIN
JSR CONCHECK
GET CHARACTER AND
JMP PUSH FUNCTION RESULT
LDA $00
PHA
LDA DATAIN
PHA
JSR OUTPUT TO CONSOLE
JSR VIDOUT
LDA BIDSOUT
PUSH PASCAL
RTS
.END
```

Listing 3 continued on page 126

Listing 3: The Pascal program called "fullduplex". This program makes use of the compiled code of the unit, linked with the assembled code of NATIVECODE.

```
PROGRAM fullduplex;
USES micromodemi
FUNCTION peek(location:INTEGER):INTEGER;EXTERNAL;
PROCEDURE dialup;
VAR number:STRING;
word:INTEGER;
PROCEDURE selmodem(var word:INTEGER);BEGIN
REPEAT
page(output);
solow(0,3);
writeln(Select the ACIA control word:);
writeln('CHAR PARITY STOP CONTROL:');
writeln('LENGTH BIT BITS WORD :');
writeln('---- ---------------');
writeln('7 EVEN 2 1');
writeln('7 ODD 2 5');
writeln('7 EVEN 1 9');
writeln('7 ODD 1 13');
writeln('8 NONE 2 17');
writeln('8 NONE 1 21');
writeln('8 EVEN 1 25');
writeln('8 ODD 1 29');
writeln('ACIA control word --> ');
readln(word);
UNTIL word IN [1,5,9,13,17,21,25,29];
END ( selmodem )
BEGIN ( dialup )
setmodem(resetflag);
.END
```

Listing 3 continued on page 126
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Pascal programs. As mentioned above, when appropriate, POKE and PEEK can be substituted whenever the variable "memory" is used to address memory.

When a call-by-value is made to an external procedure using scalar parameters, the Pascal interpreter places the values of the parameters on the stack in reverse order of declaration in the procedure, followed by the Pascal return address. External functions have 4 additional bytes added to the stack before the Pascal address. When a call-by-variable (or a call-by-value using nonscalar parameters) is made, a pointer to the variable is loaded on the stack. The difference in these calls is illustrated in the definitions of POKE, PEEK, and DIALIT.

The declarations for NATIVECODE start with the definitions for two macros and several global equates; these declarations are available to all the routines in the file. One macro pops (removes) 2 bytes from the stack (this implementation of Pascal is 2-bytes-per-word oriented) and saves them in successive locations specified by the parameters in the call; the other macro reverses this.

The global equates BIOSIN and BIOSOUT establish the addresses of two soft switches for gaining access to the Apple's BIOS. One reference to BIOSIN switches it into programmable memory while two successive references enable writing to the BIOS section of memory; a reference to BIOSOUT switches the BIOS out and the Pascal interpreter in. The declaration for CONCHECK establishes it as the starting address in the BIOS for the routine that polls the Apple's keyboard. VIDOUT is the address of the routine for displaying characters on the video monitor.

The procedure DIALIT illustrates call-by-value with a nonscalar value: a pointer to the number to be dialed is passed to the program. After storing the pointer, the routine prepares to dial by setting the temporary locations HANGUP and PICKUP and finding the length of the number. Dialing is accomplished by alternating the phone between the onhook and offhook states. (We assume the phone is off the hook when the routine is called.) The recommended dialing protocol is 61 ms onhook followed by 39 ms offhook with an interdigit delay of at least 600 ms.

The procedure SNDCHAR is used

Listing 3 continued:

```plaintext
begin
  page(output);
  dooutput(0,5);
  writeln('Enter the phone number.');
  writeln;
  write(' --> ');
  readln(number);
  setaciactrl(word);
  page(output);
  dooutput(0,5);
  writeln('Preparing to dial, please wait...');
  initaciactrl(word);
  pickup;
  setmodel(terminate,high);
  writeln('OK');
  dial(number);
  writeln('Waiting for carrier...');
  waitforcarrier;
end;

procedure terminal;
var ch: char;
error: integer;
begin
  page(output);
  dooutput(0,5);
  writeln('Carrier OK. Begin communications.');
  enabletransmit;
  repeat
    if aciaerror
    then if not carrier
        then begin
            hangup;
            unitclear(1);
            exit(terminal);
        end
    else begin
      writeln('t');
      error:=peek(datain);
    end
    else
      if rcvfull
        then setchar(ch)
      else sendchar;
  until not carrier;
end;

function trysagain:boolean;
var answer: char;
begin
  repeat
    page(output);
    dooutput(0,5);
    writeln('No carrier. Try again? (Y/N) ->
    read(answer);
    writeln;
    trysagain:=answer in ['Y','y']
  until answer in ['Y','y','N','n'];
end;

begin ( fullduplex )
  repeat
    dialup;
    if carrier
        then terminal;
    until not trysagain;
    hangup;
  end;
```
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to transmit characters through the modem. It does not check to see if the ACIA transmitter register is empty; this should be done in the calling program using "transempty". Location CONBUF is the start address for the BIOS's console keyboard buffer, and WPTR and RPRTR indicate the number of characters written to and read from the buffer. BUMP is the address of a routine that updates these numbers.

SNDCHAR first polls the console keyboard. If there is a character in the buffer, it loads it into DATAOUT, then calls the output routine on the modem. At the end of all this, the address for returning to Pascal is still on the top of the stack, so an RTS (return from subroutine) instruction transfers control to the calling program.

In GTCHAR, VIDOUT is the address of the BIOS routine for sending characters to the video monitor. GTCHAR (analogous to SNDCHAR) assumes the ACIA's receiver register is full, a condition that should be checked in the calling program. The routine starts by saving the Pascal return address, discarding 4 bytes of stack bias, and polling the Apple's keyboard. It then fetches the character from the input location DATAIN, pushes it on the stack as the function result, and jumps to VIDOUT to display the character.

Using the Unit

At this point, we need only compile the unit, assemble the file NATIVECODE, link the two, and store the resulting final code in a library in order to use the unit. The program "fullduplex" (see listing 3) illustrates the use of the unit. The program also makes a call to the external function PEEK.

The main body of "fullduplex" and the procedure "dialup" are self-documenting. As for "terminal", the procedure continues sending and receiving characters until an ACIA error is found. If the error is the lack of a carrier, the program hangs up the phone, clears the keyboard buffer of any junk, and exits "terminal" to "tryagain". If any other error is encountered, the character "#" is written to the video display and the receiver register is emptied to clear the error condition. I have used this program to communicate with several time-sharing systems and it has no problem keeping up at 300 bps.

Modifying the Apple's BIOS

The procedures presented thus far are quite adequate for a variety of dumb terminal applications, but they are not particularly well suited to mass-data transfer applications such as transmitting preprocessed files or whole volumes. For the latter, we would like to make use of the repertoire of UCSD Pascal intrinsic procedures for processing files. The key to using these procedures is an understanding of the BIOS (basic input/output system).

Each implementation of UCSD Pascal, such as Apple's, requires an interpreter and a BIOS to support it. Roughly speaking, the interpreter translates p-code (the code emitted by the Pascal compiler) into machine language, and the BIOS handles the physical I/O to system devices. The BIOS modifications discussed below apply only to the Apple and may require revision if new versions of the BIOS are released. Hints on modifying another system's BIOS may perhaps be found in the *UCSD Pascal User's Manual* published by SofTech Microsystems. However, it is likely you will need a commented listing of your BIOS; I obtained a copy of the Apple BIOS from Apple in the form "The Preliminary Guide to Interfacing Foreign Hardware."

To fully explain the operation of the BIOS and the options the programmer has for modifying it we would require a great deal of discussion. Instead I will provide a summary of its operation and offer a set of modifications that have worked for me.

Whenever a call for input or output is made from a Pascal program, the interpreter formats the data and determines which device is being called. Following this, the BIOS is switched in and then determines how the device is interfaced with the system. As currently configured, the Apple's interpreter and BIOS can recognize four types of external

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Listing 4: External procedure that modifies Apple BIOS for use with the Micromodem II. This expands the Apple's utility beyond that of a dumb terminal, allowing mass transfer (and processing) of whole files via the Micromodem II.

```assembly
;--------------------------------------
;PROC SYSGEN
;--------------------------------------
BIOSIN .EQU OC083
BIOSOUT .EQU OC088
CONCHECK .EQU OB681
ACIA .EQU OC0A6
DATAOUT .EQU 0778
DATAIN .EQU OC0A7
MODEM .EQU OC0A5
OUTA .EQU OC202
ICOM .EQU OD7A3
RINIT .EQU OD79C
RWRITE .EQU OD809
WCOM .EQU OD81F
RREAD .EQU OD85D

LDA BIOSIN
LDA BIOSIN
LDY #00
XRINIT LDA PRG2,Y
STA RINIT,Y
INY
CPY #03
BCC XRINIT
LDY #00
XICOM LDA PRG3,Y
STA ICOM,Y
INY
CPY #0A
BCC XICOM
LDY #00
XRWRITE LDA PRG4,Y
STA RWRITE,Y
INY
CPY #06
BCC XRWRITE
LDY #00
XWCOM LDA PRG5,Y
STA WCOM,Y
INY
CPY #11
BCC XWCOM
LDY #00
XRREAD LDA PRG6,Y
STA RREAD,Y
INY
CPY #03
BCC XRREAD
```

Listing 4 continued on page 132
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BEGIN
smsgen;
call sty(0,5); writeln('Welcome to Dr. Wo's Apple Pascual!'); writeln('The system has just been modified to'); writeln('enable communications through the'); writeln('Micromodem II in slot 2.'); writeln('Please set the DATE using the Filer.'); END.

Listing 5: A program to test the Micromodem II system. The program prompts the operator, then puts the modem through its various modes of operation.

PROGRAM testmodem;
(This program tests the transmission and reception of the printing characters through the Micromodem II installed in slot 2 on the Apple's board. The program uses the Library Unit 'micromode' and custom I/O drivers installed as modifications in the Apple's BIOS.)

Listing 5 continued on page 134
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Listing 5 continued:

USES micromodem;

CONST lowchar=' ' ( blank )

hishchar='z';

VAR chout:char;

errorcount:integer;

m:array[mode] of string[10];

b:array[baudrate] of string [10];

rem:removal:interactive;

BEGIN ( main )

reset(rem,'remin');

rewrite(remout,'remout');

m[answer]="answer";

b[baudrate]="baudrate";

b[low]="low";

b[hish]="hish";

FOR m=answer TO originale DO

Beginning( m );

FOR b=low TO high DO

BEGIN

Write( output );

sotOMUX(0.5);

writeln('Testing '+m[mode]'+ '+b[br]);

write(remout);

writeln('Resetting modem and ACIA.?');

writeln('Please wait...');

setmode(modem=selftest resetflag); initacia(21);

pickup;

setmode( m, br );

writeln('OK');

writeln;

writeln('Please wait for carrier...');

enabletransmit;

writeln('waitforcarrier');

writeln('OK');

writeln;

writeln('Begin test...');

errorcount:=0;

FOR chout:=low TO hish DO

BEGIN

write(remout,chout);

read(remin,chin);

writeln('Please wait for carrier...');

enabletransmit;

writeln('waitforcarrier');

writeln('OK');

writeln;

writeln('Begin test...');

errorcount:=0;

FOR chout:=low TO hish DO

BEGIN

writeln( 'Total errors this test= 'errorcount);

writeln( 'Type (ret) to continue...');

readln;

END;

writeln;

writeln;

writeln( 'Type (ret) to continue...');

readln;

END;
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physical devices—consoles, printers, disks, and remote input/output devices (such as modems)—provided these devices are interfaced via an Apple-brand card. For nondisk I/O, the Apple's BIOS recognizes the Apple communications, serial, and parallel-printer cards. If a foreign card is plugged into a slot, the Apple will know that something is there, but will not know how to communicate with it unless the card's setup happens to coincide with one of the Apple cards. Such is the case for the Micromodem interface: the Apple thinks it is communicating with a remote device via an Apple communications card, but it can't do I/O because of an address mismatch. The solution is to insert the correct addresses.

The Apple's BIOS is set up to do three things with the modem: initialize it, read from it, and write to it. In each case, the BIOS receives control from the interpreter, jumps to a location reserved for the appropriate operation with the remote I/O device, determines which type of card it is dealing with, then jumps to a location reserved for that combination of card and operation. After completing I/O, it returns control to the interpreter. This combination of jumps was observed in my modifications. Since I have no Apple communications cards connected to my system, I customized the locations to suit the requirements of the Micromodem. These modifications are applied at system startup time via an external procedure SYSGEN hosted by the program "startup".

The procedure SYSGEN (see listing 4) first enables writing the BIOS. Then it modifies the routine located at RINIT so that a JMP to location ICOM is made. In the unmodified BIOS, RINIT is the name of a routine for initializing the remote device: it first determines what type of card is in slot 2; after finding a communications card it jumps to ICOM to initialize the card. Under these modifications, control is transferred to ICOM immediately. SYSGEN next modifies RWRITE, the "write-to-remote" routine, and WCOM, the "write-to-comm-card" routine. Similar to the unmodified initialization routines, the interpreter passes control to RWRITE, which determines the type of card occupying slot 2.

Upon finding a communications card, it transfers control to WCOM. SYSGEN closes with modifications to RREAD and RCOM.

One can implement the modifications, as I have, in a program that is executed each time the system is booted up. First assemble SYSGEN, then link it to a Pascal host "startup", and then store the final code in the file SYSTEM.STARTUP on the boot disk. The program will be executed automatically at boot time.

A Test Program

The program "testmodem" tests the modem and the BIOS modifications. It starts by opening the files "remm:" and "remout:" and associating them with the volumes "remm:" and "remout:" respectively. The latter are the names given to remote I/O devices under Apple UCSD Pascal. Following this procedure, the program sets up some strings to prompt the operator, and the nested FOR...DO loops put the modem through its various operating modes. When the statement "write (remout,chout);" is encountered, the interpreter determines that a call for output to slot 2 is being made. At this time control is transferred to the BIOS location RWRITE. In order for execution to proceed satisfactorily from there, the system must recognize the card in slot 2. The situation is similar for the statement "read (remm,chin);": Thus, the program serves as a test of the BIOS modifications as well as the modem.

Summary

The library unit "micromodem" and the BIOS modifications presented here are a complete package of building blocks for developing remote communications programs using the Micromodem running under the Apple implementation of UCSD Pascal. Techniques similar to those described here should enable operators of other systems to enjoy the same advantages.

References
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Photo 1: Finished version of the circuit shown in figure 1. This 4- by 6-inch board with 22-pin connectors has enough room for the circuitry of two tracks each on twin transports.

Technical Forum

Recording with Current Instead of Voltage

David Hein
2821 Chariot Lane
Garland TX 75042

Most of the articles I have seen on the theory of mass storage using cassettes begin with a discussion of how the magnetization of the tape depends on current flow, and how changing the head-drive current creates cells of different magnetization. During a read, it is normally assumed that the sharper the transitions between current and lack of current, the higher the output and the greater the density (or speed) that can be used.

Yet after all this discussion on current, head drive is most often performed by a voltage amplifier driven to saturation. Current devices should be driven with current rather than voltage.

The circuit I use for this is simple. It consists of two current drivers, some control gates for writing, an RS flip-flop for reading, and an amplifier with a gain of 200, capacitively coupled to a differential sense amplifier (see figure 1 on page 140).

Four channels along with voltage amplifiers easily fit on a two-sided, 4- by 6-inch card with standard 22-pin connectors (see photo 1). That's enough circuitry for two tracks each on twin transports.

My tape deck, which has digital (narrow-gap) heads is capable of 8 K bps (bits per second) at 5 ips (inches per second). My neighbor's standard cassette deck is capable of 2400 bps at 1½ ips.
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<td>S100 bus</td>
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<td>Dynamic RAM (std)</td>
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<td>32 Kb.</td>
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<td>No. of drives (std/max)</td>
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<td>Capacity per drive (on-line)</td>
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<td>180 Kb.</td>
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<td>No</td>
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Dynamic Memory: Making an Intelligent Decision

Mention the words dynamic memory to an S-100 bus user and the responses will vary from one end of the spectrum to the other. In the early days of the S-100 bus, many users had bad experiences with poorly designed dynamic-memory boards. The problems varied from inadequate memory refreshing to designs that worked with only a particular processor board. However, things have come a long way since then. For the vast majority of today’s applications, dynamic memory offers the best cost/performance ratio available. With so many of the large S-100 computer manufacturers such as Cromemco, North Star, Vector Graphic, and others using dynamic memory in their systems, all users should seriously consider the advantages of including dynamic memory in their next system design.

Dynamic vs Static
In the S-100 world, static memory is the alternative to dynamic memory. When comparing the two types, three major advantages of dynamic memory are apparent. First, dynamic boards contain more memory than static boards. Even with the supporting control logic that dynamic memory requires, today’s largest available S-100 memory-board sizes are 64 K bytes for dynamic memory and 32 K bytes for static memory. For those systems that require large amounts of memory, such as the Cromemco and Alpha Micro multi-user systems, the increased density of dynamic memory can mean the difference between having enough available slots on the motherboard for all the cards necessary to complete the system or not being able to fit all of the required cards into a given chassis.

The second and probably most important advantage of dynamic memory is the low level of power dissipated. This not only reduces the amount of heat generated, but also reduces the current requirements from the power supply. A typical 64 K-byte dynamic-memory board dissipates approximately 8 watts of total power compared to as much as 50 watts for 64 K bytes of static memory. This decrease in power dissipation of more than sixfold can make a big difference in the reliability of the entire system. This is especially true when the system contains more than 64 K bytes of memory, as in a multi-user application. Since the reliability factor for electronic equipment decreases exponentially as the operating temperature increases, the mean time between failures can be drastically improved by using dynamic memories in the larger memory-intensive systems.

The third major advantage of dynamic memory is cost. Historically, its cost has always been lower, and this will continue to be so due to the increased density of dynamic-memory circuits. Once an integrated-circuit manufacturer has regained the initial development investment (assuming the yields are about equal), the price for higher-density dynamic-memory circuits can be about the same as for lower-density static-memory devices. Since it takes sixty-four of the 4 K-by-1-bit static-memory devices to build a 32 K-byte memory board as compared to thirty-two of the 16 K-by-1-bit dynamic-memory circuits to build a 64 K-byte dynamic-memory board, it becomes apparent, even when the control logic is taken into account, that a dynamic-memory board costs less to build than the corresponding static-memory board.

In comparing the two types of memory, there is one application where static memory may be a better choice. Not all types of DMA (direct memory access) controllers will correctly interface with all types of dynamic-memory boards. Depending on the particular DMA controller, static memory may be the only type that will work correctly. More will be said about this later.

Memory Features to Look For
Now that the general merits of dynamic-memory boards have been brought to light, it is important to discuss some of the differences between the commercially available designs, and what features in particular to look for when choosing a dynamic-memory board for your system. This discussion will be separated into two application areas — those requiring a maximum of 64 K bytes of memory and those requiring more than 64 K bytes of memory for multi-user and multitasking applications incorporating software-controlled, bank-selectable memory.

Many manufacturers make only one memory-board product that tries to bridge the gap between the two types of applications. However, these two applications require that the

About the Author
Larry Malakoff is the Marketing Director of Measurement Systems and Controls Inc., located in Orange, California. He has been involved in the design of S-100 dynamic-memory boards and is currently working with customers to solve their application requirements for system memory. Larry received his Master of Science in Engineering from UCLA and has been involved in electronic design for over eight years.
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memory used have different features, often resulting in a compromise where one or both of the application areas lacks the necessary hardware for a truly cost-effective solution.

**Single-User Features**

In a single-user system that requires 64 K bytes or less of memory, the most important feature to have is the ability to deselect memory in as small an increment as possible. For the majority of 64 K-byte dynamic-memory boards that offer this feature, 4 K bytes is usually the smallest block of memory that can be turned off. (Some of the older 16 K-byte memory boards allow deselection to 1 K bytes.) This feature is necessary to allow the system monitor in read-only memory and memory-mapped controller cards to reside in the memory-address space without interfering with normal memory operations.

Another useful feature is the ability to buy a memory board in either a 16, 32, 48, or 64 K-byte size, with those boards containing less than 64 K bytes able to be expanded to 64 K bytes by inserting the necessary integrated circuits into empty sockets.

**Multi-User Features**

Most multi-user and multitasking S-100 systems require bank-selectable memory boards. The requirements placed on the memory board for these applications are quite different from those placed on the single-user applications. A typical multi-user system might have an operating system of 48 K bytes and five user banks of 16 K bytes each. The operating system might occupy the upper 48 K-byte address space and be on all the time, while the five users might share the lower 16 K-byte address space. Only one user can be on at a time (there can never be more than 64 K bytes of memory on at any one time), but the operating system allows all five users to access the computer on a rotating timeshared basis. Through software control, each of the 16 K-byte banks of memory is turned on or off as required. This is usually accomplished by doing an OUT instruction to a particular I/O (input/output) port that the memory board is set to decode. The data on the bus then determines which banks are to be on or off.

A 64 K-byte dynamic-memory board optimized for this type of application would allow the user to implement the above example with only two memory boards. Other 64 K-byte dynamic-memory boards that compromise on the hardware design would require one 48 K-byte memory board and five 16 K-byte memory boards. In this case, the number of motherboard slots required increases, the total power dissipation increases, and the total cost of memory increases.

The difference between the two memory boards in the above example is in how the 64 K bytes of memory are partitioned into software-selectable banks. The optimal design, considering the limitations of board "real estate," is to have four totally independent 16 K-byte banks of memory. This allows the user to have

---

**Photo 1:** Different kinds of memory boards. These two 64 K-byte memory boards have fundamental differences that tailor them for specific types of systems. The Measurement Systems and Controls DMB6400 (photo 1a) is intended for multi-user and multitasking systems and provides a bank-select feature so that memory addresses may be shared by users. The DM6400 (photo 1b) is produced specifically for single-user systems and has a deselect feature that allows memory-mapped peripherals to occupy any 4 K address block. Both boards are manufactured by Measurement Systems and Controls of Orange, California. Prices are $1195 and $895 respectively.
UniFLEX is the first full capability multi-user operating system available for microprocessors. Designed for the 6809 and 68000, it offers its users a very friendly computing environment. After a user 'logs-in' with his user name and password, any of the system programs may be run at will. One user may run the text editor while another runs BASIC and still another runs the C compiler. Each user operates in his own system environment, unaware of other user activity. The total number of users is only restricted by the resources and efficiency of the hardware in use.

Multi-User

The design of UniFLEX, with its hierarchical file system and device independent I/O, allows the creation of a variety of complex support programs. There is currently a wide variety of software available and under development. Included in this list is a Text Processing System for word processing functions, BASIC interpreter and precompiler for general programming and educational use, native C and Pascal compilers for more advanced programming, sort/merge for business applications, and a variety of debug packages. The standard system includes a text editor, assembler, and about forty utility programs. UniFLEX for 6809 is sold with a single CPU license and one year maintenance for $450.00. Additional yearly maintenance is available for $100.00. OEM licenses are also available.

Support

UniFLEX is offered for the advanced microprocessor systems. FLEX, the industry standard for 6800 and 6809 systems, is offered for smaller, single user systems. A full line of FLEX support software and OEM licenses are also available.

FLEX

Multi-Tasking

UniFLEX is a true multi-tasking operating system. Not only may several users run different programs, but one user may run several programs at a time. For example, a compilation of one file could be initiated while simultaneously making changes to another file using the text editor. New tasks are generated in the system by the 'fork' operation. Tasks may be run in the background or 'locked' in main memory to assist critical response times. Inter-task communication is also supported through the 'pipe' mechanism.

UniFLEX is the first full capability multi-user operating system available for microprocessors. Designed for the 6809 and 68000, it offers its users a very friendly computing environment. After a user 'logs-in' with his user name and password, any of the system programs may be run at will. One user may run the text editor while another runs BASIC and still another runs the C compiler. Each user operates in his own system environment, unaware of other user activity. The total number of users is only restricted by the resources and efficiency of the hardware in use.

Multi-User

The design of UniFLEX, with its hierarchical file system and device independent I/O, allows the creation of a variety of complex support programs. There is currently a wide variety of software available and under development. Included in this list is a Text Processing System for word processing functions, BASIC interpreter and precompiler for general programming and educational use, native C and Pascal compilers for more advanced programming, sort/merge for business applications, and a variety of debug packages. The standard system includes a text editor, assembler, and about forty utility programs. UniFLEX for 6809 is sold with a single CPU license and one year maintenance for $450.00. Additional yearly maintenance is available for $100.00. OEM licenses are also available.

Support

UniFLEX is offered for the advanced microprocessor systems. FLEX, the industry standard for 6800 and 6809 systems, is offered for smaller, single user systems. A full line of FLEX support software and OEM licenses are also available.

FLEX

Multi-Tasking

UniFLEX is a true multi-tasking operating system. Not only may several users run different programs, but one user may run several programs at a time. For example, a compilation of one file could be initiated while simultaneously making changes to another file using the text editor. New tasks are generated in the system by the 'fork' operation. Tasks may be run in the background or 'locked' in main memory to assist critical response times. Inter-task communication is also supported through the 'pipe' mechanism.
bank sizes that are any multiple of 16 K, such as four 16 K-byte banks or two 32 K-byte banks or one 16 K-byte bank and one 48 K-byte bank, etc, all of which are software selectable. In addition, the four banks should be independently addressable on the four 16 K boundaries: hexadecimal 0000, 4000, 8000, and C000. A much more simplistic approach is to bank-select the entire memory board, the bank size then being determined by the size of the memory on the board.

Other important features that a bank-selectable memory board should have include the ability to decode any of the possible 256 I/O port addresses and have up to eight banks of memory for each port address. In addition, the user should be able to turn on or off any of the switchable banks when a system reset occurs. One last feature, which can be very valuable when troubleshooting a system with more than one 64 K-byte bank-selectable memory board, is an LED (light-emitting diode) indicator for each bank of memory that is being accessed. The flashing pattern of the LEDs can indicate where a problem is.

One last word on bank-selectable memory is that a well-designed board will allow the user to work correctly with the slightly different approaches taken by the manufacturers of multi-user systems: Alpha Micro, Cromemco, North Star, and Digital Research. (Digital Research only supplies the multi-user operating system, MP/M.)

Common Features

There are several other important features that are common to both single-user- and multi-user-optimized memory boards that the system designer should look for. The most important feature is the ability of the memory board to work with as many different processor boards as possible. This includes the standard 8080A-, Z80A-, and 8085-based boards, as well as the more advanced 16-bit machines (such as Alpha Micro and Marinchip's M9900).

This would not seem to be a major problem since all products manufactured for the S-100 bus should work with one another. However, in the real world this is not always the case. The S-100 bus started with and was defined around the 8080 microprocessor. As other microprocessors made their way onto the S-100 bus, they had to emulate the timing of the 8080. Each company came up with its own version for this timing. As a result, it is difficult to find two Z80A boards that generate their S-100 signals alike.

This creates a challenge to the dynamic-memory board manufacturers to come up with a flexible internal-timing scheme that allows the memory-timing circuits to adjust to the differences in the processor boards. The best way to achieve this is to use a minimum number of the S-100 bus-timing signals and, if at all possible, to avoid the use of the pSYNC signal. This one signal has created more problems than any other due to the many different processor-board designs manufacturers have come up with. The best designed dynamic-memory boards will correctly interface with the vast majority of the different board types available today, but no single dynamic-memory board can claim to work with them all.

Most of today's dynamic-memory boards use transparent (or invisible) refresh. A window in the processor timing is found where the memory
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BYTE February 1981
read and write operations are not being executed, thus allowing a refresh operation to take place without requiring the processor to wait. The result is that the system is not slowed down by the necessary refresh cycles.

A different type of refresh must be done whenever the RESET or pWAIT (S-100 bus) signals are active for any extended period of time (more than several tens of microseconds). These conditions occur whenever the system-reset switch is activated or whenever a disk access to certain disk controllers is being performed using a programmed I/O interface. Either of these conditions stops the processor-generated timing that is required by the memory board for transparent refresh. Thus, the occurrence of any of these conditions must cause the memory board to enter an automatic refresh mode that continues until the processor again starts its generation of the timing signals.

Another feature that most memory boards incorporate is the use of the PHANTOM signal from the S-100 bus. This allows read-only memory on the disk controller or other board to overlay the system programmable memory to load an initial program from disk.

Other features to look for include input filters on the address and control lines followed by Schmitt-triggered input gates. This minimizes the false starting of memory cycles due to noise on the bus signals. Good logic design also dictates the use of clocked-logic or precision-delay lines for the generation of internal-memory timing, but under no circumstances should RC (resistor/capacitor network) circuits be used between logic gates to generate delays. Products using this technique are unstable under many operating and manufacturing conditions and can only cause eventual trouble.

One other important requirement

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of dynamic-memory boards is good documentation. This should include board set-up documentation, detailed theory of operation, schematics, timing diagrams for the different processor-board types, a parts list, a board-layout drawing, and applications notes.

Finally, the dynamic-memory board should be backed up by the manufacturer through both guarantee and applications support. Several of the available memory boards come with a full one-year guarantee. The manufacturer should also be able to support the product with the necessary applications information to determine if it will work in your particular system.

**Limitations of Dynamic Memories**

Although dynamic memory usually represents the best cost/performance ratio, there are several limitations that may prevent it from functioning correctly. The system designer should investigate these cases with the memory-board manufacturer before deciding to use a product.

It should be apparent from the above discussion that not all dynamic-memory boards will work with all processor boards. Only the manufacturer can tell you if the memory board has been tested with the particular processor board you are planning to use.

Another troublesome area is in interfacing with DMA controllers. Generally, the problems arise from two different sources. First, the actual timing required from the DMA controller will vary depending on the particular memory board used. Not all memory boards use the same S-100 bus signals, thus complicating the DMA interface. If this timing is not compatible, then the memory read or write cycles will not function correctly.
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The second trouble area involves the correct refreshing of the memory. The majority of the dynamic-memory devices used today are the 4116-type, which require 128 refresh cycles every two milliseconds. This requirement is easily met when the processor controls the bus and the memory board uses transparent refresh. However, when the DMA controller takes over the bus, most memory boards will cease to do refresh cycles. If the DMA controller has access to the bus for a small number of byte transfers, this does not present a problem.

A problem may exist, however, when the DMA controller does a burst sector or track transfer. This may prevent refresh from occurring for too long a time interval, causing the memory to lose data. Some DMA controllers, particularly hard-disk controllers, avoid this problem by doing the DMA transfer to an onboard sector buffer consisting of static memory. Memory or I/O move instructions are then used to transfer the data in this memory to the system memory. Again, it is important to check with the memory-board manufacturer for compatibility with the DMA controller you plan on using.

One last area of concern involves interfacing with a front-panel type of system. Extra circuitry is required for a dynamic-memory board to correctly work with the front-panel functions such as examine, deposit, and run. Many memory-board manufacturers do not include this necessary circuitry so that they may add other functions that they think are more valuable in their intended marketplace. If you need this function, check with the memory-board manufacturer.

In summary, the dynamic-memory board represents a superior cost/performance ratio when compared to static memories. When looking at dynamic-memory boards, choose one that is optimized for your particular application, whether it be a single-user or multi-user system. It is also a good policy to check with the memory-board manufacturer before your purchase to verify that the board will work correctly in your particular system. You are best protected by a good return policy in case you experience any problems after testing the memory board.
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Stacking Strings in FORTH

John J Cassady
339 15th St
Oakland CA 94612

Anyone who is familiar with writing programs in BASIC and who later switches to writing in FORTH surely misses the convenience and ease of BASIC string handling. Fortunately, there is no need to deprive yourself all these features: they can be implemented in FORTH with the additional bonus of not being tied to the preconceived ideas of your software vendor. If you do not like the way the string operators work, you can change them: you control the source code.

Adding Strings to FORTH

Tools for manipulating strings of characters and other data items are useful to the personal computer programmer. The routines presented here are an extension to FORTH. They run in fig-FORTH (the versions of FORTH for various microprocessors written by the FORTH Interest Group) and should run with little adaptation in any standard FORTH.

String implementations abound in FORTH. Some, like the one presented here, use stacks. The use of stacks seems appropriate in FORTH. Most of FORTH programming consists of manipulating entities on various stacks.

A stack is a LIFO (last in, first out) list. Stacks usually have a fixed width; that is, the number of bits that are simultaneously pushed (ie: put onto the stack) or popped (ie: taken off the stack) does not vary. An item on the stack is usually limited to some maximum size (eg: 16 bits) that can represent numbers up to decimal 65,535. The FORTH parameter and return stacks both have fixed widths.

The string stack is like the parameter stack and the return stack, but it is not restricted in width. String-stack items can be any width and any combination of widths. However, item size and total stack size are limited only by the amount of memory devoted to them. As a rule of thumb, a few hundred bytes are more than enough.

Figures 1 and 2 and listing 1 illustrate two ways of visualizing string stacks. They show the stacks growing downward from high memory. This is typical in FORTH. Even though the string stack grows downward, we will refer to the most recent entry on the stack as the top of the stack. The unchanging end of the stack (hexadecimal 2000 in figure 2) will be called the base. When something is popped...
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from the stack, it is the top item (as defined above) that is removed.

A string consists of a 2-byte length word followed by the text of the string, as you are moving upward in memory. Since the length is explicitly stated, there is no need for a separator or delimiter. Any of the 256 possible 8-bit quantities, for example, can appear in the string. Strings can include binary numbers, floating-point numbers, encrypted messages: in short, anything that can be stored in a byte.

Before considering routines any further, heed the caution that this article presents an example of an extension to FORTH. It's not the only way to implement strings nor, perhaps, the best way. The article

---

**Figure 2:** Another view of the string stack of figure 1. $0$ is a constant that points to the address of the base of the string stack. Here it has the value of hexadecimal 2000. See listing 1 for the FORTH dialogue that uses the string stack shown here.
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<td>#7</td>
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<td>$20</td>
</tr>
<tr>
<td>#8</td>
<td>Perspectives</td>
<td>$20</td>
</tr>
<tr>
<td>No. 1-4</td>
<td></td>
<td>$70</td>
</tr>
<tr>
<td>No. 5-8</td>
<td></td>
<td>$70</td>
</tr>
<tr>
<td>Post. &amp; hand. (from US , $6 overseas)</td>
<td>$3</td>
<td></td>
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</tbody>
</table>

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simply illustrates a FORTH program and an interesting mixture of two quite distinct logical structures: the stack and the string. And it has some desirable features: it is easy to visualize and modify the operations.

Some String-Manipulation Words

In listing 2, the word "$^w" creates a constant with a value equal to the size of memory to be reserved for the string stack during compilation. The stack size can be changed simply by changing this one value and recompiling.

The words $0, $P, and \{ $PI \} are direct duplicates of the words $0, $P, and \{ $PI \} used in the FORTH kernel. The only difference is that they operate on the string stack instead of on the parameter stack. $0 is a constant that returns the address of the fixed end of the string stack (ie: the base) to the parameter stack. (See line 4 of listing 2.) This means that the value of $0, the memory address, is pushed onto the parameter stack when it is used.

$P is a variable. It is the stack pointer. At any given time, it contains the address of the top string on the stack (which is the length word of the top string). When $P is executed, it places the address (not the value) of the stack pointer onto the parameter stack. Therefore, to get the value of the string-stack pointer, we need to type the following two-word sequence:

$P @

This sequence is reduced to a single word $P@, which is defined at line 7 of listing 2. Listing 3 shows a FORTH dialogue that explains the use of VARIABLE, CONSTANT, and \( \) (pronounced "fetch").

The word \{ $PI \} empties the string stack. (The braces used in \{ $PI \} and elsewhere in the article are not part of the FORTH word. Following a convention set in the August 1980 BYTE, braces are used to surround a FORTH phrase or a FORTH word that contains a punctuation mark...GW) It does this by placing the value for the base of the string stack onto the parameter stack and making it the current value for the string-stack pointer. The word \{ $PI \} is the first colon definition encountered. The words CONSTANT, VARIABLE, and \{ \} compile words into the FORTH dictionary.

Our next definition, in line 8 of listing 2, is $DROP. This will drop (ie: delete) the string on top of the string stack. It may seem we are getting ahead of ourselves — after all, we are defining $DROP before we define any word that puts strings onto the string stack. But this is okay as long as we don't use any undefined words inside the definition. FORTH compiles its words in one pass, and it won't give us an error message as long as we don't give it a word it doesn't recognize.

If we "walk" through $DROP, we see that the value of the string-stack pointer is placed on the parameter stack by the word $P@. It is then duplicated by the word DUP, leaving two copies. The top copy of the address is replaced by the contents of the location pointed to when the word @ is executed. This places the length of the top string on the parameter stack. The word + adds this length to the value of the stack pointer, and 2+ increments that result by 2. The value on top of the parameter stack is now the address of the word containing the length of the second string on the string stack.
The sequence \{ $P \ 1 \} \) is a two-step process that places the address of the variable containing the string-stack pointer on the parameter stack and storing the new value into it. Thus, after executing $DROP, the string-stack pointer is changed to point to what was the next-to-top string. This effectively drops the top string, even though there was nothing changed in the contents of the memory buffer devoted to the string stack.

This definition of $DROP is not entirely adequate. If you execute this word with an empty string stack, there is a good chance of moving your string-stack pointer into a memory area where it doesn't belong. To avoid this, additional code must be added. The word $DROP should check that the stack is not empty before it executes. Safeguards of this nature are appropriate in many of these routines. To include them in this article would, however, needlessly complicate the description of the words.

**Loading, Storing, and Printing Strings**

The word $@ (line 9 of listing 2) is the first that expects parameters on the parameter stack. It expects a text address as the second stack item and a quantity on top of the stack. The text address points to a memory location of the first byte of the string that will be moved to the string stack. The quantity is the length of the string. Thus, if the expression "the quick brown fox" was residing in memory starting at hexadecimal location 2C80 and we wanted to move it to the string stack, we would type the following sequence:

```
2C80 13 $@
```

with the hexadecimal 13 (or decimal 19) being the length of the string. The quantities could be in decimal if the FORTH word BASE has been set to decimal.

The word \{ $! \} complements $@. It takes the string on top of the string stack and moves its text to whatever memory location is addressed by the top of the parameter stack. Thus, the string can be moved into a string variable, to an output buffer, or to a memory-mapped video display.

To print a string we use the two-character word \{ $. \} (pronounced "string dot"). This follows the FORTH convention of using dot for output. It also uses the FORTH operator TYPE to accomplish it.

$DUP (line 13 of listing 2) is shown as an example of one of several operators that might be written to manipulate string-stack items. Useful additions are $SWAP and $OVER. The need could also arise for a $ROT, although I've never wanted it. $DUP simply gets the length and location of the current top string on the string stack and executes $@.

For a truly useful system, we want a person to sit at a keyboard and be able to type a sentence directly to the string stack. This and more is accomplished by the one-character FORTH word \{ "$\} (pronounced "quote"). The techniques used in quote are exactly the same as in the fig-FORTH message-handler word \{ "$\}. This word (pronounced "dot quote") is a period followed by a double quote mark. This word checks to see if we are interpreting from the keyboard or compiling a definition. If we are interpreting, it accepts input until it detects another quote, then moves the text between the two quotes to the string stack. If we are compiling

Text continued on page 162
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**Listing 1:** Manipulating the string stack and string pointer. Figures 1 and 2 show the state of the string stack at the beginning of this dialogue. Here and in following listings, user input is underlined and computer response is not. See listing 3 for further details on the FORTH word @ (pronounced “fetch”).

Dialogue With Computer

```
HEX OK
$0, 2000 OK
SP @, 19E20K OK
SP @ @, 6 OK
$ SPRING OK
$0, 2000 OK
SP @, 19EA OK
SP @ @, 6 OK
$ SUMMER OK
F ALL OK
WINTER OK
```

Commentary

All numbers will be expressed as hexadecimal.

Base of string stack is hexadecimal 2000.

Location pointed to by stack pointer $P$.

Contents of location (length word of string on top of stack).

Print top string; notice no space between STRING and prompt OK.

The base of the stack hasn’t changed. (It’s a constant.)

But the stack pointer has changed.

Print the next three strings, popping them from the string stack.

**Listing 2:** Defining string-manipulating words. See text for details.

```
0 ( FORTH STRING STACK EXTENSION
1 HEX FORTH DEFINITIONS
2 200 CONSTANT "ST" (NUMBER OF BYTES RESERVED FOR $STK)
3 "ST" ALLOT ( LEAVE GAP IN THE DICTIONARY OF "ST" BYTES FOR $STK)
4 HERE CONSTANT $0 ( $0 RETURNS FIXED BASE OF $STK TO PSTK)
5 $0 VARIABLE $P ( $P RETURNS ADDR OF VAR HOLDING $STK PTR)
6 $P @ DUP >R $P@ ( TA-2QTY-l---FETCHSTRINGTO$STK)
7 $P! $0 $P! ( $P! EMPTIES $STK BY RESETTING $PTO $0)
8 $DROP $P@ DUP @ ; ( DROP TOP STRING)
9 $! DUP 2+ SWAP @ ROT SWAP CMOVE $DROP ; ( ADDR-1- - ­
10 SWAP - SWAP OVER R CMOVE 2 - R> OVER ! $P! ;
11 $P@ DUP >R $P@ ( TA-2 QTY-1 --- FETCHSTRINGTO$STK)
12 $P@ DUP 2+ SWAP @ TYPE $DROP ; ( OUTPUT STRING)
13 $DUP $P@ DUP 2+ SWAP @ $@ ; ( DUPLICATE STRING)
```

**Listing 3:** A dialogue that explains the FORTH words CONSTANT, VARIABLE, @, and { }. The main point to remember is that when you name a constant, its value is put on the stack; but when you name a variable, the address that contains the value is put on the stack.

Dialogue With Computer

```
100 CONSTANT CON OK
100 VARIABLE VAR OK
CON OK
VAR OK
```

Commentary

Defining CON = 100.

Defining VAR = 100.

Put value of constant onto stack; print value on top of stack, remove from stack; therefore, 100 is value of CON.

Put address of variable onto stack; print value on top of stack, remove from stack; therefore 6480 is the memory location at which the value of VAR is stored.

Listing 3 continued on page 160
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Listing 3 continued:

VAR OK
OK

100 OK

VAR @ , 100 OK

VAR ? 100 OK

---

Listing 4: More string-manipulating words.

0 \ FORTH STRING STACK EXTENSION \FIGFORTH1.1\ FIGFORTH1.1
1 \ FORTH STRING STACK EXTENSION \FIGFORTH1.1\ FIGFORTH1.1
2 \ FORTH STRING STACK EXTENSION \FIGFORTH1.1\ FIGFORTH1.1
3 \ IF ( BS ) \ FORTH STRING STACK EXTENSION \FIGFORTH1.1\ FIGFORTH1.1
4 \ ELSE \ FORTH STRING STACK EXTENSION \FIGFORTH1.1\ FIGFORTH1.1
5 \ ENDIF \ FORTH STRING STACK EXTENSION \FIGFORTH1.1\ FIGFORTH1.1

Listing 5: More string-manipulating words.

0 \ FORTH STRING STACK EXTENSION \FIGFORTH1.1\ FIGFORTH1.1
1 \ FORTH STRING STACK EXTENSION \FIGFORTH1.1\ FIGFORTH1.1
2 \ FORTH STRING STACK EXTENSION \FIGFORTH1.1\ FIGFORTH1.1
3 \ IF ( BS ) \ FORTH STRING STACK EXTENSION \FIGFORTH1.1\ FIGFORTH1.1
4 \ ELSE \ FORTH STRING STACK EXTENSION \FIGFORTH1.1\ FIGFORTH1.1
5 \ ENDIF \ FORTH STRING STACK EXTENSION \FIGFORTH1.1\ FIGFORTH1.1

Listing 6: Defining a word to get the date from the keyboard. This word, GETDATE, prompts for and will accept only an input of exactly seven characters.

FORTH Statements

7 \ FORTH STRING STACK EXTENSION \FIGFORTH1.1\ FIGFORTH1.1
1 \ FORTH STRING STACK EXTENSION \FIGFORTH1.1\ FIGFORTH1.1
2 \ FORTH STRING STACK EXTENSION \FIGFORTH1.1\ FIGFORTH1.1
3 \ IF ( BS ) \ FORTH STRING STACK EXTENSION \FIGFORTH1.1\ FIGFORTH1.1
4 \ ELSE \ FORTH STRING STACK EXTENSION \FIGFORTH1.1\ FIGFORTH1.1
5 \ ENDIF \ FORTH STRING STACK EXTENSION \FIGFORTH1.1\ FIGFORTH1.1

Listing 6 continued on page 162
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long and consists of a left parenthesis, a double quote mark, and a right parenthesis.)

$INPUT is another way of getting string data onto the string stack. When $INPUT executes, it stops everything and waits for text from the keyboard. It accepts text until it receives a return character.

The combination of \{\} and $INPUT (defined in listings 4 and 5) allows us to write programs that prompt the user to supply text to the program. For example, consider the definition given in listing 6. When GETDATE executes, it will prompt the operator with the message “Input today’s date (DDMMMYY):” and wait for a response ended by a return. It will check the length of the string entered. If it is other than seven characters long, GETDATE will discard it and ask for the day’s date again. If it is the correct length, the word will make the string just entered the value of the string variable TDATE.

Listing 7 illustrates definitions that could be used to implement a system of string variables for use in a routine like the above word, GETDATE. $VARIABLE is a defining word that uses the special FORTH words <BUILDS and DOES>. Stated briefly, these last two words allow the user to define words (like $VARIABLE or VARIABLE) that themselves define new types of FORTH words. [This subject was explained in greater detail in Kim Harris’s article, “FORTH Extensibility,” in the August 1980 BYTE, page 164...GW]

These routines by no means provide a complete string facility. Concatenation is required, and string editing is convenient. We need to be able to extract a substring. String comparisons are essential for sorting and merging. Why not perform arithmetic directly with strings of numeric characters and avoid the tedious transformations to binary numbers and back to strings? And why not have a random string generator to check sorting efficiency or test file structures? All of these niceties can be and, in fact, have been added to the basic structure I’ve described.

Summary

FORTH is a “framework” language. It doesn’t have every function you need, but it allows you to add new words that can be used to solve problems in a given application. Here, we have defined fifteen words that allow us to manipulate strings of characters in fig-FORTH. (See listings 2, 4, 5, 6, and 7.) This is only one of several ways to manipulate strings in FORTH. Once defined, these words can be used to manipulate text during the solution of a larger program.

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<td>Female to Female 9’ long</td>
<td>Dual 8” Drive Cable $34.00</td>
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<td>Quad 8” Drive Cable $39.95</td>
</tr>
<tr>
<td>Male to Open 9’ long</td>
<td>Please state type connector:</td>
</tr>
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<td>Male to Open 18’ long</td>
<td>card-edge or socket.</td>
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Articulate Automata: An Overview of Voice Synthesis

Kathryn Fons and Tim Gargagliano
1394 Rankin St
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The time has arrived for computers to begin speaking for themselves! We discussed some basic techniques for using the TRS-80 Voice Synthesizer in the October 1979 BYTE ("The TRS-80 Speaks," page 113). Response from readers showed many were interested in a more detailed look at voice synthesis. The information presented here is concerned with the basic theory of voice synthesis and the basic procedures involved in constructing a vocabulary. The type of synthesis we focus on is electronic phoneme synthesis. A phoneme is a basic unit of sound from which speech can be constructed.

Voice-Synthesis Technology
During the past two decades, almost every aspect of computer technology has progressed through several generations of advancement. A relatively recent addition to this list is speech synthesis. The area of computer technology which would seem to gain most from speech synthesis is the man-to-machine interface. This is an area which remains in need of a great deal of development. Today, computers play a role in almost everyone's life, yet we rely on a group of specialists to control the computers. If computer technology is to continue to advance, there will be a strong need for the inexperienced user to communicate directly with the computer. It seems obvious that the man-to-machine interface will be one of the biggest challenges facing this industry in the 1980s.

Another problem confronting computer users is visual confusion and/or saturation. This can occur after watching a video monitor or scanning a printout for hours at a time. Part of this problem can be eliminated by including a nonvisual output channel in the computer system. The obvious choice is voice, since most people normally communicate verbally. In a number of situations, the serial nature of voice output is more desirable than parallel data from a printout or video screen.

A number of applications are already using voice synthesis. Among these are telephone order-entry systems, telephone access systems, reading machines and terminals for the blind, communicators for the verbally impaired, and computerized dispatching.

Physiology of Speech
The production of speech in the human vocal system begins with a source of acoustical excitation to drive the vocal tract. There are two kinds of excitation: periodic and random. The first type of excitation is a pulse train caused by the vocal folds blowing apart and collapsing under lung pressure (see figure 1 on page 166). The pulse train is rich in harmonic content due to its sharp wave shape. The second type of excitation is noise (frication) caused by air passing over the articulators (tongue, cheeks, lips, teeth, etc) with the vocal folds open.

Phonemes containing periodic excitation are called voiced phonemes (eg: the vowel /a/). Phonemes containing only frication are said to be unvoiced (eg: the consonant /f/). It is also possible for a voiced phoneme to contain frication (eg: the consonant /z/).

The human vocal tract is formed from resonant cavities including the mouth and nasal cavities which respond to input excitation by filtering the input. At any given time, placement of the articulators determines the frequency response of the vocal tract. Generating speech from the input excitation involves sequentially varying the frequency response of the resonant cavities in the vocal tract. This is done by movement of the articulators. The vocal tract is a fairly complex time-variant filter network.

Speech is composed of several bands of frequencies called formants (see figure 2). Each formant varies in position, amplitude, and quality with respect to time. A static sound, such as a continuous vowel, is produced by moving the air through the vocal tract and over the articulators, which are appropriately positioned to create

About the Authors

The authors are both employed by the Votrax Division of Federal Screw Works in Michigan. Kathryn Fons is a speech scientist; Tim Gargagliano is a computer engineer. Both have done extensive research in language-processing systems and have worked on the Votrax text-to-speech algorithm. They have a special interest in voice synthesizers in relation to the needs of the handicapped and invite inquiries at the address shown above.
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Figure 1: Periodic excitation of the human vocal tract starts with the vocal folds repeatedly opening and closing (1a), regulating air flow from the lungs. This results in a pulse train of air (1b) which passes through the resonant cavities of the mouth and nasal passages.

Figure 2: Speech is composed of several bands of frequencies known as formants. Shown is a generalized formant envelope for the first two formants.

that sound. During the production of a word, the articulators are constantly moving from one phoneme position to another. This sequencing of the articulator movements is one reason why each sound in the sequence influences every other sound around it. Note that the change in articulator positions does not occur in a single-step fashion, but rather in a continuous movement from one target position toward another. The frequency response of the vocal tract is in flux between the target of the last phoneme and the current phoneme. The acoustical changes that occur during the transition are referred to as dynamic articulations. They are important to the production of intelligible speech—human or synthetic. Without dynamic articulation, speech becomes choppy and often unintelligible.
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1 One reader-noted impression in the average McGraw-Hill publication.
2 The Darden Institute of Business Research. "Telephone Marketing" by Murray Sonen, p. 77, McGraw-Hill 1976. 3 Laboratory of Advertising

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The Electronic Equivalent of the Vocal Tract

An electronic analog of the human vocal tract can be constructed using filters, oscillators, and noise-source modules (see photo 2). Control of these modules is complicated, and requires measuring the static and dynamic parameters of human speech.

The study of speech parameters requires some complex instruments. Speech is most frequently considered in terms of frequency composition, rather than waveforms measured as a function of time. Therefore, analysis of speech is typically carried out in the frequency domain. This requires instruments that are able to measure and plot frequency, amplitude, and time in various relationships. A spectrum-analyzer scope can display a picture of amplitude versus frequency for an instant in time (see photo 3). This provides accurate measurement of energy distribution among the frequencies of a static sound.

Another type of spectrum analyzer used in the study of speech is a voiceprint machine. This device provides a picture of amplitude versus frequency versus time which is collapsed into two dimensions (see photo 4 on page 172). This type of printout allows us to study the dynamic characteristics of speech, such as phoneme duration and dynamic articulations. Notice how the frequencies continuously move during the transition from one phoneme to the next.

The area of computer technology that stands to gain most from speech synthesis is the man-to-machine interface.

With these instruments, measurements can be made of the center frequencies of formants, their amplitudes, and their bandwidth. These measurements are the basis for designing the filter networks used in an electronic vocal tract. A model of a voice synthesizer in its simplest form is shown in figure 3. Depending on the desired speech quality, a varying number of parameters must be controlled. The number of bits stored for each parameter depends on the needed range and quantization tolerance of each parameter. To control this type of synthesizer, parametric data must be updated every 5 to 25 ms. The update frequency must be high enough to capture the parametric movements during phoneme transitions. While this synthesizer model can provide much flexibility, it does so at the expense of a high bit-rate/storage requirement and complex vocabulary generation.

The Votrax Phoneme Synthesizer

A phoneme synthesizer can be modeled by adding a parametric control generator and a dynamic-articulation control unit. A model for a Votrax phoneme synthesizer with several options is shown in figure 4 on page 174. Rather than have the user update all the parameters of a phoneme several times during its production, the synthesizer automatically does it using an internal algorithm. Because the Votrax phoneme synthesizer is implemented totally in hardware, there is no requirement for an external computer/memory to generate phonemes.

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Photo 4: A voiceprint of the message "hello readers." The X axis is time; the Y axis is frequency. Amplitude is displayed as a function of print density.

Figure 3: A parametric speech synthesizer. The number of bits stored for each parameter depends on the needed range and the quantization tolerance of each parameter. In order to control this type of synthesizer, parametric data must be updated every 5 to 25 ms.
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control than a minimal unit because both utilize the same phoneme call-out procedure. A command word is used to signal phoneme production. The command word for a phoneme includes phoneme-select data and optional pitch, rate, and amplitude data. Typically, there are sixty-four phonemes produced, each requiring a 6-bit command word.

There are areas where a person must interact with a computer, but where the use of a visual output channel is inappropriate, unavailable, or ineffective.

A simple digital controller or microcomputer is all that is needed for vocabulary retrieval. In the phoneme synthesizer we have modeled here, the duration of each phoneme is controlled by an internal timer. At the end of an interval, the timer output momentarily goes low, requesting the interface to send the next phoneme command word. This phoneme request signal can be used to generate an interrupt request to a microprocessor or clock a command word out of a FIFO (first-in/first-out) buffer, an interface, or ROM (read-only memory). See figure 5 on page 176.

Several types of Votrax synthesizers are available. A recent addition to this family is the SC01, the first single-chip phoneme synthesizer; it represents a significant breakthrough in speech-synthesis technology. Contained in a 22-pin dual-inline package, this low-power CMOS (complementary metal-oxide semiconductor) synthesizer can be easily used on a printed-circuit board. Latched parallel inputs permit direct connection to a microcomputer data bus. A master clock input on the SC01 permits a variety of voice effects and highly textured sound effects to be generated.

Phonetic Programming

There are a few specific speech rules that dictate how phonemes are sequenced for intelligible speech output. Pronunciation guidelines and symbols, established by the IPA (International Phonetic Association), are often used to identify the phonemes and the altered or adapted units of sound (called allophones). These are used because the standard alphabetic characters may have more than one sound associated with a single symbol. Using phonetic guidelines, phonemes and/or allophones are combined to form the symbol sequence that represents the spoken word in a language. The written symbology, however, does not always directly translate into the sounds available in a phoneme synthesizer. Thus, a sequence of the synthetic phonemes constructed from the phonetic guide-
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Programming Phoneme Voice Synthesizers

There are a number of steps involved in programming a voice synthesizer. Initially, you will probably have to frequently refer to Table 1, which lists symbols and example words which represent sounds:

- Select the words to be programmed.
- Speak the words out loud.
- Select the appropriate phonetic symbols to represent the sounds in the words. The number of phonetic symbols you use should equal the number of sounds counted when the words are spoken.
- Enter the phoneme sequence into the synthesizer and listen to the speech output. Check the synthesizer's pronunciation for the appropriate duration of each syllable and rhythm of each word. The accent (or stress) placed on each word or syllable will help define the duration parameter.
- Select the longer-duration vowel phoneme for the accented syllable and the shorter-duration vowel phoneme for the unaccented syllable. Reenter the program and listen to it again.
- Adjust the program as many times as needed to achieve the desired pronunciation. This can be done by selecting different vowel-phoneme durations for the stressed vowel so that the durational relationship between the syllables sounds correct (see Table 3). You can also adjust the sound by inserting a transition allophone between main vowels and consonants to achieve smooth pronunciation (see Tables 2 and 3).

A few examples are:

Word Initial Program Refined Program
move M-U-V M-UI-UI-V
family F-AE-M-L-EI F-AEI-EH3-M-L-Y
harvest H-AH-R-V-I3-S-T H-AH1-UH3-R-V-I3-S-T

Table 1: Phoneme-conversion table. Shown are the Votrax and IPA (International Phonetic Alphabet) phonetic symbols and example words that show the pronunciation of each sound.
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Table 2: Vowel phonemes are categorized here according to their place of production within the human vocal tract. Durational vowel allophones have a number following their symbol which indicates their durational relationship to the base vowel. (The suffix 1 indicates the longest duration; 3 indicates the shortest duration.) The Votrax phonetic symbols are used here.

<table>
<thead>
<tr>
<th>Base Vowels</th>
<th>Medial Vowels</th>
<th>Back Vowels</th>
<th>Mouth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front Vowels</td>
<td>Medial Vowels</td>
<td>Back Vowels</td>
<td>Mouth</td>
</tr>
<tr>
<td>E</td>
<td>I</td>
<td>ER</td>
<td>U</td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>UH</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>AE</td>
<td>AW</td>
<td>AH</td>
</tr>
<tr>
<td>Vowel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E1</td>
<td>11,12,13</td>
<td>UH1,UH2,UH3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A1,A2</td>
<td>O1,O2</td>
<td>AH1,AH2</td>
</tr>
<tr>
<td></td>
<td>EH1,EH2,EH3</td>
<td>AW1,AW2</td>
<td></td>
</tr>
<tr>
<td>Vowel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Y1 (short, constricted E1)</td>
<td>IU (between the OO1 and U1)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Consonant phonemes are listed here according to their voicing quality and grouped according to the manner in which they are produced. Note that all vowels are classified as voiced phonemes.

<table>
<thead>
<tr>
<th>Voiced</th>
<th>Voiceless</th>
<th>Group Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>B,D,G</td>
<td>P,T,K,DT</td>
<td>Stop Plosives</td>
</tr>
<tr>
<td>Z,ZH,V,TH,V,J</td>
<td>S,SH,F,TH,CH,H</td>
<td>Fricatives/Affricates</td>
</tr>
<tr>
<td>M,N,NG</td>
<td>R,L,W,Y</td>
<td>Nasals</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Semivowels/Glides</td>
</tr>
</tbody>
</table>

Table 4: Since a number of phonetic sequences consistently produce intelligible speech, they can be classified as phonetic pattern rules. The most consistent patterns are shown here. Other phonetic patterns are more flexible, and many specific "sound effects" can be created through experimentation.
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Phoneme Sequence Usage

AE1-EH3  The vowel sequence, for words requiring the AE sound, that creates smooth pronunciation transition from the vowel into the following consonant. Also used to create duration for the stressed syllable.
Examples: admit = AE1-EH3-D-M-I-I3-T
dash = D-AE1-EH3-SH

AE1-I3  The vowel sequence for words requiring the AE sound followed by NG or another nasal sound.
Example: hanger = H-AE1-I3-NG-ER

AH1-UH3  The vowel sequence, for words requiring the AH sound, for smooth transition into other sounds.
Examples: got = G-AH1-UH3-T
father = F-AH1-UH3-THV-ER

S-S  Doubles the S phoneme when more duration is desired, as at the end of a phrase or sentence.
Examples: gas = G-AE1-EH3-S-S
witness = W-11-I-I3-N-I3-S-S

D-J-J  Doubles the fricative portion of the “j” sound sequence for emphasis.
Examples: Germany = D-J-J-ER-R-M-I-I3-N-Y
large = L-AH1-UH3-R-D-J-J

Table 5: In voice synthesis, it is often desirable to lengthen or shorten a vowel or consonant sound at the end of a syllable, word, phrase, or sentence. Shown here are several of the most common “tricks” for creating such effects.

Test continued from page 174:

lines might produce an awkward, if not unintelligible, pronunciation of the word being translated. The pronunciation guidelines from any phonetic symbol system (IPA, Webster’s Dictionary, Thorndike’s Dictionary) can be used to establish a basic synthesized phoneme sequence, but listening is the final step used to determine the selections for a refined phoneme sequence (see textbox, “Programming Phoneme Voice Synthesizers,” on page 176).

For the purposes of this article, all phonetic sequences are presented utilizing the Votrax Phonetic Symbol System. This system is used because it utilizes characters that are found on a standard computer terminal, as well as those needed for translation.

Phonemes

The sixty-four synthetic phonemes produced by a Votrax speech synthesizer are used here as the base synthetic-phoneme reference. The phonetic symbols representing these sounds and example words are listed in table 1 on page 176. There are twenty-five different consonant sounds, thirty-six basic vowel and vowel-allophone sounds, and two pause phonemes. The sixty-fourth phoneme is called a zero-decode command phoneme. It emits no sound, but can be used as a short interruption. When you select the appropriate synthetic sounds and place them in a specific sequence, the speech synthesizer can produce any word in the English language (as well as many other languages).

Vocabulary Storage

Vocabulary storage requirements are dependent on the

---

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<tr>
<td>TNW-1000</td>
<td>1</td>
<td>One Channel Output Only</td>
<td>$129</td>
</tr>
<tr>
<td>TNW-2000</td>
<td>2</td>
<td>One Channel Input and Output</td>
<td>$229</td>
</tr>
<tr>
<td>TNW-232D</td>
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<td></td>
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Listing 1: An example assembly-language program designed to store a permanent vocabulary for voice synthesis in a read-only memory. The program generates a table of words which the user has entered and stores them sequentially in memory. It then produces a look-up table with entries that point to the corresponding word in the word-storage table.

```
00004   $ THIS DEMONSTRATES HOW AN ASSEMBLER
00005   $ CAN PACK A WORD TABLE AND GENERATE
00006   $ THE APPROPRIATE WORD LOOK-UP TABLE
00008   $ THIS IS THE LOOK-UP TABLE
00010   1000   > ORG 1000H
00011  1000 002000820   WORD ACCESS-BREAK
00012  1004 09201200   WORD CLOSE+DISK
00013  1008 17201200   WORD FREE+LEFT
00014  100C 20202420   WORD NEW+STOP
00015  1010 29202620   WORD TIME+USER
00016  1014 34203820   WORD VALUE+XXX
00018   $ THIS TABLE WILL CONTINUE FOR AS MANY
00019   $ ENTRIES AS DESIRED OR MEMORY ALLOWS
00022   $ THIS IS THE WORD STORAGE TABLE, IT CAN BE
00023   $ PLACED WHERE YOU DESIRE, WORDS APPEAR IN THE
00024   $ ABOVE ORDER IN ORDER TO USE THE START OF THE
00025   $ NEXT WORD AS THE STOP FLAG OF THE CURRENT WORD
00027   2000   > ORG 2000H
00028  2000 39350B30   ACCESS BYTE AE1+EH3+PAO+S+EHH+EHH+,.S.
00029  2004 13333513   BREAK BYTE B..R.+A1+AY.K
00029  200C 0B   CLOSE BYTE K.Is+UI+U1.Z.
00030  200D 0B   DISK BYTE D..I1+I5+S+.K
00031  2010 0B   FREE BYTE Fr+R+E1+Y
00032  2011 0B   LEFT BYTE L+.EHH+EH3+F+T
00033  2014 14   NEW BYTE NI+iU+iU+iUU
00034  2016 15   STOP BYTE S+TrAH1+iUH3+P.
00035  2017 16   TIME BYTE T+AH1+EHH+Y.M.
00036  2018 16   USER BYTE Y1+iU+iU+iU+iU+iZ.
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00038  201A 16   XXX BYTE 0
00039  201B 16

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The Challenger 8P DF.

The general purpose microcomputer was first introduced as a computer for hobbyists and experimenters. However, as the industry has grown, microcomputers have become specialized for personal use or for small business use. There is virtually no computer for the serious experimenter with one important exception, the Ohio Scientific Challenger 8P.

The C8P is unique in that it incorporates the features of state-of-the-art personal computers, with the memory and disk storage capacity of business computers, along with the "mainframe" bus architecture and open ended expansion capability of industrial control computers.

Personal Computer Features
The C8P DF's specs beat all personal computers hands down. It executes instructions two to three times faster, and displays more alphabetic characters on its screen than other models. It has upper and lower case and graphics in 16 colors. The C8P's standard I/O capabilities are far more extensive than any other computer, with joystick and keypad interfaces, sound output, an 8-bit D/A converter, 16 parallel I/O lines, modem and printer interfaces, AC remote control and security monitor interfaces and a universal accessory port that accepts a PROM blaster, 12-bit analog I/O module, solderless prototyping board and more.

Ohio Scientific offers a large library of personal applications programs, including exciting action games such as Invaders and Star Trek, sports simulations, games of logic and educational games, personal applications such as biorhythms, calorie counter, home programs such as checking and savings account balancers and a home budgeter just to name a few. A new Plot BASIC makes elaborate animations easy, and music composition program allows you to play complex multi-part music through the computer's DAC.

At the systems level the machine comes standard with OS-65D, an advanced disk operating system with Microsoft BASIC and an interactive Assembler Editor. Optional software includes UCSD PASCAL and FORTRAN and an Information Management System (OS-MOMS). Dozens of independent software suppliers now also offer personal programs for the C8P.
Business Computer Features
The CBP DF utilizes dual 8" floppy disk drives which store up to eight times as much information as personal computer mini-floppies, and an available double-sided option expands capacity to 1.2 megabytes of on-line storage. The CBP DF is compatible with Ohio Scientific's business computer software, including OS-65U an advanced operating system, and an Information Management System (OS-DMS) with supplementary inventory, accounting, A/R-A/P, payroll, purchasing, estimation, educational grading and financial modeling packages. The system also supports word processing (WP-3) and a fully integrated small business accounting system (OS-AMCAP V1.6). The CBP DF's standard modem and printer ports accept high-speed matrix printers and word-processing printers directly.

Home Control and Industrial Control
The CBP DF has the most advanced home monitoring and control capabilities ever offered in a computer system. It incorporates a real time clock and a unique FOREGROUND/BACKGROUND operating system which allows the computer to function with normal BASIC programs, at the same time it is monitoring external devices. The CBP DF comes standard with an AC remote control interface, which allows it to control a wide range of AC appliances and lights remotely, without wiring, and an interface for home security systems which monitors fire, intrusion, car theft, water levels and freezer temperature, all without messy wiring. In addition, the CBP DF can accept Ohio Scientific's Votrax voice I/O board and/or Ohio Scientific's new universal telephone interface (UTI). The telephone interface connects the computer to any telephone line. The computer system is able to answer calls, initiate calls and communicate via touch-tone signals, voice output or 300 baud modem signals. It can accept and decode touch-tone signals, 300 baud modem signals and record incoming voice messages. These features collectively give the CBP DF capabilities to monitor and control home functions with almost human-like capabilities.

For process control applications, a battery back up calendar clock with automatic computer restart capabilities is available. Ohio Scientific's unique accessory ports allow the connection of a nearly unlimited number of 4S line parallel I/O cards and 12-bit high speed instrumentation quality analog I/O modules to the computer by inexpensive 16-pin ribbon cables.

Exploring New Frontiers
Ohio Scientific's vocalizer software processes normal BASIC print statements with conventional spellings and speaks them clearly in real-time on computers equipped with the UTI (CA-15B or CA-14A). This voice output capability, combined with the CBP's remote control, remote sensing, telephone interface capabilities and reasonable cost open up new frontiers for computer applications.

Documentation
The CBP DF is not a beginner's computer and doesn't come with beginner's documentation. However, Ohio Scientific does offer detailed documentation on the computer which is meaningful for experts, including a Howard Sams produced hardware service manual that includes detailed block diagrams, schematics, parts placement diagrams and parts lists. Ohio Scientific is now also offering fully documented Source Code in machine readable form for OS-65D, the Challenger 8P's operating system allowing experimenters and industrial users to customize the system to their specific applications.

What's Next?
Ohio Scientific is working on a speech recognizer to complement the UTI system, with a several hundred word vocabulary. The company is also developing an 8 megabyte low-cost, add-on hard disk for use in conjunction with natural language parsing to further advance the state-of-the-art in small computers. The modular bus architecture of the CBP assures system owners of being able to make use of these new developments as they become available just as the owner of a 1976 vintage Challenger can directly plug in voice output, the UTI and other current state-of-the-art OSI products.

For more information and the name of the dealer nearest you, call 1-800-321-6850 toll free.
A communicator for the verbally impaired. The Phonic Mirror HandiVoice HC-110 is a battery-operated speech synthesizer controlled by a microprocessor. The user can select from its 500 word/phrase vocabulary by touching the keypad.

The Phonic Mirror HandiVoice HC-120 is an advanced version of the voice synthesizer shown in photo 5. It has a 1000 word/phrase vocabulary selected by entering a 3-digit numeric code. Paralyzed users can operate the unit through the use of a paddle switch and a scroll mode.

Talking typewriters for use by the verbally impaired. The units, which use phonemes, have a virtually unlimited vocabulary.

number of words in the vocabulary and the number of bits in a phoneme-command word. For example, a vocabulary of 100 words using a 6- to 8-bit command word to represent each phoneme will require 600 bytes of storage. A 1000-word vocabulary will require 6000 bytes of storage. A 12-bit command word will require 900 to 1200 bytes for a 100-word vocabulary and 9000 to 12,000 bytes for a 1000-word vocabulary (depending on the packing techniques).

When using a phoneme synthesizer with a 6-bit command word and a high-level computer language that allows literal strings to be assigned to a variable, vocabulary storage can be embedded within the program statements by using ASCII strings. This is because a 6-bit command word has only sixty-four possible commands, where there are at least 64 printable ASCII characters. A word or phrase is assigned to a string variable immediately before being sent to a speech-output routine. This technique is suitable for small vocabulary requirements. With large vocabularies, there tends to be word duplication because the storage unit is a sentence or phrase.

A technique better suited for handling large word bases is the assignment of the phoneme string for a single word to a subscripted string variable. This avoids the word duplication experienced by the previous technique and saves memory (provided that the language stores character strings with no wasted space). To generate a sentence using this technique, a sequence of variable subscript numbers is passed to a routine which calls up the indicated variables. Phoneme strings are then removed from the variable and sent to the synthesizer.

For permanent vocabularies stored in ROM (read-only memory) or loaded into programmable memory from a disk file, a word-address look-up scheme works well. This is done by generating a table of words stored sequentially in a portion of the memory. You then produce a look-up table whose entries point to a word in the word-storage table. The number of the look-up-table entry corresponds to the number assigned to the word (eg: the fifth entry in the look-up table will point to the fifth word in the word table). These tables can be generated easily (see listing 1). Sentences are called out in the same fashion as the previous scheme.

The assembler scheme works well with any size phoneme-command word, since it does not care how many bits are used to represent a phoneme. However, the driver program must know whether to pull 1, 1 1/8, or 2 bytes per phoneme. Listing 2 shows a driver program in BASIC to access the vocabulary in listing 1. Note that the

Listing 2: A driver program in BASIC which accesses the vocabulary as stored by the program shown in listing 1. The end of a word is detected by the starting address of the adjacent word in the table.

100 ' SPEECH OUTPUT SUBROUTINE IN BASIC
110 X = 1000H + 2 x WND  ' CALCULATE LOOK-UP ADDRESS
120 Y = PEEK(X) + 256 * PEEK(X+1)  ' LOOK-UP WORD START
130 Z = PEEK(X+2) + 256 * PEEK(X+3)  ' LOOK-UP NEXT WORD START
140 FOR X = Y TO Y+1  ' SET UP LOOP ITERATIONS
150 OUT SPEECH, PEEK(X)  ' OUTPUT A PHONEME
160 RETURN  ' EXIT

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end of a word is detected by the starting address of the adjacent word in the table.

**Applications**

In the field of computer technology alone, there is tremendous potential for the use of speech output. Through voice synthesis, applications can expand into areas formerly closed. These are areas where a person must interact with a computer, but where visual output is inappropriate, unavailable, or ineffective.

Currently, a blind person who wishes to use a computer must rely on a sighted person to relay information from a video display or printer. To eliminate this dependency, a terminal for the blind can be built to incorporate voice synthesis. Several such terminals are beginning to appear on the market.

Another situation where speech output is desirable is a warehousing/dispatching system. It is not often cost-effective to place terminals around a large warehouse to list pending tasks. A better method is speech output from a computer connected to a radio link, which dispatches a worker carrying a pocket receiver/transmitter. Similar systems are in use or being developed today.

Another area where computers are presently ineffective is in interfacing with the nonreading population. Such is the case when the users are preschool children or nonreading adults. They are the prime candidates for using CAI (computer-aided instruction) as a supplement to their education. Applications such as computerized testing and evaluation of children would invite advancements in the educational field if a speech-output channel was used.

Synthetic speech applications are not limited to merely the computer peripherals mentioned. When used with a small, dedicated microcomputer or digital controller, a stand-alone device can be produced. Such is the case with a reading machine for the blind.

A second type of stand-alone speech system is a communicator for the verbally impaired. A battery-operated microcomputer system and a speech synthesizer can provide a voice for individuals stricken with neurological or physical disorders which impair the human speech mechanism (see photos 5 and 6).

Other applications for voice synthesis are in the area of entertainment electronics. Talking card games, chess games, and video games are beginning to use voice synthesis. Many of these applications are made possible by LSI (large-scale integration) circuits such as the Votrax SC01 single-chip voice synthesizer.

The interface of man-to-machine will provide a challenge for the 1980s. Speech synthesis will play an important role in the future of computer technology.

---

**Editor's Note:** One of the first voice-synthesis products for consumers was Texas Instruments Speak & Spell, which uses a ten-stage lattice filter to simulate the human vocal tract. In the fall of 1980, as part of the continuing trend toward integrating voice synthesis into everyday products, MB Electronics (a subsidiary of Milton-Bradley) introduced an electronic game called "Milton." The game is controlled by a Texas Instruments TMS-1000-series 4-bit microprocessor and utilizes a custom voice-synthesis integrated circuit designed by MB engineers....SM

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If you have a PET – TRS-80 – APPLE II AIM-65 – SORCERER

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COGNIVOX comes complete with microphone, power supply, built-in amplifier/speaker and extensive user manual. What makes COGNIVOX truly unique, though, is the software that comes with it on cassette. Some of the programs included are: DI ALOG, a program that lets you conduct a dialog with your computer (or translate from one language to the other); WDUMP, a vocal memory dump that reads the memory contents out loud; VOTH, a voice operated talking board game and VOICETRAP, a voice operated video game.

Adding voice I/O to your own programs can be done very easily too. All that is needed is to have your computer recognize a word or say a word is a single USR statement in BASIC. No machine language programming is necessary.

With all these features, you'd expect COGNIVOX to cost a small fortune (after all, even talking chess games set over $300), yet it only costs $149 (add $4.50 for shipping in the U.S., 15% of order overseas, CA res. add 8% tax). This low price has been made possible by innovative hardware and a technological breakthrough in recognition algorithm design that uses powerful non-linear pattern matching techniques and adaptive learning.

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Nonlinearities in Illumination

Christopher Terry, 324 E 35th St, New York NY 10016

I certainly do not wish to be hastily critical of an excellently documented and very interesting project. However, my points may help constructors to carry their experiments with computer-controlled light dimmers a bit further and to avoid disappointment with the results.

The dimmer, as described in John Gibson's "A Computer-Controlled Light Dimmer" (January 1980 BYTE, page 56), will certainly fade a lamp from blackout to full brightness or vice versa. However, it is important to realize that a smooth, steady fade cannot be obtained by incrementing the delay count in equal steps throughout the fade time. Linear change of this kind is an analog of the steady motion of a dimmer slide, whose scale is normally calibrated from 0 to 10 in equal divisions. On the other hand, the response characteristics of the digital dimmer, of incandescent lamps, and of the eye itself, are all highly nonlinear.

Figure 1 shows the curve of light output (expressed as a percentage of maximum light output in lumens) versus voltage applied to a lamp (expressed as a percentage of the rated, normal operating voltage). Data for this curve was taken from the Sylvania GTE Lighting Handbook.
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and is valid for most incandescent lamps. The most linear part of the curve is above the 60% illumination point. The nonlinearity is even more apparent in figure 2, which shows a standard calibration curve for theatrical SCR (silicon-controlled rectifier) dimmers controlling 120 V lamps from a 120 V RMS (root mean square) supply. The percentage of light output is also shown on the voltage axis. Note that 70 V RMS must be applied before the brightness reaches 10%, and that raising the voltage from 80 V to 109 V increases the brightness from 25% to 75%.

Figure 3 shows the predicted RMS voltage applied to the load for trigger-delay angles from 0° to 179°, and also the percentage of light output corresponding to the applied voltage. The angle versus volts curve was derived from the formula given in the SCR Handbook for triacs and back-to-back SCRs. The formula is:

\[ V_{load(RMS)} = \frac{E_p}{\sqrt{2\pi}} (\pi - \alpha + 0.5(\sin 2\alpha))^{0.5} \]

where \( \alpha \) (the firing angle) is in radians (not degrees), and \( E_p \) is the peak value of the supply.

Evaluating this equation with a BASIC program gave excellent experimental results. Using a 46 µs clock to drive the counter, computed values agree quite closely with this curve. (The true time for 1° per pulse is 8333/180=46.294 µs, but the 46 µs clock is easily derived from a 1 MHz system clock and is only 1° off at 160°.)

The human eye's response, too, is very nonlinear. When the area lit by a controlled lamp is surrounded by constant illumination at 20% of the maximum brightness of the controlled lamp, the apparent brightness of the controlled lamp follows a Munsell curve somewhat similar to the Munsell curve relating the apparent loudness of a sound to its frequency and power.

Because of these effects, theatrical dimmers, which receive a linear control voltage from the slide potentiometer, contain internal curve-generating circuits that cause the dimmer output to follow either the linear light curve of figure 2, or more usually the square law curve. The manner in which these curves relate linear dimmer motion to apparent light output is shown in figure 4—it is evident that the square law curve provides the most linear relationship, at least for the theatrical stage.

The eye is most sensitive in the region from 25% to 85% of maximum light output. In this range, a sudden jump of 1 V produced by a delay count change is perceptible, and jumps of 1.5 V to 2 V are quite obnoxious dur-
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Figure 3: Effect of trigger-delay angle on the RMS voltage applied to the load of a thyristor-type dimmer. Plotted along with the percent of light output expected from an incandescent lamp, this curve is valuable for computer-controlled dimmer applications. This curve is based on calculations made with a 46 µs clock, which may be developed from a 1 MHz system clock.

I have some cautionary notes to add, based on my own experiments. Triacs are much more persnickety and difficult to control than a pair of back-to-back SCRs with a bridge to steer the trigger pulse. Unless great care is taken in the design of the $dv/dt$ and $di/dt$ damping networks, triacs generate a much larger amount of RFI (radio frequency interference), are more subject to "pulling," are liable to be unpredictable and have infuriating interaction between channels on the same AC power phase. I have some doubt as to whether the simple RC (resistor/capacitor) damping networks shown by John Gibson in his figure 9 will support multiple channels, all changing at different rates in different directions, without interaction. A damped inductive filter is recommended by General Elec...
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A damped inductive filter for triac dimmers. By removing RFI with an effective filter arrangement, interaction between dimmers can be reduced. This is especially important when multiple channels are used to control lamps at differing rates and in different directions.

spike that may peak at three to six times the normal full-brightness operating current of the lamp. While low-wattage lamps warm quickly, the thermal inertia of lamps rated at 200 W or more may allow the spike to be several milliseconds in duration and cause damage to the triac. Triacs are particularly vulnerable to such spikes, and I make it a rule never to load a triac to more than half its rated maximum current in applications where full voltage could be applied to a cold filament.

Theatrical dimmers reduce inrush problems by keeping filaments warm with a blackout voltage of 12.5 V RMS. You may find that this results in a perceptible filament glow. If you reduce the blackout voltage to 6 V, you will kill the glow when still keeping the filaments warm enough to avoid inrush problems.

Finally, I suggest that readers interested in precise light level control and color mixing should consult the following books:

- Sylvania GTE Lighting Handbook. Sylvania Co, any recent edition. This is a handy reference book on incandescent lamps, fixtures, and space lighting principles.
- CORTLI (Computer Output of Real Time Lighting Information), The Mimi Garrard Dance Company, Soho Loft Theatre, 155 Wooster St, New York NY 10012, 1978. (The cost is $10.) This describes a complete lighting system using digital dimmers under the control of an 8080-based microcomputer: about fifty pages on how it came to be, over one hundred pages of detailed technical information, including detailed schematics and software listings in 8080 assembly language, and some operating information. It’s very readable, and you get a tremendous amount of both solid information and speculation about future possibilities; likewise, it’s an excellent source book for the money. The system works really well, too! I have seen it in action a number of times.

The Technical Forum is a feature intended as an interactive dialog on the technology of personal computing. The subject matter is open-ended, and the intent is to foster discussion and communication among readers of BYTE. We ask that all correspondents supply their full names and addresses to be printed with their commentaries. We also ask that correspondents supply their telephone numbers, which will not be printed.
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When connecting computers, terminals, and communication equipment, it is sometimes useful to have a device called a null modem. To understand what a null modem is and why you might need one, it is first necessary to know what a modem does and what is meant by the term RS-232C serial interface.

Modems
You probably have some idea of what a modem does. It allows computers and terminals to communicate over phone lines. This is done by converting serial binary data (individual bits transmitted one bit at a time) into audible tones that can be sent over normal telephone lines. Another modem at the opposite end translates these tones back into a stream of bits, which is then regrouped into 8-bit bytes. Figure 1 is a diagram of this setup. The most common type of modem is called Bell 103A compatible.

RS-232C Serial Interface
The term RS-232C refers to a standard that specifies the connection between a modem and either a computer or a terminal, covering the physical, electrical, and functional aspects of that interface. We are most familiar with the physical side of this standard since it describes the ubiquitous 25-pin D-shaped connector (the DB-25) that is used on most terminals and computer serial I/O (input/output) ports. The electrical aspects of the standard specify what kind of electrical signals can be applied to the pins of such a connection. The functional part says what the signals on each pin are supposed to mean.

The modems shown in figure 1 are called DCE (data-communication equipment), while both the terminal and the computer are called DTE (data-terminal equipment). It makes no difference whether a unit is a terminal, a computer, or anything else—if it connects to a modem, it is DTE. One pin in the RS-232C connector is designated as a transmit-data line. This pin carries serial data from the DTE to the modem (DCE). Another pin is called receive-data, and its data goes in the other direction. It is important to note that the transmit/receive designation is always defined in reference to the DTE-to-DCE connection.

Null Modems
The name “null modem” suggests a black box that looks like a modem but doesn’t do anything. To see why you would need an “empty” modem, suppose that the terminal and the computer shown in figure 1 are in the same room and you wish to connect them together. You might be able to physically connect them if you have a cable with a DB-25P plug (male connector) on the end and the other has a corresponding socket, the DB-25S. But if both of them have been wired to connect to modems, you have a problem. Both will be sending information on the same transmit-data pin and both will be expecting to receive data from the other on the same receive-data pin. This would be equivalent to the effect of talking to someone on the telephone while the telephone handset is upside down. It just won’t work.

The simplest variety of null modem cross-connects the transmit- and receive-data lines as well as connecting the ground pins, which are required to establish a voltage reference for the other signals. In many instances, this is all you will need to allow the terminal and computer to talk to each other. In some cases, either the terminal or the computer requires other signals in addition to the data and ground lines. Table 1 lists the most commonly used pins in the RS-232C interface, along with their usual abbreviations and meanings.

<table>
<thead>
<tr>
<th>Pin Number and Name</th>
<th>Function</th>
</tr>
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<tbody>
<tr>
<td>1 (AA) FG (frame ground), protective ground connection.</td>
<td></td>
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<tr>
<td>2 (BA) TD (transmit data), from DTE to DCE.</td>
<td></td>
</tr>
<tr>
<td>3 (BE) RD (receive data), DCE to DTE.</td>
<td></td>
</tr>
<tr>
<td>4 (CA) RTS (request to send), the DTE asking permission to send to the DCE.</td>
<td></td>
</tr>
<tr>
<td>5 (CB) CTS (clear to send), the DCE granting transmit permission.</td>
<td></td>
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<tr>
<td>6 (CC) DSR (data set ready), indicates that the DCE is powered up.</td>
<td></td>
</tr>
<tr>
<td>7 (AB) SG (signal ground), ground reference for the TD and RD signals.</td>
<td></td>
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<tr>
<td>15 (DB) TC (transmit clock), clock used to generate the serial transmitted data (DCE to DTE).</td>
<td></td>
</tr>
<tr>
<td>17 (DD) RC (receive clock), clock for received data (DCE to DTE).</td>
<td></td>
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<tr>
<td>20 (CD) DTR (data terminal ready), indicates that the DTE is powered up.</td>
<td></td>
</tr>
<tr>
<td>22 (CE) RI (ring indicator), says that the incoming phone line is ringing; used with modems with answer capability.</td>
<td></td>
</tr>
<tr>
<td>24 (DA) XTC (external transmit clock), like TC but from the DTE to the DCE.</td>
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Table 1: Summary of RS-232C serial interface connections and their function.
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Figure 1: Diagram of a typical setup that allows a terminal to communicate with a computer over standard telephone lines. The modems shown are called DCE, or data-communication equipment, while both the terminal and the computer are called DTE, or data-terminal equipment. When referring to the RS-232C serial interface, the transmit/receive designation is always defined in terms of a DTE-to-DCE connection.

Many terminals and computer serial I/O circuits generate the request-to-send and data-terminal-ready signals and expect to receive the corresponding signals clear-to-send and data-set-ready back from the modem. If these are not turned on, the DTE will not allow itself to transmit or receive data. If you plug together two pieces of equipment, both of which are configured as DTE, their data-terminal-ready and request-to-send signals will be connected together, and neither will know how to get the required data-set-ready or clear-to-send acknowledgments. Again, the solution is to cross-connect the corresponding signals so that the DTR signal output of one device goes to the ready DSR input of the other and each unit's RTS signal goes to its own CTS input.

The clock signals listed in table 1 are rarely used. If you need them, cross-connect them. Sometimes a device will need the ring indicator from a modem before accepting incoming data. This can be obtained by connecting this pin to the DTR pin of the other device.

Figure 2: The interconnection scheme for a null modem. A null modem is a "black box" that allows two pieces of data-terminal equipment to communicate with each other when a phone line is not required (such as when they are in the same room). If the two pieces of equipment were connected without the use of a null modem, both would be sending information on the same RS-232C connector pin and also would expect to receive data on the same pin.

Construction

Figure 2 is a diagram of an interconnection scheme that works in most cases. If you need a different set of signals, it may be modified; table 1 provides the necessary information. In some cases you will need to connect a device that requires the DSR control signal to another that doesn't generate the corresponding DTR signal. In this event, connect the DSR pin of the first device to its own DTR pin.

If you buy one of the commercially produced null modems, you will probably get a box about the size of a large paperback book, with two female connectors (DB-25S sockets). I found it more convenient to use one male and one female connector, because their pin numbers are mirror images of each other. Placing them back-to-back lines up all the pins with the same number. I bolted one-inch separators between the screw holes of the two connectors to hold them in place and then wired the connections as shown in figure 2. I wrapped the whole thing in electrical tape to seal it. The result is a much smaller package than the commercial product. It can easily be attached to the end of the RS-232C cable and left there.

Keeping to my practice of documenting whatever I produce, I drew a diagram like figure 2 on adhesive label material and placed it on the null modem's cover. If in the future I need to know which pins are connected, I won't have to remove the covering or hunt through my files for the circuit description. It is always right there.

For Further Research

If you would like more comprehensive information on this subject, consult chapter 26 of the book Technical Aspects of Data Communication by John McNamara, published by Digital Press.
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IRV, a TRS-80 Utility Program

IRV is a new machine-language utility program for the BASIC programmer. It supplies features that all programmers will appreciate, and it uses less than 1 K bytes of programmable memory (unless you add to its definitions).

IRV gives you a flashing cursor, auto repeat on any key held down for more than one second, and keyboard control of the cassette remote plug (you can turn the cassette motor on and off simply by hitting shift-clear).

In this review, words in italics refer to keys of the same name as those on the TRS-80 keyboard...GW This is followed by the ability to define any key to your chosen definition. As sold by The Programmer's Guild, all of the shifted alphabetic keys are defined as BASIC keyword commands (see table 1); this duplicates features of the utility program called T-Short.

How is this possible? Simple: IRV provides new addresses into the keyboard Device Control Blocks used by the TRS-80. The new addresses point to IRV, which is in high memory. IRV processes each input keystroke before calling routines in read-only memory. This gives IRV its great power and versatility.

If you decide that you don't want the programmed-keys mode in operation, you can turn this feature off by hitting shift-down-arrow twice. To turn it back on, hit the shift-down-arrow twice again.

The usefulness of these definable keys is not restricted to single BASIC commands; you can actually define a key as any message, command, or series of commands up to a maximum length of 255 characters. This is true for all of the keys. If you were to exercise this option to its fullest, you would fill almost 25 K bytes of programmable memory (100 keys, uppercase and lowercase, times 255 characters per key).

Yes, one keystroke can represent a series of commands. Hitting enter inserts a carriage return but does not end the

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**Software Review**

**IRV, a TRS-80 Utility Program**

Teri Li, POB 481, Peterborough NH 03458

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**Computers**

**Terinals**

**Modems**

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Table 1: One-keystroke strings supplied with IRV. When IRV is loaded into the TRS-80, any of the single shifted keystrokes shown here will cause its associated string to be "typed" on the video display. (The word "enter" means that the last character typed is the same as pressing the enter key, thus causing the line to be executed.) These equivalencies may be changed or deleted by using the character-redact mode.

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Table 1: One-keystroke strings supplied with IRV. When IRV is loaded into the TRS-80, any of the single shifted keystrokes shown here will cause its associated string to be "typed" on the video display. (The word "enter" means that the last character typed is the same as pressing the enter key, thus causing the line to be executed.) These equivalencies may be changed or deleted by using the character-redact mode.

---

definition, so you can actually define one key to execute an entire series of commands when pressed. It will do this while executing either a machine-language or a BASIC program. For example, the back-up routine in TRS-DOS (call BACKUP, answer all the questions: date, password, drives used, etc) can be abbreviated to a one-keystroke command. This is convenient, especially if you are duplicating several disks.

One interesting advantage to IRV is that you can define the unshifted as well as the shifted keys. I used this feature to set up my keyboard to simulate the experimental Dvorak typewriter layout. [The Dvorak system is a typewriter with a keyboard layout that increases speed and accuracy during touch-typing...GW] Other possibilities could include rearranging the keys to accommodate foreign languages that use the standard Roman alphabet, but use letters in frequencies different from English.

At this point, IRV is far superior to T-Short and other keyboard short-hand routines. But IRV does not stop here; it has even more capabilities.

IRV gives you on-screen BASIC line editing similar to the on-screen line-editing features of the Commodore PET. To use this feature, first list your program on the video, then hit the break-shift key combination. The blinking rate of the cursor will change slightly. Now you can use the four arrow keys to move the cursor anywhere you like on the video screen. Full-screen wrapping is supported: if the cursor leaves the screen from the bottom, it will appear at the top of the screen in the same column; leaving the screen to the right will put the cursor on the left of the same line.

Once you have put the cursor on the line in which you are interested, you may type anything you want over the line. If there are too many characters on the line, hitting the clear key will delete 1 character. If you need more room, each time you press the break key one space will be added, over which you may type. Holding down either key for more than one second causes each key to repeat its function as long as the key is depressed.
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FIRST, WRITE A SHORT BASIC PROGRAM TO PUT THIS GRAPHICS FIGURE ON SCREEN

(b)

If you are adding spaces to a line, you will notice that repeated addition of characters does not move the rightmost character down to the next line on the video display—instead, it causes the character to disappear from the screen. Likewise, if you have removed all the characters to the right of the cursor, the first character on the next line does not move up. The reason is that IRV looks only at the line on which the cursor is set.

When the line is set to your liking, hit enter. This transfers the changes you have made in that line to the program. If you list the line, you will be able to see that the changes have been made. Should you discover that a line is misplaced, you can use this line-editing feature to type a new number over the old line number. When you hit enter, the new line will be inserted into its proper place in your program, and the old line will still be in its place. This feature is handy for moving lines around in your programs.

The best advantage of the line-editing feature in IRV is that it may be invoked while in the TRS-80 edit mode. For example, it can be used to string several BASIC statements into one long multiple-statement line. Edit the line as you would normally, but when you are ready to insert, hit shift-break. Now position the cursor over the line that you wish to insert in the line being edited. Use the clear key to remove the line number (you don't want to insert a line number), then hit enter. List the edited line and you will see that both lines have merged: the second line is positioned where you entered the insert mode. Other uses include converting IF...THEN statements to IF...THEN...ELSE statements, or vice versa.

Still another use for the IRV line editor is to put graphics characters directly into PRINT statements. First, use a short graphics routine to draw your figure on the video display. When you've finished with the drawing, enter the IRV line-editing mode. Type a line number
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Model EP-2A-88
EPROM Programmer

Implementation Details

IRV can be purchased in 5-inch floppy disk or cassette form. The cassette version has instructions for saving the file to disk; disk-based users may want to do this, even though the program takes exactly 17 seconds to load from cassette. Different versions of IRV are loaded (from either cassette or disk) depending on whether your TRS-80 has 16 K, 32 K, or 48 K bytes of memory. All three programs are contained on either the disk or cassette versions of IRV. You must also answer the MEMORY SIZE? prompt when entering BASIC in order to allow sufficient space for the storage of IRV and its key redefinitions. This is simple to do and is explained in the IRV booklet supplied with the software.

IRV is available from several software suppliers, including The Programmer's Guild (POB 66, Peterborough NH 03458), The Software Exchange (6 South St, Milford NH 03055), and Scott Adams' Adventure International (POB 3435, Longwood FL 32750). IRV is sold with predefined keys (see table 1) and will operate in both Level II and disk BASIC. It is compatible with TRSDOS, NEWDOS, and OS-80. For those of you with new-level V ROMs (or read-only memories, which power up with the abbreviated message R/S L II BASIC instead of spelling out all the words), there is also a version of IRV that will operate on your keyboards: just specify that you have the new Level II ROMs.

Conclusions

• IRV is a versatile piece of utility software for the TRS-80 Model I BASIC programmer. It allows you to redefine any keystroke as any character or series of characters, and to modify BASIC programs by simply typing over a listing of the program.
• IRV can be used to renumber BASIC lines or to merge several lines or parts of lines without having to retype the lines involved. This is a valuable aid when modifying an existing program.
• IRV can be used to turn the cassette motor on and off without repeatedly plugging and unplugging the remote motor-control plug; this is a great help when trying to work with cassette tapes.
• IRV gives every key an auto-repeat facility.

[Editor's note: IRV is one of the most exciting pieces of software I've seen in a long time, primarily because it allows you to devise uses for it that are not specifically planned by the software designers. For example, when editing a line of BASIC code, you can use a single key that is defined as ten copies of the string "S D" (each of which will search for a blank and delete it) to take all of the spaces out of a line: this speeds up the task at hand by eliminating dozens of keystrokes. Because of its open-ended design, IRV can be used in a variety of situations, and I feel that it is as important and innovative as the popular VisiCalc program. Philip Mork, the author of IRV, is to be commended for his fine work...GW]
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Spectrum color graphics board... $299 Unkit, $399 A/T, $449 CSC
2708 EPROM Board (2708s not included)... $385 Unkit, $515 A/T, $615 CSC
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Byte February 1981 211
UNIX Standard Called
For "/usr/group" is a newly
formed group for users of
UNIX and UNIX-like oper­­
ing systems. At a recent
meeting, Western Electric
representative disclosed that his company
has granted approximately
156 commercial licenses at
about 244 commercial sites.
Many present at the meeting
complained about Western Electric's excessive
charges for unsupported software.
The company typically
charges $12,000 for a single
processor license and as
much as $40,000 for users of
the DEC (Digital Equipment
Corporation) VAX machines.
UNIX users, now faced
with many different
implementations of UNIX, are
beginning to be concerned
with standards. To help cope
with the problem, the group
plans to issue a UNIX Users
Guide.

Also at the meeting,
Microsoft announced plans for
implementations of its
Xenix package on the Texas
Instruments T19900, IBM
Series/1, and Point 4 Data
Corporation systems.
For more information
write, /usr/group, POB 8570,
Stanford CA 94305.

UCSD Pascal 4.0 To Be
Released: A new version of
UCSD Pascal will soon be
released by Softech Micro­
Systems. The good news is
that Pascal 4.0 will have
many new features, such as
multitasking and better
screen handling. In other
words, it will be more flexi­
ble, do more jobs, and be
generally more powerful.
The bad news is that it will
generate code that includes
four new p-code instruc­
tions. Hence, the Pascal
MicroEngine, presently the
fastest available Pascal
system, will not be compati­
ble with the new 4.0 version.
Of course, WD (Western
Digital) can recode the
MicroEngine microcode
ROMs (read-only memories)
to include the new instruc­
tions, but I don't know.
Considering that it took WD
nearly a year to come out
with the present ROM set, I
do not foresee the possibility
of MicroEngine Pascal 4.0
for some time yet.

Voice Entry System
For The Apple: Scott In­
struments, Denton, Texas,
will introduce an Apple ver­
sion of its voice entry
system. To be called
"AppleVet," this system will
be able to recognize as
many as 680 words or ut­
erances. An $895 price tag
for the system will include a
plug-in board, a noise-canc­
ing microphone, and dem­
stration disk.

Voice-Operated Telephone Dialer Tested:
Bell Labs, Murray Hill, New
Jersey, has disclosed that it
is testing a telephone dialer
that is voice operated. The
caller can ask for a 4-digit
telephone extension or a
name in the directory of the
system, and the system will
then dial the number.
The dialer has already demon­
strated a high reliability. If in
doubt as to what it is told, it
asks the caller to repeat the
entry.
The system uses a high­
speed array processor at­
tached to a minicomputer to
detect the presence of
speech and identify voice
features to be used by a
word recognizer. The word
recognizer compares the
features of the utterance to
a subset of stored features
and generates a word-candi­
date list, which is ordered
according to the probability
of the word's occurrence.
The system uses a feature
template of the caller's
voice, learned during a train­
ing period, to recognize the
caller's voice input and dial
the number. The system rec­
ognizes only isolated word
inputs, and the user must
speak slowly and haltingly.

Where Are The
64 K-Bit Memory ICs?
At one time, memory size
quadrupled every two years.
But four years have now
elapsed between the in­
roduction of the 16 K-bit
and the 64 K-bit memory
ICs. Skyrocketing develop­
costs and difficulties in
working with such dense
devices have caused most of
the delay. It is likely that the
next quadrupling will take
even longer.
Over two dozen suppliers
are now delivering samples
of 64 K-bit programmable
memories to computer
manufacturers; some of the
samples are already in
limited production. You can
expect to see the first prod­
ucts using 64 K-bit in­
tegrated circuits in the third
or fourth quarter of this
year. However, do not look
for their widespread use un­
til sometime in late 1982 or
1983, when prices should
drop to under $10 each.
American memory manu­
factors are extremely con­
cerned about Japanese com­
petition in this area,
however. The first company
to supply 64 K-bit circuits
was Fujitsu Ltd, and eight
other Japanese manu­
facters are jumping in too.

Apple Stock Goes On Sale: Shares in Apple Com­
puter Inc, one of the most
eagerly awaited public stock
offerings, went on sale early
in December 1980. Apple of­
ered 8% of the company's 52.4 million shares (ie: 4.6
million shares) at a price of
$22 per share.
Apple, incorporated in
1977, reported profits of
$11.7 million on sales of
$117 million for the fiscal
year ending September 26,
1980. 1979's earnings were
$5 million on $48 million
sales, and, in 1978, sales were
$7.8 million with prof­
ts of $793,497.
Steve Jobs, 25 years old,
and Steve Wozniak, 30 years
old, the creators of the
Apple computer, each hold
8.3 million shares. That
means that they own well
over $100 million worth of
stock. A C Markkula, 32
years old, who took Apple
from a garage operation to
its current enviable position,
also holds 8.3 million shares.
Venrock Associates, a ven­
ture capital firm, holds 3.8
million shares. Significant
blocks are held by several
other venture capital con­
cerns. Xerox holds 80,000
shares.

Status Report On The
IAPX-432: Late last spring,
Intel announced its IAPX-432
32-bit microprocessor with
great fanfare. At that time,
only very general specifica­
tions were released and sub­
sequently reported on in this
column. (See "Intel Releases
Data On 32-Bit Microproces­
In production now for two years, the 8086 is just beginning to develop a respectable software base. For example, Digital Research is starting to supply an 8086 version of CP/M. The software bases for the Z8000 and 68000 are still extremely limited and are probably more than a year behind the 8086 software base.

National Semiconductor expects to start shipping samples of its new 16032 16-bit chip set, which promises features similar to the DEC (Digital Equipment Corporation) 32-bit VAX machines. The silicon area on this device (250 by 300 mils) is even larger than Motorola’s 68000. Industry observers concede that this set of devices is significantly more powerful than the 68000, the Z8000, or the 8086. However, many observers doubt whether National will be able to compete with Intel, Zilog, and Motorola, because of its late start and the great expense of such a project.

Soviet Develop 8080A-Like Microprocessor: According to a technical report released by CDC (Control Data Corporation), the Soviet Union is manufacturing a microprocessor that is very similar to Intel’s 8080A design. Control Data obtained samples of the integrated circuit from the Hungarian government, and promptly dissected it. They discovered that the device, called the K801K80.77, uses the same circuit blocks as the 8080A, except that it is adapted for the NMOS (n-channel metal-oxide semiconductor) process.

The manufacturing process, Soviet technicians relaxed line widths and geometry separations and used a larger chip size (214 by 192 mils, compared to 193 by 171 mils for Intel, which Intel later reduced to 165 by 161 mils). The Soviet design is thus more conservative and more expensive to produce. CDC identified several “workmanship flaws” in the devices (eg, questionable die attachments and scraping of bond wires). CDC felt that the Soviet technology was equal to American technology, vintage 1977. The device uses a 48-pin package with eight unused pins.

Home-Banking/Information System Inaugurated: Radio Shack, CompuServe, and United American Service Corporation have joined forces to inaugurate a nationwide home-banking and information system. (See “You Can Bank on It,” January 1981 BYTE, page 10.) Using the new TRS-80 Color Computer, a television receiver, and a modem, a subscriber will be able to pay bills, obtain a bank statement, do bookkeeping, apply for a loan, send and receive electronic mail, and access the CompuServe data base. The service will cost between $15 and $25 a month. United American expects to have forty banks and 20,000 subscribers in the system by the end of the year.

Digital Research To Introduce Record-Retrieve System: Digital Research (DR) will soon introduce a record-keeping software package called BT-80. Basically, it is the kernel for a data-base management system. DR has also indicated that it is “taking a hard look at possibly implementing CP/M, MP/M, and PLI on 68000 and Z8000 systems.” Further, they have purchased a Digital Equipment Corporation VAX machine. Although this machine is primarily intended to keep track of their internal operations, it will be used in the UNIX operating system. Does this mean that DR might be taking a close look at UNIX? After all, several DR staffers have strong UNIX backgrounds.

Digital Research has also disclosed that it is considering the possibility of developing a software interface between CP/NET and the EtherNet systems.

The Microprocessor Catch-22: Intel is currently the only supplier of the 8088 microprocessor (which actually is a 16-bit 8086 with 8-bit input and output). Most designers tend to avoid a part that is not “second-sourced.” In other words, they want to be able to get the part from another source if their primary source has delivery problems. Mostek has said that it is interested in being a second-source of 8086 if demand warrants. My question is, how is the demand to materialize while waiting for a second-source to enter the marketplace?

Random Bits And Random Remarks: The EtherNet’s specifications have been finalized and published. If you would like a copy, contact the EtherNet Literature department at either Xerox, Intel, or Digital Equipment Corporation. NEC is about to introduce a low-cost version of its Spinwriter word-processing printer. This new machine will sell for $1400 (in lots of 100) and it will also be used with a new NEC microcomputer system rumored for introduction later this year. It is being whispered that Epson America Inc., Torrance, California, will soon unveil a low-cost daisy-wheel printer.... Ontrax Corporation, Sunnyvale, California, plans to introduce a 116-megabyte 8-inch Winchester disk drive soon. Before long, General Instrument will place on the market a speech-synthesis chip set in the $5 price range for large volumes. The set will include the controller, 32 K bytes or 128 K bytes of ROM and speech modules....
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DG ELECTRONIC DEVELOPMENTS CO.
Hewlett-Packard is about to set forth a single-board microprocessor version of its 1000-L computer to compete with the Digital Equipment Corporation LSI-11.... Control Data plans to introduce a self-contained PLATO system. The PLATO system is currently a mainframe-based system that includes remote terminals with high-resolution graphics and an extensive library of interactive educational software.... Shugart Associates, the current leader in floppy-disk drives, is rumored to be developing an optical disk-storage system. The basic technology for this system was developed by Shugart's parent organization, Xerox, and Thompson-CSF....

First Xenix/Z8001 System Announced: Tri-Data Systems, City of Industry, California, is the first company to announce a microcomputer system using the Zilog Z8001 and Microsoft's Xenix operating system. The Z8001 employs segmented rather than direct addressing. This desk-top system, called the SST, contains a Z8010 memory-management integrated circuit that dynamically relocates code and protects memory areas. The SST utilizes a ten-slot motherboard for memory expansion in 128 K-byte modules.

Will Microcomputers Leapfrog Over Minicomputers and Mainframes? The newer 16- and 32-bit microprocessors, soon to be sampled by integrated-circuit manufacturers, will contain some new and sophisticated features. For example, the forthcoming NS16000 16-bit microprocessor from National Semiconductor and the iAPX-432 microcomputer from Intel will both have true virtual memory capability that will allow very large memory systems. Sixteen-bit microprocessors like the 8086, Z8000, and 68000 do not lend themselves to virtual memory systems. Intel, however, says that it expects to have an 8086 with virtual memory later this year.

Virtual memory requires the microprocessor to stop in the middle of an instruction if it determines that the address called is not in memory, back up execution of the instruction, and restart the instruction after the contents of that virtual address have been brought in from a mass-storage device (e.g., a hard disk).

Returning to the original question, experts concede that, simply because microcomputers now have features once found only in larger machines, it does not follow that they will overtake minicomputers and maincomputers. Each year the minicomputers and maincomputers add performance features that keep their power far ahead of microcomputers. In fact, the new more powerful microcomputers now have features that were found in larger systems five or more years ago.

Robot Kit Announced: In the December 1979 BYTE News, I predicted that a robot kit would be introduced in 1980. It now seems as if that prediction will come true in 1982. Heath Company recently demonstrated a 3-foot-high robot prototype to Heath retailers that it plans to introduce in 1982. The robot kit will use the Motorola 6802 microprocessor with 4 K bytes of programmable memory and 32 K bytes of ROM (read-only memory). It will have a detachable joystick, voice synthesis, and one multipurpose arm. At this time, it is projected that the kit will cost less than $1000.

Change Of Name: Seagate Technology is the new name for Shugart Technology. Seagate Technology is the Scotts Valley, California, firm that manufactures Winchester-technology 5/4-inch hard-disk drives. The decision to change its name was made by Seagate Technology to help distinguish it from the famous maker of floppy-disk drives. Shugart Associates. Both companies were founded by David Shugart. However, Mr Shugart is no longer affiliated with Shugart Associates.

MAIL: I receive a large number of letters each month as a result of this column. If you wish a response, please include a stamped, self-addressed envelope.
This printer costs less than $450. Beat that... if you can.

This is the Epson MX-70. The lowest priced dot matrix printer you can buy. Now, that in itself should make it very attractive to a lot of people. But you ain't heard the half of it.

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That's what you'd expect from a basic little printer. But here's something you wouldn't expect: the finest graphics package on the market today. Free.

We call it GRAFTRAX II. And it means 480 dots across the page, resolution to 60 dots per inch, and a graphic image free of the jitter and overlap that plagues other printers. You get cleaner grays and finer point resolution.

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For a long time I have been interested in producing recognizable images using a basic Teletype just as you see in many computer stores; and I thought that an expensive camera and interface were required to digitize the picture. But in 1979 an article in *Dr Dobb's Journal* described just how to do this type of image processing with a Diablo printer. (See reference 1.) While I didn't have this type of printer, I figured the concept should work with my Model 43 Teletype or any other printer. After all, the hardware interface required looked simple enough. What could I lose? I worked out my ideas, implemented the system, and now I can process images inexpensively at home. So as a successful personal-computer experimenter, I'll pass on my experience to you.

An Overview of the System

The principle behind this image processing system is easy to understand and implement in a home computer system. The procedure used to prepare a digital picture contains the following steps:

- Connect a light-sensitive device (such as a phototransistor) to the input of an A/D (analog-to-digital) converter that is connected to the computer.
- Mount the phototransistor on the print head of the printer so that it senses light reflected off the paper in the printer's print position.
- Place the paper containing the image in the printer so the print head will traverse the image; then send a series of space characters to the printer to cause the print head to move across the paper.
- Measure and store the values of light intensity at each character position under program control, using A/D-converter output.
- Insert a blank sheet of paper into the printer.
- Use a computer program to print selected characters onto the blank sheet; each character corresponds to the light intensity at a given print position. The higher the intensity, the lighter the character should be.

Having decided that this would be an interesting project, I went to the local electronics store and purchased the necessary parts and assembled the unit. When I loaded in a sample control program written in BASIC, the thing actually worked, and after a little experimentation, I could even recognize some features! Then the fun started, I cut pictures from the magazines lying around the house and started to process them while trying different substitution characters. This was great fun for my entire family!

After a few hours of playing with this system, I started to realize that I needed a better control program that would execute faster. The BASIC program worked at about three characters per second, but with a faster program, I could try larger pictures. The basic functions required were:

- Scan over a variable-width image of any reasonable length at a much faster speed.
- Save the resulting digital data out on a disk file for later use.
- Be able to use a user-defined character-substitution sequence (the more flexible, the better).

The results of this effort are shown in listing 1. Here is a control program written for the CP/M (version 1.4) operating system that does what is required (and a little more). It can scan a line of up to 255 characters and as many as 255 lines (memory permitting). The character-substitution sequence is limited to sixty-four char-
Figure 1: The image reproduced by IMAGE was originally a black-and-white photograph. The analog-to-digital converter used by the author registered a dark-to-light difference of 130, when the picture was processed. Magazine and book photos or artwork can also be reproduced satisfactorily.
acters, and there is a primary and secondary string. Two separate strings were chosen so the printer would not have to have backspace to provide overstrike capability; characters from the secondary string print on top of those from the primary string. However, it does have to return the carriage without feeding a line.

For an example of what a user can do with this system, refer to figure 1. In order to achieve the desired contrast, it was necessary to use overstrike on the darker areas. This picture originally was a black-and-white photograph reproduced from a magazine page. The difference between the maximum and minimum values read from the A/D converter for this picture was decimal 130. The higher this difference is, the more contrast the resulting printout will have and the better it will look.

Using IMAGE

The image processing program, IMAGE, is run as a transient program under Digital Research's CP/M operating system. If IMAGE is being used under some other system, the start-up procedure would change. The program is initially executed by typing in the following command line:

A>IMAGE filename

In this case, the data-storage file is identified as "filename.img". (The extension "img" is assumed by the program.) This will be used for all correspondence with the disk. When control is transferred to this program, a heading and initial menu are displayed, allowing the user to choose one of several options. (See table 1.) The user may type either F, H, M, P, Q, R, S, or T (uppercase or lowercase). Anything else is ignored and causes the full list to be printed.

F: File the Data

This writes out the data that was

Text continued on page 240

Listing 1: IMAGE, the control program for image processing. This version is written for CP/M version 1.4 (compatible with version 2.0) and can scan 255 lines of up to 255 characters. Overstrike capability is provided to increase contrast of output pictures by darkening areas as necessary. Try squinting your eyes or holding the images at different viewing distances to obtain a maximum of picture clarity (i.e., the illusion's gestalt).
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STARTING. CONTINUE SCANNING UNTIL 2SS LINES HAVE BEEN CHECKED
OR THE USER HAS TYPED A KEY (CHECKED AT THE END OF A LINE
ONLY). UHEN DONE, REPORT THE ltAXIltUlt AND ltINiltUlt VALUES READ
FROlt THE AID. ur HOPE THAT THE USER HAS ENOUGH ltEltORY FOR ALL
OF THIS SCAN DATA <ONE BYTE PER COLUltN PER LINE> AS A CHECK
IS NOT ltADE <BUT COULD BE IN NECESSARY>.

complstskit
)
with 16Kmemory

I

JZ
CPI

014C
0140
01SO
01S1
01S4
01S7
01S9
01SC
01SF
0162
0164
0167
016A
0160
016F
0171
0174
0176
0179
017C
0170
01 BO
01B1
01B4
018S
0188
0189
018C
01BF
0190
0193
0194
0197
0198
0199
019C
019F
01AO
01A3
01AS
01A7
01AA
01AB
01AE
01BO
01B3
01BS
01BB
01BB
01BE

AF
320307
30
320407
111006
OE09
CDOSOO
CD9C03
32DS07
1EOD
CDOA04
119FOS
CDF303
1604
3E01
320807
OEFF
210707
3ADS07
47
CDCF~3

;
SCAN

OUT LP
INLP

77

3AD307
BE
D28C01
7E
320307
3AD407
BE
DA9701
7E
320407
23
14
F2AS01
3AOB07
JC
320807
1600
1E20
CDOA04
OS
C27001
1EOD
CDOA04
1EOA
CDOA04
CDFD03
DACF01
OS

001

002

003

XRA
STA
OCR
STA
LXI
ltVI
CALL
CALL
STA
ltVI
CALL
LXI
CALL
ltVI
ltVI
STA
ltVI
LXI
LOA
ltOV
CALL
ltOV
LOA
CltP
JNC
ltOV
STA
LOA
CltP
JC
ltDV
STA
INX
INR
JP
LOA
INR
STA
ltVI
ltVI
CALL
OCR
JNZ
ltVI
CALL
ltVI
CALL
CALL
JC
PUSH

A

ltAX

;SET ltAXIltUlt AND ltINiltUlt VALUES

A

ltIN
D,LLNGTH
;FIND LINE LENGTH FRDH USER
C,9
CPlt
GETNUlt ;GET NUltBER FRDlt USER.
LNGTH
E, 13
;RETURN THE CARRIAGE
PRINT
;TELL USER TO READY THE PAPER
D,POS
ASK
;THIS IS A SECTOR COUNTER
0,4
A, 1

NSECT
C,2SS
H,BUFF
LNGTH
B,A
READ
lt,A
ltAX

;ltAXIltUlt ROU COUNT
;SET BUFFER ADDRESS
;coLUltltN COUNT
;GET A VALUE FROlt THE AID
;KEEP TRACK OF ltAX AND ltIN VALUES

It

001
A,lt
ltAX
ltIN
It

002
A,lt
ltIN
H
D

003
NSECT

;COUNT BYTES
;SECTOR LiltIT YET?
; YES, COUNT THElt

A

NSECT
D,O
E,' ·'
PRINT

;ltOVE ONE COLUltN

B

INLP
E, 13

PRINT
E,10
PRINT
CHECK
TOUT

;NEXT LINE

;CHECK THE KEYBOARD

D
Listing 1 continued on page 226


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Street/Apartment Number
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Listing 1 continued:

018F 110000 DELAY LXI D,0 ;DELAY TO ALLOW RETURN OF CARRIAGE
01C2 1B DELAY DCX D
01C3 E3 DELAY XTHL
01C4 E3 DELAY XTHL
01C5 7E MOV A,E
01C6 82 MOV D,A
01C7 2C2C01 JNZ DELAY
01C9 B1 POP D
01CA 0D DCR C
01C1 C229F01 JNZ OUTLP
01C6 3EFF TOUT MVI A,255 ;COMPUTE NUMBER OF LINES USED
01B1 91 SUB C
01B2 32607 DELAY STA LINES
01B5 0C INR C
01B6 0D DCR C
01B7 0E01 MVI C,1 ;RETRIEVE CHARACTER TYPED
01B8 C04500 CNZ CFM ;UNLESS THERE WAS NONE.
01B9 C214A66 FRMTX LXi H,MAXV ;SETUP THE MAX AND MIN VALUES FOR THE
01BF 3A0D07 LDB MAX USER TO SEE
01E2 5F MOV E,A
01E3 1600 MVI D,0
01E5 01A003 LXI B,3+256+10 ;USE DECIMAL
01EB CD404 CALL BITA
01EB 215A06 LXi H,HINV
01EE 3A0407 LDB MIN
01F1 5F MOV E,A
01F2 1600 MVI D,0
01F4 01A003 LXi B,3+256+10
01F7 CD3404 CALL BITA
01FA 112E06 LXi D,MAXMIN ;PRINT THIS DATA NOW
01FD 0E09 MVI C,9
0200 CD0500 CALL CFM
0202 C31E01 JMP WHAT

PRINT OUT THE IMAGE. THERE ARE TWO TONE ARRAYS THAT WILL BE
USED FOR EACH LINE SUCH THAT 'OVERSTRIKE' MAY BE USED WITH A
PRINTING DEVICE THAT DOES NOT BACKSPACE. EACH TONE ARRAY WILL
BE CONSIDERED SEPARATELY (THEY DON'T HAVE TO BE THE SAME LENGTH).
THIS WILL ALLOW THE USER TO HAVE LOTS OF CONTROL OVER THE
OUTPUT, IF HE/SHE CAN EVER DECIDE ON WHICH CHARACTERS TO USE.

0205 119F05 PRF LXi D,POS ;TELL USER TO READY PAPER
0208 CD0300 CALL ASK
020B 3A0707 LDB LINES ;THIS IS HOW LONG THE SCAN IS
0212 8B FRMTL XCHG ;MOVE DATA ADDRESS TO (DE)
0213 0C PUSH B
0214 211107 LXi H,HINV ;THIS IS THE PRIMARY TONE ARRAY
0217 3A0107 LDB NUMBR1 ;AND ITS LENGTH
021A 05 PUSH D
021B CD4E02 CALL PRINTLN ;PRINT THIS LINE
021E 01 POP D ;RESTORE DATA ADDRESS
021F 215307 LXi H,TONE2 ;NOW USE THE SECONDARY TONE ARRAY
0222 3A0207 LDB NUMBR2 ;NOTE THAT THIS IS ZERO IF THERE IS
0225 47 PUSH D ;NO SECONDARY ARRAY.
0226 35 MOV E,A
0227 44E02 CALL CFM
022A E1 POP H ;SET (HL) TO START OF LINE JUST PRINTED.
022B CD0F03 CALL CALL ;CHECK IF ANYTHING IS PRESENT
022E 0A0502 JC POUT ;AND QUIT IF ANYTHING IS PRESENT
0231 E0A MVI E,10 ;ADD A (LF) TO THE OUTPUT FOR THE NEXT
0233 CD0A04 CALL PRINTLINE ;LINE.
0236 3A0D07 LDB LNGTH ;COMPUTE START OF NEXT LINE
0239 5F MOV E,A
023A 1600 MVI D,0
023C 19 BCD POP B ;DECREMENT LINE COUNTER.
023D 0C DCR B
023E 05 DCR B
023F C21202 JNZ PRTLP ;NEXT
0242 C31E01 JMP WHAT ;BACK TO OPTION SELECTION LEVEL
0245 C1 POUT POP B ;SET STACK STRAIGHT
0246 0E01 MVI C,1 ;GET CHARACTER FROM USER
0248 CD0500 CALL CFM
0249 C31E01 JMP WHAT ;INSTRUCTION R.

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Confusion and problems of inaccurate or even staggering.

The biggest challenge for any multi-user system is co-ordinating requests from several users to change the same record at the same time.

Without proper co-ordination, the confusion and problems of inaccurate or even destroyed data can be staggering.

Our File and Automatic Record Locking features solve these problems. For example: normally all users can view a particular record at the same time. But, if that record is being updated by one user, automatic record locking will deny all other users access to the record until the up-date is completed. So records are always accurate, up-to-date and integrity is assured.

Pros demand file & automatic record locking. OASIS has them.

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Without proper co-ordination, the confusion and problems of inaccurate or even destroyed data can be staggering.

Our File and Automatic Record Locking features solve these problems. For example: normally all users can view a particular record at the same time. But, if that record is being updated by one user, automatic record locking will deny all other users access to the record until the up-date is completed. So records are always accurate, up-to-date and integrity is assured.

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Listing 1 continued:

02AA 115C00 LXI 000CH ;USE DEFAULT FCB
02AD 0E13 NVI C,19 ;DELETE THE FILE
02AF C00500 CALL CPM
02B2 115C00 LXI 000CH
02B5 0E16 NVI C,22 ;CREATE IT NOW
02B7 C00500 CALL CPM
02BA 115C00 LXI 000CH
02BD 0EOF HVI C,15 ;AND OPEN IT.
0287 C00500 CALL CPH
02BA 3C INR A
02CB 115C00 LXI D,OOSCH
02C9 0EOF HVI C,15 ;AND OPEN IT.
02D1 21D307 LXI H,HAX ;THIS IS WHERE IT IS STORED.
02D4 AF XRA A ;SET INITIAL SECTOR COUNTER TO ZERO
02D5 327COO STA 005CH+32;IN DEFAULT FCB.
02D8 3A0807 LDA NSECT ;AND THIS IS HOW LONG
02DB F5 FILELP PUSH PSU
02DC 115F06 NOTHING LXI D,128 ;TELL USER TO SCAN SOMETHING FIRST.
02DE 118000 LXI D,128 ;COHPUTE ADDRESS OF NEXT
02F0 115C00 MVI C,16 CALL CPM
02F2 39 21D307 LXI H,HAX
02F4 F1 POP H
02F5 3D DCR A
02F6 C2DB02 JNZ FILELP
02F9 115C00 MVI D,000CH ;CLOSE THE FILE NOW
02FC 0E10 CALL CPM
0301 C31E01 JHP UHAT
0304 115F06 NOTHING LXI D,128 ;TELL USER TO SCAN SOMETHING FIRST.
0307 0EOF MVI C,9 CALL CPM
0309 C00500 CALL CPH
030C C31E01 JHP UHAT
030F 115C00 MVI D,000CH
0312 READLP PUSH PSU
0315 C3 ES PUSH H
0318 320807 STA NSECT ;READ IN THE FILE THAT WAS GIVEN IN THE INITIAL COMMAND.
0322 F5 READLP PUSH PSU
0325 3C INR A
0328 C24003 XRA A ;SET THE TRANSFER ADDRESS
032B 0E1A NVI C,26
032E C00500 CALL CPM
0331 115C00 LXI 000CH ;READ A SECTOR
0335 0E14 NVI C,20 CALL CPM
0338 0EOF HVI C,16 CALL CPM
033B 115C00 LXI 000CH
033F 0E19 DAD D ;COMPLETE NEXT ADDRESS
0342 3C INR A
0345 32203 JMP READLP
0348 3300 POP PSW ;SAVE SECTORS READ
034B 320807 STA NSECT
034E 115C00 MVI D,000CH ;CLOSE THE FILE
0351 0E10 CALL CPM
0354 C00500 CALL CPM

Circle 156 on inquiry card.
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<thead>
<tr>
<th>Line</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>034C</td>
<td>C3DC01</td>
<td>JMP PRTHX ; GIVE DENSITY LIMITS.</td>
</tr>
<tr>
<td>034F</td>
<td>117704</td>
<td>NOFILE LXI B, nfshg ; TELL USER THAT THIS FILE IS NOT</td>
</tr>
<tr>
<td>0352</td>
<td>0E09</td>
<td>MVX C, 9 ; SAVED.</td>
</tr>
<tr>
<td>0354</td>
<td>C06000</td>
<td>CALL CPM</td>
</tr>
<tr>
<td>0357</td>
<td>C31E01</td>
<td>JMP WHAT ; BACK TO OPTION LEVEL</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Line</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>035A</td>
<td>11D405</td>
<td>TSET LXI B, ngs1</td>
</tr>
<tr>
<td>035B</td>
<td>0E09</td>
<td>MVX C, 9</td>
</tr>
<tr>
<td>035F</td>
<td>C06000</td>
<td>CALL CPM</td>
</tr>
<tr>
<td>0362</td>
<td>11FO07</td>
<td>LXI B, input1 ; PUT THE STRING HERE</td>
</tr>
<tr>
<td>0365</td>
<td>0E0A</td>
<td>MVX C, 10 ; USE CP/M'S LINE INPUT ROUTINE</td>
</tr>
<tr>
<td>0367</td>
<td>C06000</td>
<td>CALL CPM</td>
</tr>
<tr>
<td>036A</td>
<td>11E006</td>
<td>LXI B, ngs2 ; ASK FOR SECONDARY ARRAY</td>
</tr>
<tr>
<td>036B</td>
<td>0E08</td>
<td>MVX C, 9</td>
</tr>
<tr>
<td>036E</td>
<td>C06000</td>
<td>CALL CPM</td>
</tr>
<tr>
<td>0372</td>
<td>11F107</td>
<td>LXI B, input2 ; PUT IT HERE</td>
</tr>
<tr>
<td>0375</td>
<td>0E0A</td>
<td>MVX C, 10</td>
</tr>
<tr>
<td>037D</td>
<td>C31E01</td>
<td>JMP WHAT ; NOTHING TO IT.</td>
</tr>
</tbody>
</table>

### SET MAX

- LXI B, setmax ; TELL USER WHICH ONE TO TYPE. |
- MVX C, 9 |
- C06000 CALL CPM |
- CALL GETNUM ; AND GET IT. |
- STA MAX ; AND SAVE IT. |
- LXI B, setmin ; NOW DO THE SAME FOR THE MIN VALUE. |
- MVX C, 9 |
- C06000 CALL CPM |
- CALL GETNUM |
- STA MIN |
- JMP WHAT ; NO CHECK IS MADE FOR LEGAL VALUES. |

### ROUTINE TO READ IN A DECIMAL NUMBER TYPED BY THE USER. THE RESULTING VALUE IS RETURNED IN REGISTER (A). ALL REGISTERS ARE USED AND NOT RESTORED.

<table>
<thead>
<tr>
<th>Line</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>039C</td>
<td>119007</td>
<td>GETNUM LXI B, inbuff ; INPUT BUFFER TO USE</td>
</tr>
<tr>
<td>039F</td>
<td>95</td>
<td>PUSH D</td>
</tr>
<tr>
<td>03A0</td>
<td>0E0A</td>
<td>MVX C, 10</td>
</tr>
<tr>
<td>03A2</td>
<td>C06000</td>
<td>CALL CPM</td>
</tr>
<tr>
<td>03A5</td>
<td>0F</td>
<td>XRA A ; CORRECTIONS. CLEAR THE ACCUMULATOR.</td>
</tr>
<tr>
<td>03A6</td>
<td>E1</td>
<td>POP H ; POINT TO BUFFER</td>
</tr>
<tr>
<td>03A7</td>
<td>23</td>
<td>INX H ; AND SKIP OVER BOTH COUNTERS</td>
</tr>
<tr>
<td>03A8</td>
<td>332007</td>
<td>STA MAX ; AND SAVE IT.</td>
</tr>
<tr>
<td>03B0</td>
<td>11D004</td>
<td>LXI B, setmax ; NOW DO THE SAME FOR THE MIN VALUE.</td>
</tr>
<tr>
<td>03B2</td>
<td>0E09</td>
<td>MVX C, 9</td>
</tr>
<tr>
<td>03B6</td>
<td>C06000</td>
<td>CALL CPM</td>
</tr>
<tr>
<td>03B9</td>
<td>0D0500</td>
<td>CALL GETNUM</td>
</tr>
<tr>
<td>03C0</td>
<td>11D007</td>
<td>STA MIN</td>
</tr>
<tr>
<td>03C3</td>
<td>C31E01</td>
<td>JMP WHAT ; NO CHECK IS MADE FOR LEGAL VALUES.</td>
</tr>
</tbody>
</table>

### GET RNM

- LXI B, inbuff ; INPUT BUFFER TO USE |
- MVX C, 10 |
- CALL DPX |
- USE CP/M'S INPUT ROUTINE TO ALLOW |
- XRA A ; CORRECTIONS. CLEAR THE ACCUMULATOR. |
- POP H ;POINT TO BUFFER |
- INX H ;AND SKIP OVER BOTH COUNTERS |
- STA MAX ;AND SAVE IT. |
- STA MAX |
- JMP WHAT ; NO CHECK IS MADE FOR LEGAL VALUES. |

**Listing 1 continued on page 234**
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INVENTORY ANALYSIS
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BUSINESS CHECK REGISTER AND BUDGET: Our Check Register and Budget program expanded to include up to 50 budgetable items and up to 400 checks per month. Includes bank statement reconciling and automatic check search (48K). $49.95

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LOGIC SIMULATOR: SAVE TIME AND MONEY. Simulates your digital logic circuits before you build them. CRTs, TTL, or whatever, if it's digital logic, this program can handle it. The program is an interactive, menu driven, full-fledged logic simulator capable of simulating a large network of user-specified input patterns. It will handle up to 1000 gates, including NANDS, NORs, INVERTERS, FLIP-FLOPS, SHIFT REGISTERS, COUNTERS and user-defined MACROS. Up to 40 user-defined random or binary input patterns. Simulation results displayed on CRT or printer. Accepts network descriptions from keyboard or from LOGIC DESIGNER for simulation. $159.95

LOGIC DESIGNER: Interactive Hi-Res Graphics program for designing digital logic systems. A menu driven series of keyboard commands allows you to draw directly on the screen up to 15 different gate types, including 10 gate shape patterns supplied with the program and 5 reserved for user specification. Standard patterns supplied are NAND, NOR, INVERTER, EX-OR, T-FLOP, JK-FLOP, D-FLOP, RS-FLOP, 4 BIT COUNTER and N-BIT SHIFT REGISTER. User interconnects gates just as you would normally draw using line graphics commands. Network descriptions for LOGIC SIMULATOR generated simultaneously with the CRT diagram being drawn. $159.95

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Listing 1 continued:

03C3 C9 RET ;ALL DONE, RESULT IS IN (A).
03C4 110006 BADNUM LXI D,BADNP ;TELL USER TO TRY AGAIN.
03C7 0E09 MVI C,9
03C9 CD0500 CALL CPM
03CC C39C03 JMP GETNUM

READ THE A/D AND AVERAGE OVER EIGHT READS TO REDUCE THE SCATTER THAT IS BOUND TO EXIST WITH THIS SIMPLE IMAGE PROCESSING SYSTEM.

03CF E5 READ PUSH H
03D0 C5 PUSH B
03D1 210000 LXI H,0 ;KEEP SUM HERE
03D4 0608 MVI B,B
03D6 CD1604 RLP1 CALL ATOD ;READ THE A/D
03D9 85 ADD L ;ADD VALUE TO OUR SUM
03DA 6F HOV L,A
03DB 3EO0 HVI A,0
03DD BC ADC H
03DE 67 HOV H,A
03DF 05 DCR B
03E0 C2D603 JNZ RLP1
03E3 06E03 MVI B,3 ;NOW DIVIDE BY 8
03E5 7C MOV L,A
03E7 1F RAR
03E8 6F MOV H,A
03E9 70 MOV A,L
03E9 1F RAR
03EB 6F MOV L,A
03EC 05 DCR B
03ED C2E03 JNZ RLP2
03E4 7C MOV A,H
03E6 7C MOV A,H
03E7 1F RAR
03E8 6F MOV H,A
03E9 70 MOV A,L
03E9 1F RAR
03EB 6F MOV L,A
03EC 05 DCR B
03ED C2E03 JNZ RLP2
03F0 C1 POP B
03F1 E1 POP H
03F2 C9 RET

UTILITY ROUTINES...

ASK A MESSAGE POINTED TO BY (DE), AND GET A ONE CHARACTER
RESPONSE. THE RESPONSE IS RETURNED IN (A). ALL REGISTERS
ARE USED AND NOT RESTORED.

03F3 0E0A ASK MVI C,R ;PRINT MESSAGE AND GET RESPONSE
03F5 CD0500 CALL CPM
03F8 0E01 MVI C,1
03FA C30500 JMP CPM

CHECK THE KEYBOARD TO SEE IF ANYTHING IS READY. ON SYSTEMS
THAT LATCH THE OUTPUT FROM THE TERMINAL, THE USER JUST HITS
A KEY AND THEN THIS WILL DETECT IT. ON OTHER TYPES (LIKE MINE),
THE USER MUST HOLD THE KEY DOWN UNTIL THIS ROUTINE IS CALLED.
A MAJOR INCONVENIENCE. ALL REGISTERS EXCEPT (A) ARE SAVED.
IF A KEY IS TYPED, THEN THIS WILL RETURN WITH THE CARRY FLAG
SET.

03FD C5 CHECK PUSH B ;CHECK THE KEYBOARD FOR ANYTHING
03FE E5 PUSH H
03FF 0E0B MVI C,11
0400 0E0B MVI C,11
0402 CD0500 CALL CPM
0404 0F11 POP D
0406 0E0B MVI C,11
0407 C1 POP B
0408 1F RAR
0409 C9 RET

SEND ONE CHARACTER TO THE LIST DEVICE. THE CHARACTER MUST BE
IN REGISTER (E) AND ALL REGISTERS (EXCEPT A) ARE SAVED.

040A C5 PRINT PUSH B ;PRINT (E)
0409 E5 PUSH H
040B CD0500 CALL CPM

Listing 1 continued on page 236
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Listing 1 continued:

0412 D1 \ POP D \read a/d (.34 ms per read average).
0413 E1 \ POP H \read a/d
0414 C1 \ POP B
0415 C9 \ RET

READ THE A/D. IT IS ASSUMED HERE THAT THE SETUP IS SIMILAR TO THAT PROPOSED IN DDJ, OCTOBER 1979. HERE, THE A/D IS CONNECTED TO OUTPUT PORT 2, AND THE RESULT OF THE COMPARE IS READ FROM INPUT PORT 2, BIT 0. FOR THE DIGITAL GROUP SYSTEM, THE INPUT DATA WILL BE INVERTED BY THE CPU CARD. IF YOURS DOES NOT WORK THIS WAY, CHANGE THE 'JNZ' TO A 'JZ' IN THE CODE BELOW. THE RESULTING VALUE IS RETURNED IN (A) AND ALL OTHER REGISTERS ARE SAVED. THIS PROCEDURE USES A BINARY SEARCH TECHNIQUE TO FIND THE VALUE OF THE VOLTAGE INPUT TO THE A/D.

0416 C5 \ ATAD \ PUSH B \read a/d (.34 ms per read average).
0417 AF \ XRA A \read the a/d
0418 0680 \ MVI B,128
0419 0680 \ MVI B,8
041A B0 \ ADLOOP \ ADD B \set the d/a
041B F5 \ PUSH PSU
041D D302 \ OUT 2
041F FS \ PUSH PSU
0420 DB02 \ IN 2 \read and check bit no
0422 E601 \ ANI 1
0424 C22A04 \ JNZ ADI \ *** system dependent ***
0427 F1 \ POP PSW
0428 90 \ SUB B \too far, back off
0429 F5 \ PUSH PSW
042A 7B \ ADI \MOV A,B \next bit
042B 1F \ RAR
042C 47 \ MOV B,A
042D F1 \ POP PSW
042E 0D \ DCR C \do all 8 bits
042F C21C04 \ JNZ ADLOOP
0432 CI \ POP B
0433 C9 \ RET

BINARY TO ASCII ROUTINE
THIS ROUTINE WILL CONVERT A 16 BIT BINARY NUMBER INTO ASCII
ACCORDING TO A SPECIFIED RADIX VALUE. THE DIGITS USED ARE:
0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F,G,H,I,J,K...ETC
TO USE:
HL=ADDRESS OF A BUFFER FOR THE RESULTING ASCII DIGITS
DE=CONTAINS THE 16 BIT NUMBER TO CONVERT
B=THE MAXIMUM LENGTH OF THE BUFFER
C=THE RADIX TO USE (<2,16,16,...ETC)
ON RETURN, THE CARRY FLAG IS SET IF AN OVER-FLOW OCCURRED
(BUFFER WAS TOO SMALL).

0434 3E30 \ BTOA \ MVI A,'0' \adjust the radix for ascii conversion
0435 8E01 \ ADD C
0436 FE39 \ CPI '9' \9+2
0439 DA3E04 \ JC BTOA1
043C C607 \ ADI 7
043E 4F \ BTOA1 \MOV C,A
0442 90 \ MOV A,B
0443 3E30 \ BTOA2 \MVI A,'0'
0444 C24004 \ JNZ BTOA2
0447 2B \ DCX H

CONVERT THE NUMBER NOW,

0448 3E30 \ MVI M,'0' \zero out the first digit.
0449 7A \ MOV A,D \check for zero
044B 53 \ MVI M,'0'
044C 30 \ DCX E

Listing 1 continued on page 238
ANALOG INTERFACES

Industrial, Scientific, Laboratory, or Commercial Microcomputer Users.

Industrial quality data conversion boards are available for APPLE, S-100, PET, TRS-80, AIM, and KIM systems. Tecmar can provide individual boards, data conversion subsystems, or complete Data Conversion Systems. Tecmar's growing product line offers outstanding features, meticulous engineering, exceptional documentation, and a seven year record of proven reliability.

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AD-200 Features
- 12 bit accuracy and resolution standard
- 30 KHz conversion rate standard
- 16 single-ended or 8 true differential inputs - jumper selectable
- External trigger of A/D operation
- Output formats: Two's complement, binary, offset binary
- Auto channel incrementing from any channel to any channel
- Data is latched providing pipelining for higher throughputs
- Provision for synchronizing A/Ds
- Utilizes interrupt or status test
- Jumper selectable input ranges: ±10V, ±5V, 0 to +10V, 0 to +5V
- 3 microsecond conversion time
- Minimal software required
- Optional 4-20mA board available

S-100 PET² TRS-80¹ AIM³ KIM²

The original Tecmar data conversion boards (AD-100 and DA-100) continue to solve less sophisticated conversion problems. These S-100 boards interface to the PET, TRS-80, AIM, and KIM through S-100 expansion interfaces.

AD-100 Features $495
- 12 bit accuracy and resolution
- 30 KHz conversion rate
- 16 single-ended or 8 true differential inputs
- Jumper selectable input ranges: ±10V, ±5V, 0 to +10V, 0 to +5V
- Minimal software required
- IEEE S-100

DA-100 Features $395
- 12 bit accuracy and resolution
- 3 microsecond settling time
- Jumper selectable output ranges: ±10V, ±5V, ±2.5V,
- Minimal software required
- IEEE S-100
- Optional 4-20mA board available

S-100 Real Time Video Digitizer
- Digitizes and Displays in 1/60 sec. flicker-free
- 16 Gray Levels
- Switch Selectable to display Black and White Graphics (8 pixels/byte)
- Maximum Resolution: 512 pixels/line x 240 lines
- Minimal software requirements $850

Options for AD-200
- Programmable gain up to 500 $ 175
- 14 bit accuracy $ 717
- 16 bit accuracy $1,117
- 100 KHz conversion rate $ 517
- 125 KHz conversion rate $ 617
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- Thermocouple cold junction compensation $125
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### Listing 1 continued:

```assembly
044E 18 BL 044F 78 DB 0450 82 DB 0451 C8 DB
0452 E5 DB 0453 C5 DB 0454 7E DB 0455 3C DB
0456 89 DB 0457 C26C04 DB 0458 3630 DB
045C 28 DB 045D 05 DB 045E C7504 DB 045F 7E DB
0462 FE20 DB 0464 C25404 DB 0467 3630 DB
0469 C25404 DB 046C 76 DB 046D 7E DB
0472 C2504 DB 0473 37 DB 0475 9C DB
0474 C7 DB 0475 C1 DB 0476 E1 DB 0477 C24E04 DB
0478 37 DB 0479 C9 DB
```

### Data Storage Area

```
0702 00 DB 0704 00 DB 0706 00 DB 0708 00 DB
0709 00 DB 070A 00 DB 070B 00 DB 070C 00 DB
070D 00 DB 070E 00 DB 070F 00 DB
0710 0E DB 0712 0E DB 0714 0E DB 0716 0E DB
0718 0E DB 071A 0E DB 071C 0E DB 071E 0E DB
```

Listing 1 continued on page 240
A Microcomputer for everyone at a Micro Price

The unique and valuable components of the MicroAce

The MicroAce is not just another personal computer. Quite apart from its exceptionally low price, the MicroAce has two uniquely advanced components: the powerful BASIC interpreter, and the simple teach yourself BASIC manual.

The unique versatile BASIC interpreter offers remarkable programming advantages:

- Unique 'one-touch' key word entry: the MicroAce eliminates a great deal of tiresome typing. Key words IRUN, PRINT, LIST, etc. have their own single-key entry.
- Unique syntax check. Only lines with correct syntax are accepted into programs. A cursor identifies errors immediately. This prevents entry of long and complicated programs with faults only discovered when you try to run them.
- Excellent string-handling capability — takes up to 26 string variables of any length. All strings can undergo all relational tests (e.g., comparison). The MicroAce also has string input — to request a line of text when necessary. Strings do not need to be dimensioned.
- Up to 26 single dimension arrays.
- FOR/NEXT loops nested up to 26.
- Variable names of any length.
- BASIC language also handles full Boolean arithmetic, conditional expressions, etc.
- Exceptionally powerful edit facilities, allows modification of existing program lines.
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- Timer under program control.
- All characters printable in reverse under program control.
- LINES of unlimited length.
- PEEK and POKE enable entry of machine code instructions, USR causes jump to a user's machine language sub-routine.
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For just $149.00 (including handling charge) you get everything you need to build your own personal computer at home. PCB, with IC sockets for all ICs; case; leads for direct connection to a cassette recorder and television (black and white or color); everything!

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$149.00 with 1K COMPLETE

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collected onto the file specified in the initial command “filename”. If this file already exists, it will be deleted. This allows the user to keep the basic data for processing at a later time. When completed, the user is returned to the option-selection level. Two possible errors may occur here:

- “Disk or directory full”. This means that you don’t have enough room on the current disk to save all the data. Sorry, you will have to start over. Note that the storage space required is 1 byte per column per line.
- “No image was scanned”. Here, you must scan an image before trying to file the data.

H: Help Me
The user can type H to view the whole menu again. Normally only the “option” line is printed.

M: Set the Maximum and Minimum Values
This option allows the user to specify what values are to be used in place of the actual maximum and minimum values in the data array. This is necessary when you want to print two separate pictures with the same character-substitution sequence. (For example, this is the case when, due to its size, a picture was broken up into two or more sections.) The numbers are entered as decimal numerals in the range 0 to 255. If the data is filed after making this change, the new maximum and minimum values will be permanent.

P: Print the Data
When you are ready to print the image, with the character-substitution array set and an image scanned, this option will give you time to change the paper and position the carriage by issuing the following message:

Position paper (space)

Hit the space bar when ready to begin. The program scales all of the light intensity levels stored so that the picture fits the length of character-substitution array entered. (Both the primary and secondary arrays are treated separately.) To terminate the printed listing prior to the actual end of the data, type any key. You are returned to the option-selection level.
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Q: Quit and Return to CP/M
This returns control directly to CP/M. If you want to save the collected data, this must be done prior to quitting the program.

R: Read In the File
The current disk will be searched for "filename.img", as specified in the initial command. If it is found, the entire data file will be read into memory. The maximum and minimum values associated with the data will be printed. If the file cannot be found, then an appropriate message will be printed and the user will be returned to the option-selection level.

S: Scan a New Page
The length of the scan line will be asked first. Type in the decimal number of characters per line (1 to 255). You will be given a chance to position the paper before the scan is started. Hit the space bar to begin. The program will scan over the image in the print device until 255 lines have been scanned or a key has been hit. The maximum and minimum values read from the A/D converter are printed, and control is returned to the option-selection level.

T: Set the Tone Array
This is the heart of the processing system. For each column position, up to two characters will be typed to represent the A/D-determined intensity at this point. To accomplish this character substitution, two tone arrays are used. A primary tone array is always used and consists of up to sixty-four characters chosen by the user. They are entered in the order of maximum darkness to minimum darkness. (Minimum darkness is usually a space.) A secondary tone array can also be given for overstriking characters to achieve greater density variation. This array, if given, is generally the same length as the primary array, although this is not required. The program will determine which character to use for any given value read from the A/D converter by the procedure:

\[
\text{SCALE} = \frac{\text{MAX} - \text{MIN}}{\text{N}} \\
\text{INDEX} = \frac{\text{VALUE} - \text{MIN}}{\text{SCALE}} \\
\text{if INDEX} > \text{N-1 then INDEX} = \text{N-1}
\]

where:

\[
\text{MAX} = \text{the maximum integer value in data.} \\
\text{MIN} = \text{the minimum integer value in data.} \\
\text{N} = \text{the integer number of characters in the tone array.} \\
\text{VALUE} = \text{the integer value read from the A/D converter for this position.} \\
\text{SCALE} = \text{the integer scale factor to use.} \\
\text{INDEX} = \text{the integer index into the tone array (0 to N-1).}
\]

The result of these computations (INDEX) specifies which of the N characters in the tone array will be used. A 0 refers to the first (or maximum density) character and (N-1) refers to the last available character (the minimum density). Note the value of (INDEX) is prevented from being greater than (N-1).

Integer arithmetic is used for all computations and, as such, the number of characters in the tone array affects the scale factor used. If the number of characters in the tone array is not an even divisor of the maximum-to-minimum variation, then the truncation that occurs in computing the scale factor has the effect of extending the minimum-density character until the number is an even divisor. This can cause large blank areas to appear in the final printout.

The tone arrays are entered using CP/M's buffered input routine. This means that all normal correction keys can be used on mistakes. Type a carriage return to end the line. To skip
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the secondary tone array, just type a return. This doubles the output speed but won’t allow overstrike on certain characters.

**Setting the Tone**

To help me decide which characters to choose for the substitution arrays, I wrote a simple program (though it’s not included here) that took the character set as a dot matrix and looked at all overstruck combinations of two characters. The following algorithm was used to determine the resulting intensity from each combination:

$$I(i,j,k,l) = RCI \times [P(i,j,k) + (S(i,j,l) - RCI \times P(i,j,k))]$$

$$INTENSITY(k,l) = \text{sum} I(i,j,k,l)$$

where:

$$INTENSITY(k,l) = \text{intensity value for character ”k” printed over character ”l”}$$

$$P(i,j,k) = \text{primary character number } k, \text{ row } i, \text{ and column } j.$$

$$= 0, \text{ if this dot is not printed}.$$

$$= 1, \text{ if this dot is printed}.$$

$$S(i,j,l) = \text{secondary character number } l, \text{ row } i, \text{ and column } j.$$

$$= 0, \text{ if this dot is not printed}.$$

$$= 1, \text{ if this dot is printed}.$$

$$RCI = \text{ribbon condition index (range from 0.0 to 1.0)}.$$

$$n = \text{number of rows for character matrix}.$$

$$m = \text{number of columns for character matrix}.$$

Using this method, I checked all combinations of two characters and made a list ranging from maximum to minimum darkness. (There were 4560 in all.) The resulting intensities ranged from 0 (a space over a space) to 27 (a # on an @). To account for the results of typing one dot on top of another, an RBI (ribbon-condition index) was used. It works like this: for a new ribbon (RBI=1.0), two superimposed dots are not blacker than one dot. However, for an older ribbon (RBI<1.0), the second dot will result in a darker intensity. A value of 0.75 for RBI seems about right for a normal ribbon. The characters I use for the Teletype 43 are shown in table 2. Note that the quotes (“) at the ends are used here as delimiters and should not be typed in.

If your printer does not use a dot-matrix system, there are other ways to objectively judge character combinations. Write a simple BASIC program to print out a character combination and then position the phototransistor over this and read the result with the A/D converter. Or, of course, you could just guess. The characters listed in table 2 would be a reasonable place to start. Experimentation is the way to find the best character-substitution array for your own printer.

**Recognition of Images**

Pictures generated by this system are easier to recognize if they are “blurred” by moving the paper or your head rapidly, by squinting, or by viewing the object from a distance. This has the effect of reducing the geometric distortion caused by the sudden change in contrast from one character to the next. Such blurring can be automated. A simple procedure would be to select the intensity value at a given point by averaging the points around it. This average value is then used when
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selecting an appropriate character to print. Different amounts of blurring can be simulated by using more or fewer points in the averaging process. Obviously, the current program would have to be modified to accomplish this.

Area for Further Investigation

Due to the digital form of the data, an area that would be interesting to look into is anamorphic art. This term refers to pictures that are greatly distorted (usually by some geometric procedure) and the original contents are difficult to recognize without transforming the image back by an appropriate means (like curved mirrors). A description and analysis of anamorphic art is contained in Martin Gardner's "Mathematical Games" noted in the references. Because the images are in digital form, transformation becomes a mathematical problem and not an artistic one. I am sure that many enthusiastic hobbyists can produce fascinating pictures along these lines.

Running Under Another Operating System

This program can be modified to run under most operating systems, in-
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including cassette-tape systems, if the necessary system routines are provided. The calling sequence for all CP/M functions is to specify the desired function by using the C register, loading any arguments using the DE register pair, and calling location 0005 (hexadecimal). Function results are returned in register A. The functions used by IMAGE are:

- Function 1: Read a character from the keyboard. This routine will return a character (with bit 7 cleared) in the A register. If a character is not ready, it waits until it is.
- Function 5: Print a character on the list device. The contents of the E register are sent to the printer.
- Function 9: Print a message. The ASCII (American Standard Code for Information Interchange) character string pointed to by DE will be sent to the console device. A dollar sign ($) terminates the message.
- Function 10: Buffered input. The register pair DE points to a buffer that will contain a line typed by the user. The first byte must contain the maximum number of characters to be read; the second byte will be set to the actual number read (less the carriage return). The following space will be used to store the input characters (bit 7 cleared).
- Function 11: Interrogate console status. This checks the status of the keyboard. If a character is ready to input (by function 1), the A register will be set to hexadecimal FF. Otherwise the A register is cleared.
- Function 15: Open a file. For this call, DE points to a FCB (file control block) describing the file that will be opened. The program uses the default FCB built by the initial command processor within CP/M. The file is opened for either reading or writing unless the A register contains hexadecimal FF, indicating that the file was not present.
- Function 16: Close a file. Pointing DE at the FCB for the desired file will cause it to be closed. All I/O (input/output) must be completed. The directory will be updated.
- Function 20: Read the next record. The next 128-byte record will be read from the file (DE points to the proper FCB). The data will be read into a buffer whose address is set with function 26. On return, A will contain 0 (if the transfer went properly) or a 1 (if the end of the file was reached).
- Function 21: Write the next record. The FCB pointed to by register pair DE indicates from which file the 128 bytes are taken. The address of the data must be set by function 26. On return, the A register should contain 0; anything else is interpreted by IMAGE as an out-of-space error.
- Function 26: Set the DMA (direct memory access) address. The next disk read or write will reference data at the address specified by register pair DE. If this is never called, hexadecimal 0080 will be assumed by default.

So there's my system. It's simple, inexpensive, and leaves enough room for your creative modifications such as manipulating blurrriness, shadows, outlines, overstrikes, etc. The possibilities are myriad—how about using colored ribbons on your printer to obtain different overstrike hues? Whatever modifications you design, enjoyment is guaranteed.

References

For those readers who do not care to type in a program as long as the one in listing 1, the author is willing to provide source code on a floppy disk for $10. The disks will be IBM soft-sectored format, written in single density, and will be compatible with CP/M versions 1.4 and 2.0. Contact:

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Southern California—a mecca for engineers—is rallying in anticipation of a booming business economy because of increased military spending expected under the new Reagan administration. The result is that the demand for electrical/electronic, computer science, data communications or aerospace/aeronautical engineers in the Golden Gate State has never been better.

As one engineer working in Southern California recently remarked, “If an engineer doesn’t like the job, he or she can literally walk across the street to another one.”

The hub of Southern California’s aerospace activity is located in Los Angeles County, Orange County, and San Diego County, areas which in 1980 utilized the talents of 55,859 engineers. This year, according to economists, an additional 15,040 will be required by the high-technology companies that need them.

With 40% of the total aerospace population employment in the United States located in Southern California, New England, another high technology area, runs a distant second, providing 14% of the nation’s aerospace engineering employment. Southern California will continue to outshine the rest of the nation in this industry during the 1980s because of two reasons:

1. The projected spurt in defense spending by the Reagan administration.
2. The construction of commercial, fuel-efficient jet aircraft that will be sold here and abroad.

A spokesman for a major aircraft manufacturer says, “There’s talk of a new military bomber, either the B-1 or another one. There is even the possibility that the MX missile program may be sited for our state, and that the cruise missile program will be accelerated. The Polaris, a submarine-launched missile, may also be built here.”

Another engineer at the plant of a major aircraft manufacturer confided, “Because Reagan is homegrown, we hope he’ll let us build the B-1 bomber here.” He added that in addition to the need for aerospace engineers, there are also great opportunities for those interested in alternative energy sources.

The reason is that tax credits of 25% to 50% are awarded to anyone who installs solar heating. Approximately 100,000 solar-heated
homes and businesses exist in the Golden Gate State. Obviously Southern California is a hot market for this field, which is growing in importance.

The computer business is also booming, and companies are scouring the country seeking engineers with the qualifications necessary to develop the high technology products we need for tomorrow.

In addition to the progressive scientific climate, the weather in Southern California is “the closest thing to perfect,” according to the United States Weather Bureau. The average temperature is a sunny 71 degrees, with only 14 inches of rain a year, falling mostly between November and March. ("It never rains in Southern California," so the song goes.) The proximity of the ocean, the desert, and the mountains makes it possible to ski, bask in the desert sun, and swim in the Pacific ocean, all in the same day.

Southern California’s standard of living is one of the highest in the nation: the median family income in Orange County in 1980, for example, was $29,000. Los Angeles families averaged $26,000, Santa Barbara, $27,000, and San Diego households took home $24,000. But the Catch-22 on housing is that the median price was a whopping $100,000, and this substantial rate is exacerbated (if not caused) by a housing shortage and high interest rates. Businesses employing engineers are, in some instances, trying to circumvent this problem by paying part of the interest rate on the mortgages of employees that relocate. For example, if the mortgage rate is 14%, the company may pay 4% of the cost.

To help ease the housing problem, business-oriented Lieutenant Governor Michael Curb has assembled a task force of real estate, government, and labor officials. He blames rent control for the shortage because he says it discourages construction of new housing.

“If we could increase the supply of houses, demand would diminish, and so would prices,” an aide says. He adds, “Average personal income in the state is the highest in the country; it’s $9,900 compared with a national average of $8,700. Housing is the only major stumbling block to an otherwise excellent quality of life.”

He concludes, “Today business is no longer a dirt word. It’s a four letter word meaning jobs.”

This statement is borne out by recent figures that show that California will continue to grow at a rate of 30% to 50% through the mid-’80s. Economists in the state predict that there will be 300,000 new jobs needed for manufacturing in the next few years, a sure sign of the state’s vibrant economy.

Another advantage of living and working in Southern California is that it offers engineers the opportunity to continue their education. The University of California at San Diego, for example, boasts three Nobel Prize winners on its staff and 36 members of the National Academy of Sciences.

California Institute of Technology in Pasadena is another first-rate school for engineers.

In addition, many of the high technology companies in Southern California offer their employees in-house courses. In some cases engineers are updated in their specialties through the use of closed-circuit television beamed from schools in other parts of the state.

Most companies encourage their engineer employees to upgrade their skills, and many pay full or partial tuition.

To sum up, the demand for engineers in beautiful Southern California in this decade is expected to remain strong. The salaries are high, the work is both exciting and important, and industry is hiring at an accelerated rate. In addition, the Golden Gate State offers a lifestyle with every kind of cultural and recreational activity available anywhere in the world.

As one Southern California economist put it, “Where are all those engineers? We need them.”

If you are a recent graduate or a veteran engineer seeking a virtually unlimited future, the Golden Gate State offers an opportunity that you may never have again. If you are serious about your career, are an electrical/electronic, computer science, data communications, or aerospace/aeronautical engineer, don’t miss the following Southern California Career Opportunities Section featuring blue-chip companies that are interested in you and your talents now and in the future.

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The Heath H-14 Printer
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What this country needs is a good $250 printer. It ought to accept characters at 9600 bps (bits per second) and print them at 100 lines per minute. It should produce letter-quality print in various formats, including 80, 96, and 132 columns per page and 6, 8, or 10 lines per inch. It should have graphics capabilities, and it should offer an adjustable tractor-feed mechanism that can use narrow or wide paper. It should be very reliable, easy to service, quiet, and pleasing to look at.

Has Heath given us the All-American line printer? Perhaps not, but the folks in Benton Harbor, Michigan, have chalked up real accomplishments in several areas. As a $595 kit, the H-14 comes closer than any other 80-column impact printer on the market (at this writing) to meeting the price criterion. The somewhat higher “assembled” price still falls below most of its competitors’ prices. And the H-14 does this while making a fine showing in the area of capabilities.

The H-14 Kit
The kit version of the printer is somewhat intimidating because of the sheer number of parts that emerge from the shipping carton. Rumors have been circulating to the effect that Heath had simply built electronics around an imported printer mechanism or that they had built a new enclosure around a familiar American-made mechanism which uses the Practical Automation dot-matrix print head. The truth is that while Heath uses the Practical Automation DM-101 print head, the rest of the mechanism (except, of course, for the driver motors) is of Heath’s own design.

The builder, at any rate, assembles the printer mechanism from the very beginning. Happily, it is surprising to discover how easy the assembly is to execute, because, as always, Heath has done an outstanding job of preparing the kit manual. In fact, it is hard to believe that Heath charges $300 more for the assembled version.

There are few special parts in the mechanical portion of the printer. Two of the four shafts that operate the sprocket feed and support the print head, for example, are standard, quarter-inch extension shafts. This allows use of common quarter-inch bushings, collars, and grommets, which not only contributes to the low cost of the device, but also makes maintenance simpler.

Heath chose a more expensive route in providing a substantial die-cast metal base upon which the printer is built. It forms the lower half of the housing and supports the print-head mechanism, power transformer, and printed-circuit board. Although the molded plastic cover of the device is very light (why not, since it supports nothing), the metal base gives the H-14 the hefty, stay-put feel of a heavy-duty piece of equipment.

The Electronic Circuitry
Nearly all of the parts in the electronics portion of the H-14 are mounted on two printed-circuit boards. The main board is busy but by no means crowded, and there are two extra LEDs (light-emitting diodes) available for checking logic functions as the integrated circuits are installed. The second, smaller board, which corrects a design oversight and which was not initially shipped with the kit (original shipment, February 1979), is mounted adjacent to the paper-drive motor.

The circuit is assembled on a double-sided, 12.5 by 25.5 cm (4½ by 10½ inch) board which includes the power-supply rectifier diodes, the printer-data-handling electronics, and the print-head and motor-driver circuits. The power-supply filters, a low-voltage regulator and a series-pass transistor, and an end-of-paper sensor are mounted off the board.

Because a microprocessor-controller is used, the circuitry is straightforward. Data enters and leaves the printer through a pair of EIA or 20 mA current-loop interfaces. These are connected to a UART (universal asynchronous receiver/transmitter) that provides the inter-

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**At a Glance**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Value</th>
</tr>
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<tr>
<td>Name</td>
<td>H-14</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>Heath Company</td>
</tr>
<tr>
<td>Dimensions</td>
<td>Height: 12.2 cm (4¾ inches); Width: 46.5 cm (18½ inches); Depth: 36.2 cm (14¾ inches)</td>
</tr>
<tr>
<td>Price</td>
<td>$595 kit; $895 assembled</td>
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<td>Software</td>
<td>Requires H-8-14, H-8-17, or H-8-18 software for use with Heath H-8 computer or HT-11 software for use with Heath H-11A computer</td>
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Two Interesting Circuit Details

Two other sections of the circuit merit attention. Asked about how Heath was able to make the Practical Automation print head operate at speeds in excess of 120 cps (characters per second) while other printers using the same head have been restricted to lower speeds, an engineer at Heath explained that the H-14 continually monitors the resistance of one of the head magnet coils. In light-duty printing, the coil temperature does not rise significantly. During long printing jobs or when using the compact 132-column print, the internal temperature will rise to the point at which the head could be damaged. The increased temperature also increases the resistance of the winding, however, so a simple bridge circuit, monitored by two op amps, is used to detect the change and briefly halt printing.

On learning about this trick, one wonders if the printer will spend most of its time cooling down after it reaches operating temperature. In practice, however, this arrangement works well. The H-14 printed eight to fifteen 80-column pages before pausing to cool. The number of pages it executes seems to depend mainly on the ambient air temperature and circulation. Heath has left a slot in the bottom plate to provide cooling air from below, which can exit through the paper-viewing slot in the top cover, so the Heath engineers clearly understand that air circulation affects throughput.

That large rectangular slot in the bottom plate, just below the print head, is surrounded by a row of small holes. Some H-14 owners will visualize a blower and bellows arrangement fastened to the bottom plate at a flange bolted at these holes. It is surprising that they are not there for that reason at all. Although the printer is not certified by the US Underwriters’ Laboratories, it has been approved by the latter’s Canadian counterpart. The row of holes is necessary so that the H-14 can pass a test in which flaming oil poured into the enclosure must be quenched as it exits from the ventilation slot on the bottom plate. (Isn’t it good to know your H-14 can be used as a flaming-oil quencher?)

The number of pages which can be printed before the first cool-down pause is smaller, of course, when the 96- or 132-column print format is selected. The duty cycle of the head is increased in these modes—laying down 96 characters in a line before taking a breath (while going to the next line starting position) is more taxing than printing only 80 characters before taking a line break. Nevertheless, the pauses the H-14 takes for head cooling are not long. Again, the time required depends upon the ambient air temperature, but I find that most pauses are on the face between the serial communication lines and the parallel data bus of the microprocessor. The latter is a descendant of Fairchild’s F8 family and includes on-chip read-only memory. This custom-masked device holds the program which enables the microprocessor to operate the printer. Data storage and address latching (which helps the processor interleave I/O [input/output] and printing tasks) are handled by a pair of 2112 memory devices and a 74LS273 8-bit latch. The processor also has four 8-bit I/O ports which are used as follows: two drive the seven print-head solenoids, the head-drive motor, the ribbon-drive motor, and the paper-drive stepper motor; another does I/O to the UART; and the remaining one selects the specific device which is being driven.
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How closely does the H-14 approach the thermal limits of the print head in this kind of operation? A call to Practical Automation in Shelton, Connecticut, yielded the information that the DM-101 head can be operated at 100 cps (characters per second) bidirectionally if sufficient forced-air cooling is available. Continuous bidirectional operation above 16.5 cps is not recommended without forced ventilation or other protection, and the maximum internal operating temperature of the head is 62° C.

Heath claims that the temperature threshold for the shutdown has been set at approximately 50° C, which is well within the Practical Automation specification. This suggests that the printer can be run for long periods without fear of overheating the head. If you should want to try this, by the way, you may want to make sure that the head nose bearing has adequate lubrication. There is a felt-pad oil retainer on the back of the unit which should normally be given a few drops of machine oil after running through five boxes of paper. Giving it a drop or two before printing a whole box nonstop would be prudent.

There is no way to directly lubricate the solenoid-operated wires that actually do the printing. As is true for most wire-matrix heads, the wires are continuously lubricated by ink in the ribbon. This means that if you intend to realize the full, 100-million-character life of the H-14's head, you will never want to run the printer with a dry ribbon or without paper. You will also want to use only nylon ribbons, since cloth ribbons are easily perforated by the head wires.

Practical Automation recommends that nylon ribbons containing oil-based ink be used. A Heath representative that I contacted could not confirm that the office-equipment-type ribbon Heath supplies contains an oil-based ink. Testing at Heath has shown, however, that maximum head life is possible with its ribbons. (The manufacturer of one of the leading brands of ribbons available in office-supply stores was also contacted in an attempt to learn whether the ink used in these products is oil-based. In spite of the best efforts of the company's Dallas office, we were not able to acquire the information.)

The other interesting circuit is the driver for the paper-feed motor. There was a note in the original instruction manual for the H-14 saying that Heath would provide, upon request, a modification kit to enable the printer to more reliably lift paper from a box placed on the floor below it. The problem addressed occasionally appeared when my H-14 was required to lift 20-pound paper. The paper-drive stepper motor would occasionally growl and feed the paper in fractional-line increments instead of a full line.

The original stepper drivers used 7416 open-collector inverter/buffer devices to interface the microprocessor port to transistors that switched the motor on and off. One side of each winding was pulled high by a 12 V supply, while the other was pulled low by a transistor. A step was executed by turning off a pair of transistors. The problem was that the motor did not develop enough torque with a 12 V supply, but a higher voltage would probably have overheated it (stepper motors consume...
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H-14 is an F8 processor with different programming to permit graphics printing. The reason is the lack of program and table space in the processor. Another consideration is that the paper movement is not reversible because of the H-14's rear paper inlet. One is tempted to try to feed the paper through the ventilation slot in the bottom plate of the enclosure—it is in just the right position below the print head and platen. An LED and photodiode are mounted in the normal feed path, however, to detect the out-of-paper condition. If the paper were brought in through the bottom of the cabinet, modifications to a paper guide would have to be made and the paper-detector feature would have to be sacrificed.

The Results

The print output of the H-14 is pleasing to the eye and easy to read, even when the 132-column format is used. The ribbon is canted a few degrees to minimize ink draining caused by the print head's covering the same area of the ribbon in repeated passes across the page. The ribbon can be canted further by shifting washers under its pulley. This gives additional protection from draining.

The spacing between the tractor-feed gears is adjustable, so that they can accept papers from 5.5 to 24.5 cm (2½ to 9½ inches) wide. Although I normally use 24.5 cm (9⅛-inch) forms which can be burst to a 22 cm (8⅛-inch) page, I have also used 22 cm multiform paper and 8 cm (3½-inch) wide label forms. The H-14 handles the heavy labels very well, and it easily pulls 20-pound paper from a box on the floor, two feet below the feed inlet.

Is the H-14 the All-American Printer?

A number of new, inexpensive impact printers have entered the market since the H-14 was first advertised in January 1979. IDS, C Itoh, and Anadex are a few of the companies which have produced under-$1000 offerings with a variety of features. A buyer faced with the task of choosing among them will do well to check the performance specifications very closely. The H-14's need for cool-down time after printing ten or fifteen pages could be annoying in an office environment. On the other hand, some of the units that can print continuously may have no thermal overload protection and rely on the office air conditioning to keep things cool. Others have long duty cycles, but do not offer variable page and line widths.

The H-14 is a particularly good choice for the personal-computer user because it not only performs well, but it should be inexpensive to maintain. It accepts a standard B-72 Teletype ribbon that can be purchased at most office supply stores for two or three dollars. If the kit is assembled, the buyer has a working knowledge of the construction of the unit and can probably repair mechanical faults which might develop. The excellent testing and troubleshooting guides included in each of the printer's two manuals cover most electrical problems.

Finally, there are Heath's own service and parts distribution facilities. Service is available in many cities at Heathkit stores, and parts are shipped from the factory within 24 hours of a telephone call, if a credit-card number is provided.

Parts are not expensive, by the way. The most expensive is the print head itself, which costs $133. The next dearest (excluding the power transformer) are the paper-drive motor and F8 microprocessor, priced at $15.95 and $14.90, respectively. Considering that a service contract for a commercial printer can cost in excess of $50 per month and that a service call to replace an ailing circuit board has been known to cost over $125, the H-14 should, indeed, be very economical to operate, even in the unlikely event that a part should fail.

The H-14 does not quite satisfy my criteria for the All-American line printer, but it is certainly an excellent buy and, more important, a tough competitor for the title.
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From Song of Zork by
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Adventure has evolved many times during its short history. From Crowther's and Wood's creation to the genius of Scott Adams to the wild antics of Greg Hassett, the journey has been exciting and entertaining for the fans of inventive computer puzzles. No single advance in the science of Adventure has been as bold and exciting as the introduction of Personal Software Inc's Zork, The Great Underground Empire.

The first thing that everyone will look for when Zork boots up is the blinking cursor, and the "I AM..." and "YOU SEE..." format that Scott Adams has popularized in his nine Adventures. That is not the case here. The screen layout is arranged in such a way as to move the WHERE prompt (which gives your current location in the game) down to the bottom of the screen. I found this most useful after reading ten or twelve lines of detailed area description. Additionally, the number of turns elapsed, the number of points accumulated, and the location form an information display on the bottom line of the screen. Other game information scrolls upward as the game progresses, giving a very professional screen layout for the game.

If you happen not to have an unlimited amount of time to spend with your computer, Zork has a SAVE command that allows you to save your position in the game onto a blank, initialized floppy disk. While some cowards use it to retain their hard-earned position in the game before making some dangerous move, the true purpose of this command is to let you follow the game through to its ultimate end (which may take weeks), or as protection against losing your position due to, say, a brief power failure.

Zork comes on a write-protected single-density 5-inch disk with what appears to be its own operating system doing the booting and initialization. The disk defied examination by the most sophisticated methods available to me. I hope that Personal Software (which distributes Zork) will be able to foil the software pirates and traders for a while. The disk seems to be absolutely uncopyable.

Loading and preparing for play is simple enough. Merely insert the Zork disk into drive 0 and press the reset button of your computer. When the program is up and running, a pleasant block cursor greets you. You are now ready to play Zork.

Zork requires a 32 K-byte disk system (in this case, a Radio Shack TRS-80 Model I with 32 K bytes of memory and one disk drive) due to the eloquence of the descriptions and the large number of locations that are stored on the disk to be recalled at the appropriate times during the game. The advance copy I used had no instructions, so, in the beginning, I played a fairly straight game of Adventure.

I was eager to test Zork's biggest selling point, intelligent input (ie: its ability to accept free-form instructions). I typed "OPEN THE BAG AND GET THE LUNCH," in reference to a brown paper sack inside the house. The computer compiled. There was water and food, so I typed "EAT THE LUNCH AND DRINK THE WATER," to which the computer responded with gratitude for satisfying its hunger and thirst.
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Exploring Zork

This Adventure begins in a beautiful forest near a large white house that is boarded up in an obvious attempt to keep explorers out. I managed to get into the house through the front once, but I was plunged into darkness and eaten by a monster called a grue. The game gave me the option of reincarnating myself, which I did (at a cost to myself of 10 points). I was revived in a forest.

Beyond the forest is a deep and beautiful canyon through which the River Frigid flows. This was the first time I had ever been at the end of the rainbow. No, I didn't see a pot of gold, but just because I didn't see it doesn't mean it wasn't there.

In these three locations (ie: house, forest, canyon), the descriptions were lavish, sparing no words in their bestowal of clues and information to the player. An ordinary jeweled treasure, in the form of a bird's egg, more than once sent me scurrying to the dictionary in search of the meanings of some of the words used to describe it.

There are many tools available to the explorer. I was able to obtain a lantern (light wards off grues), a length of rope, a nasty-looking knife, an elvish sword (which glows for reasons of its own), a refillable water bottle, a lunch, and garlic (which presumably repels Were-beings or Vampires, though I encountered none). Armed with these things, I entered the Underground Empire in search of gold and glory.

There was this pugnacious troll who popped up in the middle of a room description early in the game. Here, I got a chance to test the combat capabilities of the game. I typed "ATTACK TROLL", to which the computer supplied a supplemental <with hands>. Look out! Remembering that the program accepts more complex input, and, having survived the first combat turn, I typed "ATTACK TROLL WITH SWORD." This gave more satisfactory results: the troll expired, his body obligingly turning to black smoke in the interest of litter-free dungeon delving.

A thief came along shortly thereafter and challenged my right to exist in Zork. I typed "THROW KNIFE". He caught it in his sack and dispatched me to the netherworld, all in one swift motion. I could still hear him laughing as I lay ruefully reincarnated on the forest floor. I was ten points lighter and my possessions were scattered to the four winds. Sadder but wiser, I reentered the lower levels after 20 minutes of rounding up those items that were absolutely needed.

More cautious now, I explored the passages and tunnels of Zork (level 1). There are no unwarranted locations here—unless you can count the presence of a dam with color-coded control buttons in a maintenance room. Gleefully, I began pushing buttons, something I should know better than to do, as a veteran of the Death Dreadnought and Strange Odyssey Adventures. When the water level began rising, I was not concerned. Then I drowned.

The program was really getting testy with me by now. Grudgingly I was reincarnated by the Patron Deity who guards the souls of all Adventurers. Empty-handed once more, I resumed my journey. I retraced my steps to the Loud Room, where whatever you say is echoed. Then, after 768 turns and an afternoon of unparalleled enjoyment, my luck ran out. I became Grue Munchies, part of the balanced diet of silly dungeon players allotted to those carnivorous native dark dwellers of Zork.

On other occasions, I have been expelled from Zork on multiple charges of being a reckless Adventurer. Nonetheless, armored with the dubious rank of Amateur Explorer and my knowledge of the highest levels, I am looking forward to the time when I will plunge once more into the troll-, thief-, and grue-laden depths of the Underground Empire.

Zork, as peer to the Microsoft Adventure and heir apparent to the throngs of Adventure cultists who wait breathlessly for each new offering, is equal to the awesome task it has been given. That the program is entertaining, eloquent, witty, and precisely written is almost beside the point. Unlike the kingdoms of the Adventures for machines with 16 K bytes of memory and far from the classic counter-earthiness of the Colossal Cave in the original Adventure, Zork can be felt and touched—experienced, if you will—through the care and attention to detail the authors have rendered.

I've been to Zork today. Tomorrow, I will take a friend. Together we will unwrap the cloaks of mystery surrounding this most excellent and memorable work of computerized fiction. And when we have extracted from this land every drop of adventuring that can be obtained, we will likely not be kept waiting. A sequel is nearing completion, even as this is being written.

Somebody, please, let me know when it's done.
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Seattle Computer Products, Inc.
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(206) 575-1830

Circle 181 on inquiry card.
Energy-Saving Cost/Benefit Analysis

Richard Hetherington
637 Pendleton Ave, Apt D
Chicopee MA 01020

The recent skyrocketing cost of energy makes us think of ways of conserving heat and saving money, whether by increased home insulation, using storm windows, lowering the thermostat, or any number of other methods. Cost versus benefit is always debated. How many times have you asked yourself: will the cost of adding 6 inches of insulation to the attic far outweigh the benefits?

In order to answer the cost/benefit question relating to home insulation, the mechanism of heat travel must be understood. I will briefly review the concepts of heat transfer, what influences it, and show how to use a BASIC program to make the cost/benefit decision.

Heat Transfer

Heat can travel between locations by any of three mechanisms: conduction, convection, or radiation.

Conduction is the flow of heat by molecular vibration and is usually associated with transfer through solids. For example, when a spoon is placed in a cup of hot coffee, the spoon gets hot by conduction of heat from the liquid.

Convection is the transport of heat through a fluid transporting medium by fluid movement caused by differences in density due to different temperatures, as when air picks up heat from a radiator in the home and distributes it throughout a room.

Radiation transports heat through electromagnetic energy, which is absorbed and converted to heat energy by a solid material. For instance, if you stand close to a blazing fireplace the radiant heat can become unbearable.

Heat can be lost from your home by all three mechanisms, but in most cases, the loss by conduction is most significant and is our main consideration.

The flow of heat from one place to another by steady-state conduction can be expressed by:

\[ Q = T \times A / R \]

where:
- \( Q \) = heat flow in BTU (British thermal units)/hour
- \( T \) = temperature difference in °F (degrees Fahrenheit)
- \( A \) = area of heat flow in square feet
- \( R \) = resistance to heat flow in hour-square-feet-°F/BTU

The resistance to heat flow is related to the thickness of the material through which the heat is flowing, and the thermal conductivity (shown in Table 1) of the material. For flat surfaces, it is found by:

\[ R = L / K \]

where:
- \( L \) = thickness of material in inches
- \( K \) = thermal conductivity of the material in BTU-inches/hour-square-feet-°F

If the heat is traveling through more than one material then \( R \) is expressed as:

\[ R = L_1 / K_1 + L_2 / K_2 + L_3 / K_3 + \ldots \]

where:
- \( L_1, L_2, L_3 \ldots \) = the thickness of each material through which the heat flows
- \( K_1, K_2, K_3 \ldots \) = the thermal conductivity of each material

The \( R \) value can be calculated for any number of materials sandwiched together as long as the thickness and thermal conductivity of each material is known.

Looking at the formulas, you can see that the flow of heat depends on the temperature difference, the area it flows over, and the thickness and thermal conductivity of the material it flows through. Using these three formulas, you can readily calculate heat loss by conduction through flat surfaces.

Once the rate of heat loss is known, its cost can be calculated. Table 2 lists common fuels, the heating value of the fuel, and approximate cost of that fuel. The cost of the fuels will vary significantly depending on your location and the quantity purchased. For maximum accuracy, modify the fuel costs in Table 2 to match the particulars of where you live.
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Programming Quickies

Table 1: Thermal conductivity (K) of common materials used in construction and insulation. Note that the K for air is relatively constant for 1/4-inch to 4-inch thicknesses. When entering these values into the BASIC program shown in listing 1, use the indicated figures for air (1.0 or 1.2) regardless of the thickness of the air layer. (Data is from various sources researched by the author.)

<table>
<thead>
<tr>
<th>Material</th>
<th>Thermal conductivity (K) BTU-inches/hour-square feet-°F</th>
</tr>
</thead>
<tbody>
<tr>
<td>air (horizontal heat flow)</td>
<td>1.00</td>
</tr>
<tr>
<td>air (vertical heat flow)</td>
<td>1.20</td>
</tr>
<tr>
<td>aluminum</td>
<td>1400.00</td>
</tr>
<tr>
<td>asbestos cement board</td>
<td>5.16</td>
</tr>
<tr>
<td>asphalt</td>
<td>5.16</td>
</tr>
<tr>
<td>building brickwork</td>
<td>4.80</td>
</tr>
<tr>
<td>concrete</td>
<td>6.50</td>
</tr>
<tr>
<td>concrete block (6-inch)</td>
<td>6.60</td>
</tr>
<tr>
<td>copper</td>
<td>2700.00</td>
</tr>
<tr>
<td>corkboard</td>
<td>0.27</td>
</tr>
<tr>
<td>corrugated cardboard</td>
<td>0.44</td>
</tr>
<tr>
<td>dry sand</td>
<td>2.28</td>
</tr>
<tr>
<td>expanded vermiculite</td>
<td>0.48</td>
</tr>
<tr>
<td>fiberboard</td>
<td>0.34</td>
</tr>
<tr>
<td>fiberglass</td>
<td>0.26</td>
</tr>
<tr>
<td>granite</td>
<td>18.00</td>
</tr>
<tr>
<td>gypsum</td>
<td>3.00</td>
</tr>
<tr>
<td>ice</td>
<td>15.60</td>
</tr>
<tr>
<td>lead</td>
<td>240.00</td>
</tr>
<tr>
<td>masonite</td>
<td>0.33</td>
</tr>
<tr>
<td>macerated paper fill</td>
<td>0.28</td>
</tr>
<tr>
<td>mineral wool</td>
<td>0.27</td>
</tr>
<tr>
<td>paper</td>
<td>0.80</td>
</tr>
<tr>
<td>plaster</td>
<td>2.00</td>
</tr>
<tr>
<td>plywood</td>
<td>0.79</td>
</tr>
<tr>
<td>polyurethane foam</td>
<td>0.20</td>
</tr>
<tr>
<td>slate</td>
<td>13.20</td>
</tr>
<tr>
<td>snow</td>
<td>3.24</td>
</tr>
<tr>
<td>sawdust</td>
<td>0.41</td>
</tr>
<tr>
<td>styrofoam</td>
<td>0.31</td>
</tr>
<tr>
<td>water</td>
<td>4.80</td>
</tr>
<tr>
<td>window glass</td>
<td>5.00</td>
</tr>
<tr>
<td>white pine</td>
<td>1.04</td>
</tr>
<tr>
<td>wood shingles</td>
<td>1.15</td>
</tr>
</tbody>
</table>

Table 2: The heating value in BTUs (British thermal units) and cost of various fuels commonly used for home heating. The indicated costs are local spot prices in western Massachusetts during the winter of 1979-80 and will vary significantly in different areas. For the greatest accuracy when using the BASIC program shown in listing 1, make sure the fuel costs are accurate for your area. (Data is from various sources researched by the author.)

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Heating Value (H)</th>
<th>Cost (Z)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L P gas</td>
<td>21,000 BTU/lb</td>
<td>$0.245/lb</td>
</tr>
<tr>
<td>hardwood</td>
<td>21,000,000 BTU/cord</td>
<td>$100.00/cord</td>
</tr>
<tr>
<td>electricity</td>
<td>3413 BTU/kW hr</td>
<td>$0.055/kW hr</td>
</tr>
<tr>
<td>anthracite coal</td>
<td>12,700 BTU/lb</td>
<td>$0.047/BTU</td>
</tr>
<tr>
<td>natural gas</td>
<td>1050 BTU/ft</td>
<td>$0.00485/cu ft</td>
</tr>
<tr>
<td>#2 fuel oil</td>
<td>138,700 BTU/gal</td>
<td>$0.03/gal</td>
</tr>
<tr>
<td>kerosene</td>
<td>135,500 BTU/gal</td>
<td>$0.97/gal</td>
</tr>
</tbody>
</table>

The cost of heat lost is calculated by:

\[ C = Z \times Q \times H \]

where:

- \( C \) = cost of heat lost in dollars/hour
- \( Z \) = fuel cost in dollars/unit
- \( H \) = heating value of fuel in BTU/unit
- \( Q \) = heat flow in BTU/hour
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Programming Quickies

Listing 1: A BASIC program for cost/benefit analysis of energy-saving expenditures. Line 250 adds a constant factor to the resistance to heat flow (R) to take into account external-surface air-film resistance. This program is written in Processor Technology Extended Cassette BASIC and can easily be modified for other BASIC systems.

```
10 REM--SOLVE MONEY BY INSULATING
20 REM--WRITTEN BY RICHARD E. HETHERINGTON
35 REM--MARCH 1980
40 FOR J=1 TO 2
50 PRINT "FOR CASE #", J
60 INPUT "AREA OF HEAT FLOW <SQ. FT.>)", A
70 INPUT "INDOOR TEMPERATURE <DEG. F.>)", T1
80 INPUT "OUTDOOR TEMPERATURE <DEG. F.>)", T2
90 LET T=T1-T2
100 INPUT "HEATING VALUE OF FUEL USED <BTU/MBTU>)", H
110 FOR I=1 TO N
120 PRINT "NUMBER OF LAYERS OF MATERIAL"
130 INPUT "THICKNESS (IN.)", I
140 H=H/T*3.413
150 PRINT "THE RESISTANCE TO HEAT FLOW"
160 INPUT "OUTDOOR TEMPERATURE <DEG. F.>)", T2
170 INPUT "OUTDOOR TEMPERATURE <DEG. F.>)", T2
180 LET R=.5
190 PRINT "EXTERNAL SURFACE RESISTANCE"
200 PRINT "HEAT LOST IS = BTU/H"
210 PRINT "COST OF FUEL LOST IS = $/HR"
220 PRINT "WHAT WILL BE THE COST TO YOU"
230 INPUT "TO ACHIEVE THIS SAVINGS?", E
240 PRINT "PAY-OUT PERIOD IS = HOURS"
250 PRINT "NUMBER OF LAYERS OF MATERIAL"
260 PRINT "THICKNESS (IN.)", I
270 PRINT "THE RESISTANCE TO HEAT FLOW"
280 INPUT "OUTDOOR TEMPERATURE <DEG. F.>)", T2
290 INPUT "OUTDOOR TEMPERATURE <DEG. F.>)", T2
300 LET R=.5
310 PRINT "EXTERNAL SURFACE RESISTANCE"
320 PRINT "HEAT LOST IS = BTU/H"
330 PRINT "COST OF FUEL LOST IS = $/HR"
340 PRINT "WHAT WILL BE THE COST TO YOU"
350 INPUT "TO ACHIEVE THIS SAVINGS?", E
360 PRINT "PAY-OUT PERIOD IS = HOURS"
370 PRINT "WHAT WILL BE THE COST TO YOU"
380 PRINT "TO ACHIEVE THIS SAVINGS?", E
390 PRINT "PAY-OUT PERIOD IS = HOURS"
400 END
```

Another important consideration is the pay-out period. This is the length of time to recover any money spent on conserving energy through fuel savings. The pay-out period is:

\[ t = \frac{E}{(C_1 - C_2)} \]

where:
- \( t \) = pay-out period in hours
- \( E \) = cost to achieve the savings (in dollars)
- \( C_1 \) = cost of heat lost before (in dollars per hour)
- \( C_2 \) = cost of heat lost after (in dollars per hour)

The pay-out period is the real indicator of whether you should spend the money. Generally, the shorter the pay-out period the better; however, under certain conditions pay-out periods as long as ten years may be acceptable. For example, it may take ten years to recover the cost of insulating the walls of your home. However, if it is a new home and you don't plan to move for a long time, then it will be worth it.

Listing 1 is a BASIC program that uses the equations to calculate the pay-out period and other information. The program is designed to compare two situations. Line 250 adds a constant factor to the resistance to heat flow (R) to take into account external-surface air-film resistance. This resistance becomes significant when considering materials with very low resistance to heat flow. The program is written in Processor Technology Extended Cassette BASIC.

One more thing: don't forget that you might be able to deduct money spent on energy conservation from your federal income tax!

Problem 1
You have purchased a home that doesn't have any insulation in the attic, and you want to insulate it with 6 inches of fiberglass insulation. The attic is 20 by 25 feet (ie: 500 square feet). The ceiling below the attic is constructed of ½-inch pine boards (K=1.04) and ½ inches of plaster (K=4). Average attic winter temperature is 40 °F and room temperature below the attic is 68 °F. The insulation will cost $110 for 500 square feet (K=0.25). The house is heated with natural gas (H=1050 BTU/cubic foot, Z=$0.004845/cubic foot). You will do the work, so the only cost will be the insulation. Should you insulate the attic?

Solution
A 96% reduction in heat loss is indicated, and you will recover the money spent in 1970 hours (ie: 82 days) under the conditions given. Since this is less than one winter season, you should insulate.

Problem 2
You have a house identical to the one described in Problem 1, except there already are 6 inches of insulation in the attic. Should you add 6 more inches of insulation?

Solution
By adding the insulation, you will save 49% of the heat presently lost. However the pay-out period is 87,469 hours. This is 3645 days (ie: thirty winter seasons). Under these conditions it's advisable not to spend the money.

Problem 3
Your house is well insulated but doesn't have any storm windows. There are twelve windows in the house, each 3 by 5 feet. (The total window area is 180 square feet.) Combination windows cost $35 each and will be installed by a contractor for a total cost of $1020. (The average window is 68° F and room temperature below the attic is 68 °F, and the inside temperature is 72° F. The house is heated with electricity (H=3413 BTU/kW-hour, Z=$0.055/kW-hour). Should the combination windows be installed?

Material the heat passes through is:

Case 1: one layer of glass (L=0.125 inches, K=5)
Case 2: two layers of glass (L=0.125 inches each, K=5)
Case 3: one layer of air (L=1 inch, K=1)

Solution
There is a 66% reduction in heat lost through the windows. The cost savings is quite high at $0.135 per hour. But the installation cost is so high that the pay-out period is fairly long (about three winter seasons). The best plan would be to look for a cheaper contractor and then have the windows installed.
A Variable Type Converter for Numerical Quantities

Mike Moskowitz, 23400 E Silsby, Beachwood OH 44122

Listing 1: A Hewlett-Packard BASIC program that converts string variables to numeric variables.

10 REM MIKE MOSKOWITZ
20 REM CONVERTS STRING VARIABLES TO NUMERIC VARIABLES
30 DIM A$101, B$101, C$101, D$101, E$101, A$91
40 A=C=D=E=9
50 B=1
60 A$="";
70 PRINT "#";
80 INPUT A$;
90 C=LEN(A$)
100 FOR D=C TO 1 STEP -1
110 IF ASC(D)="A" THEN 220
120 IF ASC(D)="1" THEN 240
130 IF ASC(D)="2" THEN 260
140 IF ASC(D)="3" THEN 280
150 IF ASC(D)="4" THEN 300
160 IF ASC(D)="5" THEN 320
170 IF ASC(D)="6" THEN 340
180 IF ASC(D)="7" THEN 360
190 IF ASC(D)="8" THEN 380
200 IF ASC(D)="9" THEN 400
210 GOTO 410
220 E(D)=A
230 GOTO 410
240 E(D)=B
250 GOTO 410
260 E(D)=C
270 GOTO 410
280 E(D)=D
290 GOTO 410
300 E(D)=E
310 GOTO 410
320 E(D)=F
330 GOTO 410
340 E(D)=G
350 GOTO 410
360 E(D)=H
370 GOTO 410
380 E(D)=I
390 GOTO 410
400 E(D)=J
410 A=A+E(D)*B
420 B=B*10

Listing 1 continued on page 272

In most versions of BASIC, there are some operations and functions which can be performed only on alphanumeric (string) variables and not on numeric variables. Likewise, there are operations which will work only on numeric variables and not on strings. For example, most BASICs will accept operations such as these:

10 A=LEN(A$)
20 PRINT A$(1,1)
30 LET A=B*C
40 PRINT SQR(A)

But these statements are illegal in BASIC:

10 A=LEN(A)
20 PRINT A(1,1)
30 LET A=B$*C$
40 PRINT SQR(A$)

It would be convenient to have a subroutine which would convert numeric quantities stored in string variables into numeric variables, and vice versa. This would allow all numeric quantities to gain the use of both types of functions, regardless of the type of variable they were originally assigned to. This is an easy task in some of the newer, more powerful BASICs which allow access and manipulation of ASCII representations. Most BASIC systems, however, do not have this capability.

Listing 1 converts numbers from strings to numeric variables. This subroutine is invaluable when some number which must be operated on arithmetically is embedded in an input string. Listing 2 converts numbers from numeric variables into string variables. It allows numeric quantities to receive the use of operations such as substring selection, A$(X,Y), and the LEN function. These subroutines may be improved by modifying them to accommodate decimal points or scientific notation. These programs were written in BASIC on a Hewlett-Packard 2000E computer, and may need slight modifications, but will run on many microcomputer BASICs.
Listing 1 continued:

434 \texttt{NEXT D}
440 \texttt{PRINT A}
450 \texttt{PRINT}
460 \texttt{GOTO 30}
470 \texttt{END}

Listing 2: A program that converts numeric variables to string variables.

10 \texttt{REM MIKE MOSKOWITZ}
20 \texttt{REM CONVERTS NUMERIC VARIABLES TO STRING VARIABLES.}
30 \texttt{DIM A[50], B[50], C[50], D[50], X[50], A$[50]}
40 \texttt{A=B=C=D=X=0}
50 \texttt{A$=\texttt{"\textquoteleft\textquoteleft\textquoteleft;}}
60 \texttt{PRINT "#";}
70 \texttt{INPUT A}
80 \texttt{B=B+1}
100 \texttt{IF INT(A/10*B)=0 THEN 120}
110 \texttt{GOTO 80}
120 \texttt{FOR X=1 TO B}
130 \texttt{D[X]=INT(A/10*X)*10*X-(A-INT(A/10*(X-1)))*10*(X-1))}
140 \texttt{NEXT X}
150 \texttt{C=1}
160 \texttt{FOR X=B+1 TO 1 STEP -1}
170 \texttt{IF D[X]=0 THEN 290}
180 \texttt{IF D[X]=1 THEN 290}
190 \texttt{IF D[X]=2 THEN 310}
200 \texttt{IF D[X]=3 THEN 330}
210 \texttt{IF D[X]=4 THEN 350}

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Microcomputers in the Chemistry Laboratory

The advances in microcircuitry, the production of solid-state components, and the development of microcomputers provide small chemistry departments with inexpensive resources for interfacing computers and laboratory instruments (see references 1 and 2). Marketed by a cottage industry that serves hobbyists, microcomputers and their peripheral devices offer faculty and students modern means to gather data, process information, and enrich their understanding of chemistry.

Equipment and Hardware

In the last three years, faculty and students in the Chemistry Department of Westminster College built from kits an Altair 8800b microcomputer, a Lear-Siegler ADM 3A terminal, 48 K bytes of dynamic memory, two serial ports, and four parallel ports. In addition, the department bought a graphics module (Digital Engineering RG-512 Retrographics card) for the Lear-Siegler terminal and a MITS 3200 disk drive. We assembled these components into a system (see figure 1 and photo 1) that samples the output of gas chromatographs, spectrophotometers, or pH meters, stores data on disks, calculates results, and displays information on a video terminal and a printer.

To change analog signals into digital information for the computer, we use a digital-panel meter (Analog Devices AD2010 DPM) that converts signals in the range ±199.9 mV into 3½ binary coded decimal (BCD) numbers and displays the data transferred to the computer. We program a Motorola PC6820 Peripheral Interface Adapter (PIA) to handle two status bits and thirteen parallel-data bits transferred between the computer and the DPM. The DPM delivers data at controlled rates up to a maximum of 24 readings per second, a pace sufficiently rapid for many instrumental measurements of chemical behavior.

Laboratory Activity

To introduce techniques of interfacing, we guide upper-level students for four weeks while they use a microcomputer to study the rate of reaction between ferric and iodide ions and determine titration curves for reactions between acids and bases.

Students use an ultraviolet-visible spectrophotometer (Bausch & Lomb Spectronic 20) set at a wavelength of 425 nm (nanometers) to observe the increasing absorbance of light in a solution of ferric and iodide ions. Triiodide ions, a product of the reaction in solution, cause the growth of absorbance and the changing absorbance signal in the spectrophotometer reflects the rate of
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this reaction. The absorbance signal is captured at the amplifier of the spectrophotometer and delivered through the DPM to a parallel port of the computer. To transfer data to the processor and calculate rate constants, exponents of terms, and energy of activation from their rate studies, students program the microcomputer in Extended Disk BASIC.

To trace the behavior of acid-base titrations, students use a combination glass and reference electrode to measure changing concentrations of protons in solution and deliver changing potential differences between these electrodes to a pH meter. A syringe driven by a pump delivers the base at a fixed rate into the acid to be titrated. A clock controlled by software coordinates the rate of travel for a vector across the video screen with the rate of delivery of base. The clock and the pH meter (by way of the DPM and a port) provide pairs of data needed to use the graphics terminal as an \( x, y \) plotter (see photo 2).

Educational Approach

These projects embody chemistry that our students have studied earlier in laboratories of lower-level courses. This earlier experience lends confidence to students and helps them concentrate more effectively on the details of interfacing. Students compare results from observations made with the aid of interfacing to results they obtained from earlier studies and to information reported in the literature. Such comparisons impress upon them the value of checking conclusions on the way to scientific understanding.

Students learn quickly that interfacing a microcomputer to a laboratory instrument requires comprehensive understanding of the work they will do. To attain their goals, they must:

- become familiar with the theory of the measurements they will make in order to write and test software that instructs the computer to calculate results and establish a format for reporting information
- connect the computer with the aid of appropriate hardware to the instrument
- use and test software that will control the transfer of information between the computer and the instrument (handshaking)
- prepare and standardize solutions required for the project

To help students develop the skills they will need, we assign exercises that familiarize them with our microcomputer, an instrument, and the details of interfacing these devices. We divide students into two groups: those who have programmed and those who have not.

Students who have programmed refresh their skills by programming with Extended Disk BASIC to calculate physical properties and chemical behavior of gases, liquids, solids, and solutions. We assign tutorials in computer-aided instruction to students who have had no programming experience and work closely with these students until they grasp the fundamental qualities of programming and can also use the computer to solve...
We all know that bilge pumps suck. And by now, we've found out—the hard way—that a lot of software seems to work the same way.

So I got pretty excited when I ran across dBASE II, an assembly-language relational Database Management System for CP/M. It works! And even a rank beginner like myself got it up and running the first time I sat down with it.

If you're looking for software to deal with your data, too, here are some tips that will help:

**Tip #1: Database Management vs. File Handling:**

Any list or collection of data is, loosely, a data base, but most of those "data base management" articles in the buzzbooks are really about file handling programs for specific applications. A real Database Management System gives you data and program independence (no reprogramming when data changes), eliminates data duplication and makes it easy to turn data into information.

**Tip #2: Assembly Language vs. BASIC:**

This one's easy: if you're setting up a DBMS, you're going to be doing a lot of sorting, and Basic sorts are s-l-o-w. Run a benchmark on a Basic system like S*-IV against a relational DBMS like dBASE II and you'll see what I mean. (But watch it: I've also seen one extremely slow assembly-language file management system.)

**Tip #3: Relational vs. Hierarchal & Network DBMS.**

CODASYL-like hierarchal and network systems, around since the 1960's, are being phased out on the big machines so why get stuck with an old-fashioned system for your micro? A relational DBMS like dBASE II eliminates the pre-defined sets, pointers and complex data structures of a CODASYL-type DBMS. And you don't need to be a programmer to use it.

dBASE II vs. everything else.

dBASE II really impressed me. Written in assembly language (with no need for a host language), it handles up to 65,000 records (up to 32 fields and 1000 bytes each), stores numeric data as packed strings so there are no roundoff errors, has a superfast multiple-key sort, and supports ISAM based on B* trees.

You can use it interactively with English-like commands (DISPLAY 10 PRODUCTS), or program it (so when you've set up the formats, your secretary can do the work). Its report generator and user-definable full screen operations mean that you can even use your existing forms.

And if all this makes your mouth water, but you've already got all your data on a disk, that's okay: dBASE II reads your ASCII files and adds the data to its own database.

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problems in chemistry. Eight to ten hours of programming on an interactive terminal, guidance from a teacher, and help from other students give all students the ability and confidence to use the computer for elementary interfacing operations.

To help students understand how information is transferred between the computer and an instrument, a process called input/output or I/O, we provide hard and disk copies of routines that manage I/O. Students study these routines and explore the relationships between hardware and the software that executes I/O. The students then embed their software for calculating results within these routines and synthesize a program that controls transfer of information among instrument, computer, and disk files, as well as presents results at the video terminal.

When students have completed these tasks, we provide sample data retrieved from disk files so they can simulate their experiments and test and correct their programs. Assured of hardware and software that work, students complete their lab work by selecting substances and concentrations that will provide a range of data commensurate with the most reliable operation of the instrument and the computer. To enhance their understanding of interfacing, students write a comprehensive report that describes the procedures and apparatus they have used, as well as the relationships between what they measure, how they measure, and what they conclude. These reports reveal that the careful attention to detail inherent in the use of computers improves the quality of our students' laboratory work.

Conclusions
We have just begun to teach interfacing of computers in the laboratory. Yet, we believe that such teaching is valuable and conclude:

- Many students who have not used computers fear them and the specific action required to use them successfully.
- Once they use microcomputers to solve traditional problems in chemistry, students develop confidence and approach interfacing with enthusiasm.
- Because students can write software to analyze data only if they possess understanding and expectations of their intended studies, interfacing microcomputers with instruments encourages them to study their project before they begin work in the laboratory.
- Interfacing encourages students to gather more data and analyze the statistical reliability of their information. Moreover, qualities such as signal-to-noise ratio, rates of measurement, and detection limits, frequently given minimal attention in traditional laboratory work, receive careful attention from students when they interface a microcomputer to a laboratory instrument.
- By interfacing the microcomputer with instruments, students learn the differences between analog and digital information and how to report precision and significant figures with the aid of hardware and software.
- Writing software compels students to select a format for information they will report. Thus, experiments that use interfacing encourage students to consider their reader as they use the computer to prepare charts, tables, or outlined presentations of their data and conclusions.
- Interfacing encourages students to blend the systematic use of a computer with their experimental work. Thus, students use, to their benefit, flowcharts to select and guide laboratory activity, or design software for their projects.
- Interfacing of computers encourages a sense of community among students in the laboratory. We urge them to solve their experimental and software problems independently and this produces a variety of solutions for gathering and interpreting data with the aid of the computer. Students enjoy comparing solutions and merging ideas that improve on the techniques they have used.

Our students have emerged from these projects with more confidence in their ability to solve problems. From interfacing, our faculty has gained a more comprehensive basis for discussing the design of laboratory projects and the significance of results that students report. Interfacing microcomputers in the laboratory has guided our students to more detailed awareness of cause and effect. We are designing other interfacing projects that will extend similar educational benefits to students in other laboratories of this department.

References
Why is the 88G Printer the new industry leader?

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Complete forms control allows the 88G to be quickly configured for printing single or multiple-ply invoices, purchase orders, checks, or any type of preprinted form. Optional paper roll holders and single sheet feeders can be quickly attached.

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Dear Steve,

I am currently designing a home-alarm system. I have been reviewing your BYTE articles from January 1979 thru March 1979. (See "Build a Computer-Controlled Security System for Your Home," Part 1, January 1979 BYTE, page 56; Part 2, February 1979 BYTE, page 162; Part 3, March 1979 BYTE, page 150.) I am hoping that you can clear up a couple of questions I have about your articles.

For a little background, my computer system is based on a Z80 microprocessor, rather than the 8085. I will be using sensors which you described in your articles, and that is where my questions arise.

To begin with, I refer to photo 3 (January 1979 BYTE, page 68) and figure 1 (March 1979 BYTE, page 151). Is the LM3911 integrated circuit equivalent to the sensor in photo 3? Can the sensor in photo 3 be used in the system by adding the comparator in figure 1, but leaving out the temperature trigger-point potentiometer, since the sensor in photo 3 will trip above a certain point? My idea is shown as a schematic diagram in figure 1 below. If a commercial device is suitable, can you recommend one for me to use?

Thank you for your time.
Brian P Mulhearn

---

The sensor shown in January's photo 3 is simply a temperature sensitive switch (shown here as figure 2). It operates like any push-button switch. It is either open or closed. When the temperature is below 135°F it will be open, and above that temperature it will be closed. The circuit in figure 2 is a way to test these devices. It consists of an LED (light-emitting diode) and a 6 V battery. Just dip the sensor in hot water and the LED should light.

The LM3911 is a linear integrated circuit and not a mechanical switch. It uses the difference in emitter-base voltage of transistors (operating at different current densities) as the basic temperature sensitive element. The output voltage of the LM3911 is directly proportional to temperature in degrees Kelvin (10 mV/°K). External resistors can scale this to any desired value through an op amp. Internally, the LM3911 appears as in figure 3. The device itself is the temperature sensor. To measure the temperature of a water pipe, the LM3911 would have to be placed against the pipe. To make it operate like the mechanical sensor, a comparator is added which trig-
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gers when a preset level is reached (see figure 4). The 50 k-ohm potentiometer is set for some temperature of interest. When the output of IC1 exceeds the setting, the output state of IC2 changes. The advantage of this circuit over the mechanical sensor is that any temperature may be set.

It appears that you want a sensor that signifies a temperature greater than 135°F and is compatible with the computer input. Using the mechanical sensor, this can be accomplished with the circuit in figure 5. A 7414 Schmitt-trigger inverter produces a clear output level once contact bounce has ceased. If you prefer, CMOS (complementary metal-oxide semiconductor) devices can be used instead to reduce power requirements....Steve

Probing for Probes

Dear Steve,

This is a nontech request, but I sure hope you can help me.

I have been trying for two months to locate an outlet for the type of probes shown in photo 5 of your article "Mind Over Matter: Add Biofeedback to Your Computer," (June 1979 BYTE, page 56). After a letter, three Telex messages, and three telephone calls to American Optical (both east coast and west coast), I finally received a reply from Cambridge Instruments, formerly American Optical, Medical Division, saying, "We don't make the probes, and we don't know anyone who does."

I wear a transcutaneous electronic nerve stimulator over a shoulder injury. The flat carbonized-rubber probes, held on with separate adhesive, sometimes lift free of skin contact when I am active. The normal 40 V 23 μs pulse (loaded voltage) goes up to about 400 V open line voltage. When it again contacts the skin, it arcs and makes a sore spot.

Your probe, with the predrilled sponge center, looks as if it would work much better—if I could only locate it. If you give me the address of the medical supply house where you obtained yours, I will contact them directly. I used biofeedback for several months at the UCLA Pain Control Unit, and I intend to build the unit you describe in your article, using a scope as an output, and possibly interface it to a computer later.

Bob Vinson

The two kinds of silver/silver-chloride electrodes I tried were P/N 5113 from American Optical and P/N 14245B from Hewlett-Packard. The probes themselves were nothing more than fancy clips at the end of 3 feet of shielded cable. When using three probes as shown in the article, the three shields are connected together and attached to the guard input of the isolation amplifier.

I hope this information helps....Steve

Voltage Fluctuations

Dear Steve,

I have a Radio Shack TRS-80 Model I. Occasionally the machine acts strangely, either by "locking-up" so that the reset button must be used to start it again, or by randomly accessing the disk. When I first got the disks, the problem with the random accesses was quite frequent. I have since purchased Radio Shack's power-line filter and it seems to have almost eliminated the problem.

I suspect that the difficulty is caused by fluctuations in the voltage in my office. I have noticed interference on the video display when running the printer and when the air-conditioning unit starts. However, neither of these seems to cause the problem, at least, not consistently.

The landlord says that the power service into the building is 600 amps. Also, certain offices having unusual power requirements have their own circuits within the building (not, however, separate service entirely). He also has some sort of transformer that he says should eliminate fluctuations caused by the air conditioners.

My questions are:

• Is the TRS-80 sensitive to power fluctuations?
• If so, how can I monitor the circuits in my office to determine whether the computer's requirements are being met?
• If the circuits aren't adequate, is there any way to shield the computer from the fluctuations?
• If power fluctuations aren't to blame, what might be?

I have no knowledge of electronics, so I would be interested in either buying or renting (or borrowing) whatever I might need to solve the problem, rather than building something.

Guerr F Stevens

Intermittent operation and bizarre behavior are by no means limited to the TRS-80. It can be a problem with any computer installed and operating under what might be termed marginal conditions. There are quite a few TRS-80s, so, if just 1% have problems, approximately 3000 people would have complaints.

The first order of business is to determine the source of the problem. Three possibilities immediately come to mind:

• bus cabling between peripherals
• power fluctuations
• power-line transients and induced noise

Make sure you keep the interconnecting cables between peripherals away from power lines and as short as possible. Do not leave equipment attached directly to the computer that is not powered or properly terminated. Keep the bus cabling and disk cables away from the left side of the s
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video display (where it can pick up noise from the high-voltage flyback transformer).

Power fluctuations can indeed cause marginal operation. In my mind, however, there are two separate problems: fluctuations and transients. Fluctuations are slow (greater than 5 ms) voltage changes involving a 10 or 20% variation in line voltage. As long as the line voltage does not dip below 105 V AC, you should be all right. Have you ever noticed your room lights dim when you plug in a toaster or an air conditioner? Well, that dimming of the lights is a typical case of power-line fluctuation. A drop of only a few volts will visibly dim a lamp. Fixing this problem is easy, but it is expensive.

Transients, on the other hand, are fast (1 µs to 5 µs) voltage changes involving a 10 or 20% variation in line voltage. Generally these are caused by the inductive kickback of motors and equipment. Usually, the more sophisticated measures employed to limit general line noise (a power-line filter) will eliminate this problem as well. If you have particularly strong narrow-band noise, then a special low-pass filter may have to be used. For example, if the reason your computer malfunctions is the 200 W radio transmitter from the business next door, then a 30 MHz filter might be required.

The fact that you have no knowledge of electronics limits the diagnostic tests that you could use to determine the problem. If you can find a nearby Radio Shack store (or, perhaps, a friendly technician) where you can obtain a VOM (volt-ohm-meter), set it on the 200 V AC range and put the probes in the wall socket next to the computer. The "safe range" is between 110 and 120 V AC. If, however, you notice the indicator taking a dive every now and then, you have a line-regulation problem. This is only a rudimentary check, because the meter has slow response. Checking for line noise and transients requires an oscilloscope (to see the fast pulses).

If you find you need better power-line regulation, you will have to resort to a constant-voltage transformer from the power company (or it may be installed privately). Two companies to contact for further information are: Sola Electric, 1717G Busse Rd, Elk Grove Village Il 60007, (312) 439-2800, and California Instruments, 5150 Corvory St, San Diego CA 92111, (714) 279-8620. Finally, if all else fails, you could encase the entire computer in copper screening and run it from a battery. See my article on "Electromagnetic Interference" in last month's BYTE....Steve

**Modem**

Dear Steve,

Thanks for the article on modems. (See "A Build-It-Yourself Modem for Under $50," August 1980 BYTE page 22.) It got me thinking about something.

I am an ACM (Association for Computing Machinery) member at OSU (Ohio State University). I am lucky enough to be able to have an open account on computers like the DEC PDP-10, IBM 370, and PDP-11. To log onto the system, you call a telephone number, and I would like to use the modem you described to do this from my dorm room. (I have to walk about fifteen blocks to get to the computer center, and, boy, is it cold in the winter.)

How can I build a cheap keyboard/modem/television set terminal? I can wire-wrap and understand schematic diagrams. I know a bit about computers but not a lot.

Marc Taylor

At first I was going to point out that there have been numerous articles in previous issues of BYTE on the design and construction of a video terminal. There are also some kits offered for less than $200 in the advertisements at the back of every issue. At least that's what I was going to say.
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Circle 120 on inquiry card.
However, I have changed my mind in favor of practical reality.

Microcomputers and terminals configured from them are becoming cheaper all the time. It isn't quite like the 6-transistor radio or the calculator—yet. But, you may find that the cost of building a terminal is greater than what it costs to buy one. This is especially true if you purchase used equipment.

Also, the new Radio Shack Videotex combination terminal and modem for $399 is worth investigating. It sounds exactly like what you need—at a reasonable price.

As soon as I can get a chance, I'm going to attempt to make a terminal using the Sinclair ZX80 computer. How does a $300 smart terminal sound?...

**Shedding Some Light**

Dear Steve,

My name is Chris Richard, and I'm 13 years old. I am doing a science project called "Talking on a Beam of Light." I saw your article in the May 1979 BYTE (see "Communicate on a Light Beam," page 32), and I was wondering if you could tell me where I can buy some optical fibers. Could you also send me a list of reading material on optical communications? I am especially interested in getting several plans for optical transmitters and receivers.

I really enjoyed your article, and I learned a lot from it. Thank you for any help you can give me.

Chris Richard

The best sources of information on optical fibers are the manufacturers themselves. Many of them publish application notes which are usually free for the asking. Three of the largest suppliers are: Amp Inc, 449G Eisenhower Blvd, Harrisburg PA 17105; Corning Glass, Electronic Products Division, Department G, Houghton Pk A2, Corning NY 14830; and Galileo Electro Optics, Department G, Galileo Pk, Sturbridge MA 01578.

Another source of circuits comes from optoelectronics manufacturers application notes. These are companies with familiar names like Texas Instruments, General Instrument, General Electric, and Hewlett-Packard. Any good library should have an electronics manufacturers product directory. Ask the librarian if he or she has the Gold Book or EEM Directory.

As far as getting optical fiber materials, unless you want a few thousand feet of cable, I suggest you write for a catalog from: Edmund Scientific Company, Department G, E Gloucester Pike, Barrington NJ 08007.

I think you have chosen a good subject. I wish you luck. When you write to the optics companies, tell them it is for a science fair project. You may find them to be very helpful...

—Steve
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BLACKJACK MASTER: A Simulator Tutor Game (Wazaney) A serious game that performs complex simulations and evaluations of playing and betting strategies, 0303, TRS 80 Level II tape. $29.95, 0308, TRS 80 Disk Version. $39.95

REVERSAL (Spracklen) Winner of the software division of the First International Man Machine OTHELLO" Tournament, this version of the 200-year-old game Reversi, features 27 levels of play and high resolution color graphics, 07004, APPLE II tape. $29.95, 07009, APPLE II Disk. $34.95


FLASH & CRASH SOUND EFFECTS (American Micro Products) A collection of 18 subroutines that can be incorporated into your own programs to produce sound effects with the American Micro Products music board. Included are: Train, Explosion, Phaser, Chimes, Sirens, Jet and others. 08070, APPLE II Disk. $39.95

6502 DISASSEMBLER (Stamms) Produce assembly language source files with labeled subroutines and references from programs already in memory. It is compatible with Hayden's ASSEMLY LANGUAGE DEVELOPMENT SYSTEM. 08069, APPLE II Disk. $34.95

PSEUDODISK (Neuchter) This money-saving program simulates a disk memory system for integer BASIC programs. It can store 128 programs in memory at the same time which can be run from a catalog. 04804, APPLE II tape. $24.95

LINE & VARIABLE CROSS REFERENCE GENERATOR (Johnson) Provides a cross reference of line numbers and variable names. 07301, PET tape. $16.95

DISK CATALOGER (LeBar) Automatically maintain a cross-reference list of all your programs, their location by disk number, their function and use. Catalogs, lists and sorts programs. 02003, TRS 80 Level II tape. $16.95. 03308, TRS 80 Level II Disk. $21.95

APPLE II PLUS ASSEMBLY LANGUAGE DEVELOPMENT SYSTEM: An Assembler/Editor/Formatter (Lutus) Write and modify your machine language programs quickly and easily, 04609, APPLE II Disk Version. $39.95

SUPER APPLE II BASIC (Lutus) A structured BASIC that compiles into an optimized Applesoft integer BASIC program. 05203, APPLE II Disk Version. $39.95

MAILING LIST (Tru Data Software) List addresses, prints labels, allows for alterations and deletions, and has the capacity to make duplicate data file disks. Can only be used with version 1.5. 05713, Heath tape. $49.95

FINPLAN: A Financial Planning Program for Small Business (Montgomery) Allows you to enter data from a balance sheet into the program, to make assumptions about future growth of business, and to have the computer project results for up to five years period based on those assumptions. And if you change any data, the program revises all resulting data automatically. The disk version can only be used with TRSDOS Version 2.3. 05103, TRS 80 Level II tape. $69.95. 05018, TRS 80 Level II Disk Version. $74.95

DATA MANAGER: A Data Base Management System and Mailing List (Lutus) Store information on a floppy disk, and retrieve it quickly and easily by specific names or by category, 04090. Apple II Disk Version. $79.95

MCAP: A Microcomputer Circuit Analysis Program (Savona) Performs a linear voltage, impedance, or transfer impedance analysis of an electronic circuit. 04501, PET: 04503, TRS 80 Level II. 04504, Apple II: each tape $24.95, 04513, Heathkit Zemith Disk. $29.95

MICROCOMPUTER AIDED DESIGN OF ACTIVE FILTERS (Gildef) Eight programs that simplify the design of active filters and will calculate the component values needed for various bandpass, low-pass, and notch type filters. 01401, PET: 01403, TRS 80 Level II. 01404, Apple II. 01407, Heath: each tape $16.95, 01413, Heathkit Zemith Disk Version. $21.95

DISK CERTIFIER AND COPIER (Jacx Inc.) A handy utility program that certifies the acceptability of blank diskettes and rejects those with flaws. It also includes a fast machine language disk copying program that will work on single and dual drive systems. 07809. APPLE II Disk. $19.95

SONGS IN THE KEY OF APPLE (Locelain) Allows you to see and hear your favorite tunes, pre-programmed tunes or music you create (up to 200 notes, including rests, per musical piece). 03304, Apple II tape. $10.95

HOW TO BUILD A COMPUTER-CONTROLLED ROBOT (Loofbourn) Contains 5 control programs that consist of: Joystick Control Program, Self Direction Program, Impact Sensor Control Routine, and more. 00100, KIND 1 tape, $14.95. Should be used with the text HOW TO BUILD A COMPUTER-CONTROLLED ROBOT, 5681. $9.95

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Circle 996 on inquiry card.

BYTE February 1981 287
Forcing the Z80 Starting Address

Randy Soderstrom, 1201 W Valencia Apt 224, Fullerton CA 92633

Late in the design phase of my homebrew Z80 microprocessor-based system I realized there would be a problem in bringing the system up. My monitor program was in ROM (read-only memory) and was written to begin at hexadecimal page F0, character 00. My programmable memory began at page 00, character 00, and to further complicate matters, my system had no front panel.

I faced a number of problems in order to get the processor to begin execution at page F0. When the Z80 reset line was enabled, it zeroed the program counter, causing execution to begin at location 00. Since the interrupt mode was unpredictable on power up, it was no help either.

After some thought, I came up with the circuit shown in figure 1. When the Z80 reset line goes low, the circuit prevents the memory from being enabled. Instead, machine code is generated for a jump to the start of the program monitor.

When the reset switch is pushed, flip-flop IC1 (integrated circuit 1) is set. This makes the output of OR gate IC2 high, no matter what happens with the processor RD line. Any memory-read operations are inhibited and the IC3 buffers are activated.

While all of this is happening, the Z80 is clearing the program counter and will begin execution on page zero at location 00. However, when the Z80 pulses the RD line low, the OR gate (IC2) blocks it, and no memory data is placed on the bus.

The IC4 NOR gates decode the address, which in this case is 00, and place hexadecimal C3 on the data bus. Since this is the machine code for a jump instruction, it is executed as such.

Next, the processor expects to find the low bits of the branch address. Address 01 is decoded to address 00 and is placed on the data bus. It will be used as the eight low-order bits of the branch address.

Finally, the Z80 places 02 on its address bus and expects the eight high-order bits of the branch address on the data bus. Gates IC4 place hexadecimal F0 on the system data bus. After this byte is read, the Z80 executes the entire instruction and jumps to page F0, character 00.

Because of the jump, address bit A15 goes from low to high, clocking a zero into the flip-flop. This change disables the buffers and restores the system to its normal state.

The Z80's refresh cycle does not interfere with the circuit. The refresh register operates only on A0 through A6.

If you require a more complex initialization, this same concept can be used with a ROM (read-only memory) placed on the bus rather than gates. Done in this manner, the memory space becomes free for other uses after initialization.

Figure 1: This circuit will force a Z80 microprocessor to begin execution at hexadecimal page F0, character 00, instead of page 00, character 00. The circuit can be easily modified to begin execution at other addresses.
The following is a list of software packages that have been received by BYTE Publications during the past month. The list is correct to the best of our knowledge, but it is not meant to be a full description of the product or the forms in which the product is available. In particular, some packages may be sold for several machines or in both cassette and floppy-disk format; the product listed here is the version received by BYTE Publications.

This is an all-inclusive list that makes no comment on the quality or usefulness of the software listed. We regret that we cannot review every software package we receive. Instead, this list is meant to be a monthly acknowledgment of these packages and the companies that sent them. Companies sending software packages should be sure to include the list price of the packages and (where appropriate) the alternate forms in which they are available.

Apex, disk operating system for the Apple II. Floppy disk, $99. Apparat Inc, 4401 S Tamarac Pky, Denver CO 80237.


Communications Software for the RS-232C, utility program for the transmission of data over telephone wires. Cassette, $29.95. Radio Shack, 1 Tandy Ctr, Fort Worth TX 76102.

Concentration, graphics game with sound for the TRS-80. Cassette, $9.95. Adventure International (see above).

Data Manager, data base system for the Apple II. Floppy disk, $49.95. Hayden Book Company Inc (see above).

Dogfight, graphics game for the Apple II. Floppy disk, $29.95. Micro Lab, 811 Stonegate Dr, Highland Park IL 60035.

FINPLAN, a small business financial planning program for the TRS-80. Floppy disk, $74.95. Hayden Book Company Inc (see above).

Generate, a TRS-80 program generator. Floppy disk, $100. DataWorks Inc, 97 Jackson St, Cambridge MA 02140.

Interactive Fiction—His Majesty's Ship Impetuous, role-playing game for the TRS-80. Floppy disk, $19.95. Adventure International (see above).

Interactive Fiction—Local Call for Death, role-playing game for the TRS-80. Floppy disk $19.95. Adventure International (see above).

Interactive Fiction—Six Micro Stories, role-playing game for the TRS-80. Floppy disk, $14.95. Adventure International (see above).

Interactive Fiction—Two Heads of the Coin, role-playing game for the TRS-80. Floppy disk, $19.95. Adventure International (see above).

Magician's Hat, a game program for the Commodore PET/IBM. Floppy disk, $25. Southern Software Ltd, 100 Anzac Ave, POB 8683, Auckland, New Zealand.


Microtyping, touch-typing tutorial program for the Apple II. Cassette, $10.95. Hayden Book Company Inc (see above).

Majesty's Ship Impetuous, role-playing game for the TRS-80. Floppy disk, $19.95. Adventure International (see above).

Musical Yat-C, strategy game for the TRS-80. Cassette, $9.95. Adventure International (see above).

The Osborne system is the industry standard accounting package, with literally thousands of users. We offer an enhanced version of that package that will run on most systems without recompiling.

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Before you buy the programs that your company is going to depend on for its accounting, ask the following questions:

Do I get the source code? (Don't settle for less. You cannot make the smallest change without it.)

Is it well documented? (The Osborne documentation is the best.)

Is it fully supported? (If not, why not? What are they afraid of?)

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Circle 197 on Inquiry card.
**Software Received**


PseudoDisk, a disk simulator for Apple II Integer BASIC. Cassette, $24.95. Hayden Book Company Inc (see above).

Royal Flush, poker solitaire game for the Commodore PET/IBM. Cassette, $14.95. Hayden Book Company Inc (see above).

Royal Flush, solitaire game for the TRS-80. Cassette, $14.95. Hayden Book Company Inc (see above).

Scramble, word-guessing game with sound for the TRS-80. Cassette, $9.95. Adventure International (see above).

Shark Attack, game for the TRS-80. Cassette, $7.95. Adventure International (see above).

Slag, multiplayer graphics game for the TRS-80. Cassette, $14.95. Adventure International (see above).

Spelling, educational graphics game for the Apple II. Floppy disk, $21.95. Software by Witzel, 7778 S Poplar Way E, Englewood CO 80112.

Star Trek 3.5, graphics game with sound for the TRS-80. Floppy disk, $19.95. Adventure International (see above).

TRS-80 Opera, music-playing program for the TRS-80. Cassette, $9.95. Adventure International (see above).

Tunnels of Fahad, graphics "chase" game for the TRS-80. Cassette, $9.95. Adventure International (see above).

Word Challenge, game with sound effects for the TRS-80. Cassette, $9.95. Adventure International (see above).


Zossed in Space, space exploration for the TRS-80. Cassette, $14.95. Adventure International (see above).
AARDVARK SOFTWARE takes home computer use one practical step further with "Personal Tax," a federal income tax program designed specifically for home use.

"Personal Tax" was developed by CPA's and computer professionals. It will calculate Federal Forms 1040 and 4726, as well as schedules A, B, G and TC. The program features multiple entries for a variety of inputs (e.g. wages, dividends and charitable contributions). An indexed instruction manual and easy-to-follow input forms are included.

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"Personal Tax" will run on: Apple II, TRS-80 Models I and II, and OSI. Additionally, under CP/M, the program will run on Vector Graphics, North Star and Cromemco.

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Note: CP/M, Microsoft, and North Star are registered trademarks of Digital Research, Microsoft, and North Star Computers respectively.
Books Received


This is a list of books received at BYTE Publications during this past month. Although the list is not meant to be exhaustive, its purpose is to acquaint BYTE readers with recently published titles in computer science and related fields. We regret that we cannot review or comment on all the books we receive; instead, this list is meant to be a monthly acknowledgment of these books and the publishers who sent them.
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BYTÉ February 1981 293
Pascal/Z Users Group

The purpose of the Pascal/Z Users Group is to spread the application and use of the Pascal language. The group is offering four disks of public-domain software applicable to Z80 and Pascal/Z systems. The floppy disks cost $10 each; membership in the group is not required for purchase. The programs are in source code and in a COM file. They include tutorials, utilities, and various applications. The group is continually seeking quality software from programmers. A bimonthly newsletter is available for $6 per year. Additional details can be obtained by writing the Pascal/Z Users Group, 7962 Center Pky, Sacramento CA 95823.

I-SUG

This group has been organized as a co-op to enable Exidy Sorcerer users to gain access to a mailing list and a user-contributed library. The library contains programs and other technical information for the Sorcerer. I-SUG charges neither fees nor membership dues. Clubs and individual Sorcerer users are encouraged to use I-SUG to contact other clubs and attract new members. For complete details, send a self-addressed, stamped envelope to I-SUG, POB 1542, St. Catharines, Ontario, L2R 7J9, Canada.

Pocket Computer Newsletter

The Pocket Computer Newsletter reports on the latest developments concerning pocket and hand-held computers. Published ten times a year, the newsletter also features programming tips, operating time-savers, tutorial articles, notes on customizing units, programming shortcuts, listings of programs, technical information, application forums, and product reviews. The subscription price is $20 in the US, $24 in Canada, and $30 elsewhere. For information, contact The Pocket Computer Newsletter, POB 232, Seymour CT 06483.

Monroeville Apple Users Club

This club has just recently formed. If you would like more information, write to the Monroeville Apple Users Club, attn: Dr G J Harloff, 579 Carnival Dr, Pittsburgh PA 15239.

The Cursor Group

The Cursor Group is a manufacturer-supported user group for the Bally Arcade that supports over forty affiliated local users groups. The Bally Arcade employs an enhanced version of Palo Alto Tiny BASIC, which includes analog-to-digital con-

DataSouth Announces... THE TOTAL PRINTER PACKAGE!

With so many matrix printers available today, it's tough to find the right one for your application. Some offer the speed you need, others the communications flexibility and still others the form handling capability. But no printer offers all the features you need... until now.

The DS180 matrix printer provides the total package of performance features and reliability required for applications such as CRT slave copy, remote terminal networks and small to mid-range systems. Not a "hobby-grade" printer, the DS180 is a real workhorse designed to handle your most demanding printer requirements. And pricing on the DS180 is hundreds of dollars below competitive units.

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Communications Versatility—The DS180 offers three interfaces including RS232, current loop and 8-bit parallel. Baud rates from 110-9600 may be selected. A 1K buffer and X-on, X-off handshaking ensure optimum throughput.

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version, a three-voice music synthesizer, 156 by 128 resolution with up to 256 colors, and user-accessible graphics. Commands and routines not included in the documentation are published in the group's newsletter, The Cursor. Other manuals are being published. Contact The Cursor Group, POB 266, North Hollywood CA 91603.

SD User Exchange

SD User Exchange is a dealer group designed to meet the needs of the SD dealer. The group's goal is to provide an avenue for the exchange of software programs, technical knowledge, marketing tools, and ideas among SD dealers. This group was recently formed, so if you would like to become a part of this growing pool of SD resources, contact SD Systems, 3401 W Kingsley Rd, Garland TX 75041, or call Bob Sherman, Director of Marketing, at (214) 271-4667.

Newsletter for Home Computer Users

Home Computers is a brand-new newsletter for hobbyists, investors, and the small-business person. The publication is written for home computer users who use their machines for taking inventory of collections or products, investment analysis, bookkeeping, and educational and recreational game playing. Home Computers contains equipment reviews, programming methods, a forum for input standards, coding for specific functions, and a primer for beginning programmers. Subscription information can be obtained by sending a self-addressed, stamped envelope to Home Computers, POB 616, Silverton OR 97381.

SuperLetter

SuperLetter is for Super-Brain users. Subscribers will be able to keep pace with the latest technical news, operating tips, accessory ideas, and software designs for Intertec's machine. Regular monthly features include a technical corner, a question-and-answer forum, the latest-breaking news from the factory, guest interviews, and the SuperClassifieds. SuperLetter inquiries can be addressed to Abrams Creative Services, 369 S Crescent Dr, Beverly Hills CA 90212, (213) 277-1588.

PET Users Group

At 7:30 PM on the second Tuesday of the month, you can find the NW PET Users Group meeting in the University of Washington's Academic Computer Center, 3737 Brooklyn, in Seattle, Washington. This group is dedicated to the use of PET/CBM microcomputers. The NW PET Users Group publishes a newsletter on a semiregular basis and it occasionally charges membership dues. Contact Richard Ball, 2565 Dexter N # 203, Seattle WA 98109, (206) 284-9417, for complete information.

Club In Venezuela

Civil Engineering students and professors at the University of Carabobo, Valencia, Venezuela, have formed a computer club. The Club de Computacion Lampas de Carabobo meets on the first and second Tuesdays of each month. The primary interest is in the application of microcomputers to civil engineering practice and teaching, including basic sciences as well as administrative and technical aspects. Write to the club at Apartado 716, Valencia, Venezuela, 2001A.
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February 1981

February-May
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ICS (Integrated Computer Systems) is presenting a series of intensive 3- and 4-day courses on computerized robots; interactive computer graphics; programming in Ada; structured design and programming; microprocessor software, hardware, and interfacing; computer network design and protocols; and many other topics. Contact ICS, 3304 Pico Blvd, POB 5339, Santa Monica CA 90405, (800) 421-8166; in California (800) 352-8251.

February-May
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This course is geared for engineers specializing in reliability, product assurance, logistics, quality assurance, and product design, and is designed for those who design and predict the reliability of components, equipment, and systems. The course fee is $975. Contact Continuing Education in Engineering and Mathematics, UCLA Extension, POB 24901, Los Angeles CA 90024, (213) 825-1047.

February 14-16
International Conference on Microcomputer Applications to Industrial Controls, Jadavpur University, Calcutta, India. Papers will be presented on the applications of microcomputers to industrial controls in the areas of general systems. Contact Dr Sushil Dasgupta, Professor and Head, Electrical Engineering Department, Jadavpur University, 40B, Southern Ave, Calcutta-700029, India.

February 17-18
Integrating Word Processing and Electronic Data Processing: Technology, Architecture, Planning, The Harvard Club, New York NY. The topics of this seminar will be the study of word processing today and its future, the evaluation and selection of systems, electronic mail and communications, and the automated office. For further details, contact the seminar coordinators at the Center for Management Research, 850 Boylston St, Chestnut Hill MA 02167, attn: Ms Karen Smolens, (617) 738-5020.

February 19-20
Business- and Personal-Computer Sales and Exposition and the Houston Business Show, Houston Civic Center, Capitol Ave and Bagby St, Houston TX. Data-processing managers, systems analysts, programmers, educators, hobbyists,
BASIC A+ from the Authors of ATARI® BASIC

BASIC A+ for the ATARI 800®
BASIC A+ will rate an A+ from any ATARI user! It is upward compatible with ATARI Basic, this adds statements and features that enhance the ATARI 800's real power, flexibility, and ease of use. Superior I/O features for business and other applications. Additional file manipulation commands. Significant help in program development and debugging. Structured programming aids. And MORE! A partial list of the enhancements of BASIC A+ includes:

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and user's groups will find this exposition useful. The business show is primarily designed for purchasing and office managers, executives, business owners, attorneys, accountants, and physicians. For details, contact Produx 2000 Inc, POB 2000, Bala-Cynwyd PA 19004, (215) 457-2300.

February 23-26
Computer Science Conference, Stouffer's Riverfront Towers Hotel, St Louis MO. The conference is sponsored by the ACM (Association for Computing Machinery). The Ninth Annual Computer Science Employment Register will be conducted. This register aids in matching computer scientists and data-processing specialists with employer opportunities. For information, contact Orrin E. Taulbee, ACM Computer Science Employment Register, Department of Computer Science, University of Pitts-burgh, Pittsburgh PA 15260, (412) 624-6475.

February 24-25
The Ninth Annual Midwest Digital Equipment Exhibit and Seminar, Thunderbird Motel, Minneapolis MN. More than sixty manufacturers of computer terminals, data-communication equipment, peripherals, and test instruments will be displaying their products. Over 1500 users and manufacturers are expected to attend. Registration at the entrance area is required, but there is no charge to attend exhibits or seminars. Contact Kim Shobe, c/o Loonam Associates Inc, 7720 Bush Lake Rd, Minneapolis MN 55435, (612) 831-1616.

February 26-27
Louisiana Computer Exposition, University of Southwestern Louisiana, Lafayette LA. Papers will be read on operating systems, data-base management and support, distributed computers systems, and related topics. Contact William R. Edwards, c/o the Computer Science Department, University of Southwestern Louisiana, POB 44330, Lafayette LA 70504, (318) 264-6284.

March 1981
March-November
Advanced Data Processing Workshops, Deltak Inc, various cities throughout the US and Canada. For details, contact TI-MIX, M/S 2200, POB 2909, Austin TX 78769, (512) 250-7151.

March 11-13

March 17-20
The Fourteenth Annual Simulation Symposium, Tampa FL. Papers describing digital discrete simulation and other techniques will be read. This symposium is a put time and remote control in your apple II

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thread for the exchange of ideas and techniques in computer simulation. Contact Annual Simulation Symposium, POB 22621, Tampa FL 33622.

March 20
Digital Computer Association Annual Meeting, Pacifica Hotel, 6161 Centinela Blvd, Culver City CA. Cocktails, dinner, and the annual meeting are the features of this gathering. For more information, contact Mary Rich, 731 Bayonne St, El Segundo CA 90245.

March 23-25
Office Automation Conference, Albert Thomas Convention Center, Houston TX. This conference will present seminars on concepts and methods behind the latest office technologies and an exhibition of office equipment. Contact Office Automation Conference, POB 9659, Arlington VA 22209, (703) 559-3617.

March 24-26
The Southwest Semiconductor Exposition, Phoenix Civic Plaza Convention Center, Phoenix AZ. More than 140 equipment and materials makers will exhibit semiconductor, hybrid, and printed-circuit board production, processing, and test equipment. Contact Cartridge & Associates Inc, 491 Macara Ave, Suite 1014, Sunnyvale CA 94086, (408) 245-6870.

March 31-April 2
Cincinnati Business Show, Cincinnati Convention-Exposition Center, Cincinnati OH. Office equipment and services, including automated systems, communications, computers, telephone systems, word processing, data processing, printing equipment, and other office supplies, will be featured. A program of business seminars is also scheduled. Contact Ray G Nemo, 3679 Creek Rd, Cincinnati OH 45242, (513) 531-5959.

April 1981

April 1-3
Assuring Quality in Electronic Data Processing Applications, McCormick Inn Hotel, Chicago IL. The objective of this conference is to explain the methods, tools, and techniques that are valuable in improving the quality of computerized applications. Tutorials will cover the areas of quality assurance; managing structured design; and designing, implementing, and enforcing application standards. Contact DPMA Quality Assurance Conference, 12611 Davan Dr, Silver Spring MD 20904, (301) 622-0066.

April 3-5
The Sixth West Coast Computer Faire, Civic Auditorium, San Francisco CA. The Faire, a major personal-computing event, has continually attracted larger and larger numbers of exhibitors and attendees. A full program of talks plus a large display of hardware and software are featured. For more information, contact Computer Faire, 333 Swett Rd, Woodside CA 94062, (415) 851-7075.

April 7-8
Top Secrets '81, Pointe Resort, Phoenix AZ. Honeywell's annual computer security and privacy conference. Many authorities in the field of data security will discuss the business and legal impact of the latest incidents in computer crime and abuse. The conference fee is $500. Contact the Security Symposium Registrar, Honeywell Information Systems, M/S T-99-4, POB 6000, Phoenix AZ 85005, (800) 528-5343.

April 7-9
Computerized Office Equipment Expo, O'Hare Exposition Center, Rosemont IL. Over 200 exhibitors will be featuring their office equipment at this show. Executives and administrators from wholesale, retail, commercial, financial, and industrial establishments are invited, along with the general public. Contact Industrial & Scientific Conference Management Inc, 222 W Adams St, Chicago IL 60606, (312) 263-4866.

April 7-9
Electro/81, New York Coliseum and Sheraton Centre Hotel, New York NY. Electro/81 will feature computers and computer-related equipment, plus seminars on components, devices, and materials; computer communications; memories; office automation; speech; and more. Contact Electronic Conventions Inc, 9901 Sepulveda Blvd, Suite 410, El Segundo CA 90245, (213) 772-2965.

April 13-16
The Fifteenth Annual Symposium on Minicomputers and Microcomputers, MIMI '81, Sheraton Hotel, Mexico City, Mexico. This symposium covers hardware, software, distributed processor architecture, computer networks, telecommunications, real-time applications, education, and more. Contact Ing. Jorge Gil, Academic Secretary, MIMI Symposium, IIMAS-UNAM, Apartado Postal 20-726, Mexico 20 D F, Mexico.

April 26-30
Saudibusiness '81, Riyadh, Saudi Arabia. This show has been designed for the fast-growing Saudi Arabian business community. Pavilions by the United States, the United Kingdom, West Germany, France, Italy, and approximately fifteen other countries will be featured. For more information, contact Donald Ryan, Project Manager, Rm 3200, US Department of Commerce, Washington DC 20230, (202) 377-4652.
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**Features**
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**NEWDOS/80** is Apparat’s latest upgrade to NEWDOS. Features include variable length records, chaining, and drivers specifically configured for Omikron’s MAPPER II. $150.

**MAPPER II** adapts the TRS-80 to run both 5" and 8" drives. With NEWDOS/80, storage is increased to 300K per 8" drive. $99 plus $10 per cable connector.

**MAPPER I** adapts the TRS-80 to run the vast library of CP/M software as well as the TRS-80 software. All Lifeboat Software may be ordered for the MAPPER I. All MAPPER I CP/M software is compatible with the CHYM for the Model II. With MAPPER II and 8" drives, the Model I becomes disk compatible with the Model II. Standard features include lower case support, serial and parallel printer drivers, and an addressable cursor. MAPPER I is supplied with complete utilities including a memory test, a disk test, a copy program, and a proprietary program for converting TRS-DOS files to CP/M files. $199.

**WORD PROCESSING**— MAPPER I supports professional word processors like the Magic Wand and Word Star (see reviews in June 80 Kilobaud). Omikron’s implementation includes a blinking cursor, auto repeat, shift lock, de-bouncing, and an input buffer that eliminates missed characters. MagicWand super discount price $299.

**FIELD PROVEN DESIGNS**— After one year of MAPPER production, Omikron has established an impeccable reputation for reliability, integrity, and user support. Omikron’s customers include the US Government, major corporations, universities, medical doctors, and professionals in all fields.

**SYSTEMS**— Omikron sells complete systems featuring Model II compatible Shugart disk drives. Call for prices and delivery.

**FOREIGN ORDERS** must include full payment in US funds plus $25 for air shipping and handling.

See review in July 80 BYTE By Jerry Pournelle.
There are two important aspects of compiler writing. One is that compilers are big programs, and big programs are very difficult to write. (A thousand-line program is considerably more than ten times as difficult to write as a hundred-line program.) The other aspect is that there are many well-known techniques for translating or interpreting programs. Brown's book deals with this aspect. He assumes you are able to program in a high-level language (such as Pascal) and that you have had some experience with an interactive language (preferably BASIC).

Brown discusses the fundamentals of compiler writing. He strongly emphasizes interactive programming languages, like BASIC, where programs are developed one segment at a time, as opposed to being carefully edited and put through a compiler. He also assumes that most of his readers are working with single-user microcomputer systems which have limited memory. Therefore, he often mentions ways to squeeze a few extra bytes from the programs, but he does not worry very much about speed.

The book is divided into eight parts. They deal with planning of the project, the overall structure of the compiler (including the internal representation language, error checking, symbol tables, storage management,
and such), the internal language (most often Reverse Polish Notation), parsing and translation, the run time system, other modules, compiler testing, and advanced topics.

Throughout the book, Brown emphasizes the modular approach—designing, coding, and testing the system one piece at a time. He spends much time on the recreation of programs from the internal representation. For instance, if the BASIC you use sometimes inserts or drops spaces in your statements, it is because the editor within the BASIC system does not store your program as it was entered, using a total of twice as much memory. You need a way to recreate the program from the internal representation.

Brown also discusses incremental compiling—compiling a program a segment at a time. (If the version of BASIC you use translates each line as it is typed in, it is doing incremental compilation.) And Brown talks about handling what he calls "break ins"—what must be done after you hit the break or reset key. There is a very complete index, and an excellent bibliography.

Brown does not say much about the other major aspect of compiler writing—how to write very large programs. However, he suggests several "deadly sins" to avoid. He recommends the book Software Tools, by Brian Kernighan and P J Plauger, for more on this subject.

If you have had some experience with writing very large programs, Writing Interactive Compilers and Interpreters has all you need to know to write a compiler or interpreter that handles BASIC, PILOT, or Logo (or even APL or LISP). It is a little weak for handling more complex languages.
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Reviewed by

Thomas Munnecke

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At first glance you might wonder what this book by the flamboyant senator from California has to do with computers. Although it is ostensibly a textbook for students of semantics, it is actually a very timely and insightful guide for anyone interested in computer languages, systems design, program documentation, or software engineering.

Written in 1939, before the digital computer was even a dream, Language in Thought and Action offers valuable lessons for today's computer-smart reader.

Forty-two years after publication, Hayakawa's book seems almost prophetic. Or perhaps our technology has not taken us as far as we would like to believe.

Hayakawa will appeal to anyone interested in logical thought processes and, more particularly, linguistics. He wrote "as a response to the dangers of propaganda, especially as exemplified in Adolf Hitler's success in per-
suading millions to share his maniacal and destructive views. It was my conviction then, as it remains now, that everyone needs to have a habitually critical attitude towards language—his own as well as that of others."

In order to fully appreciate his book, you must transfer the concept of "language" as the spoken word to the concept of "language" as it exists in the computing world. Both have syntax (how you say it), semantics (what you mean), and pragmatics (what you are trying to accomplish). Once you grasp the generality of language, you can understand the concept of computer language. Languages, specifications, and documentation suddenly appear in a new light.

Beginning programmers often seem unable to recognize the arbitrary nature of the symbols in the programming language. It is as if they see the term "SIN(X)" as some kind of magical incantation, rather than as a programmed abstraction of a particular language. Hayakawa's statement on this is as follows:

"We are, as human beings, uniquely free to manufacture and manipulate and assign values to our symbols as we please. Indeed, we can go further by making symbols that stand for symbols."

Although all computer languages manipulate and assign values to symbols, the early computer languages, such as FORTRAN, COBOL, and BASIC, restrict the dynamic manipulation of these symbols. Newer languages have gone further, creating symbols that stand for symbols, as in APL, PL/I, MUMPS, LISP, and Pascal.

For those initially confused by the apparent complexities of higher-level languages, Hayakawa offers this encouragement:
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He also warns that symbols must be viewed in their relationship to other symbols. I once had an experience with a computer programmed to assist in medical diagnoses. I was asked to type in my symptoms, and the computer would respond with a possible diagnosis. Being on the last leg of a hectic cross-country trip, I selected symptoms of headache, tiredness, and so forth. The computer responded with the suggestion that I was suffering from pre-menstrual tension. I unfortunately ignored the critical context that I was male.

The chapter on “Reports, Inferences and Judgments” directly corresponds to the chronological development of the computer technology industry. The “report” concept is equivalent to the old batch-run systems in which the entire file is reported to the user after each batch is run. Many of these systems are being reprogrammed to run on-line with the manipulation of only selected data—in correspondence to Hayakawa’s “inference.”

And finally, the “judgment” concept applies to the use of the computer in the future, as it becomes actively involved in making its own decisions in such disciplines as artificial intelligence or modeling.

Hayakawa then turns to a discussion about standards. He cites the chaos existing in the time zone standards before the year 1883:
"When it was noon in Chicago, it was 12:31 in Pittsburgh, 12:24 in Cleveland, 12:17 in Toledo... There were twenty-seven time zones in Michigan alone. (When the time zones were standardized, farmers were afraid of the change, saying that their cows would not know when to come home.)"

The comparison with computer language standards is clear. How many BASIC and Pascal dialects and extensions are there? And how many interpretations of the S-100 bus are floating around? When it comes to getting modern-day language implementors to agree on a standard version, one meets just as many sacred cows.

His section "Presymbolic Language in Ritual" could just as well have been discussing the ritualistic statements forced upon the COBOL programmer every time he writes a program. A strong comparison could be made between this meaningless process in COBOL and the multitude of religions around the world which conduct services in old and forgotten languages.

In "How We Know What We Know," Hayakawa explains the process of abstracting. He takes us from a quote by Ambrose Bierce:

"An edible: Good to eat and wholesome to digest, as a worm to a toad, a toad to a snake, a snake to a pig, a pig to a man, and a man to a worm...."

to an exposition of the levels of abstraction of a cow, in an essay that should be required reading for all programmers who strive for structured programming or structured design.

The section "On Definitions" should be read by anyone who is too impressed by program documentation outside the program:
Definitions, contrary to popular opinion, tell us nothing about things... That is, when we stay at the same level of abstraction in giving a definition, we do not give any information, unless, of course, the reader is already sufficiently familiar with the defining words to work himself down the abstraction ladder.

The concept of "Dead-Level Abstracting" describes the person who is permanently stuck at a certain level on the abstraction ladder. Hayakawa defines the two extremes—the low-level, who "go on indefinitely, reciting insignificant facts, never able to pull them together..." and the high-level, whose language "remains permanently in the clouds." These extremes describe two personalities often found in computer-related environments. The low-level personality is typified by a COBOL programmer, determined never to learn another language because he already "knows how to program." The high-level person is apt to be a systems analyst who dreams of creating the world. These two approaches to systems design could be called "bottom down" and "top up," respectively.

The sections "Confusion of Levels of Abstraction," "Classification," "The Blocked Mind," and "Cow, is not Cow," will capture the sympathy of anyone who has grappled with the problems of systems design. "The Two-Valued Orientation" could have been written by someone criticizing the computer's ruthless binary decision-making process.

Today, "Poetry and Advertising" could easily be renamed "Poetry and Programming." Hayakawa's phrase, "Advertising is a symbol-manipulating occupation," is reminiscent of Frederick Brooks's approach in his excellent book about computer programming, The Mythical Man-Month:

"The programmer, like the poet, works only slightly removed from pure thought-stuff. He builds castles in the air, from air, creating by the exertion of the imagination. Few media of creation are so easy to polish and rework, so readily capable of realizing grand conceptual structures."

This analogy might help explain the programmer's personality to outsiders.

Perhaps the most meaningful summary of the book is Hayakawa's own. In his section "Rules for Extensional Orientation," he writes:

1. A map is NOT the territory it stands for; words are NOT things.
2. The meanings of words are not in the words; they are in us.
3. Contexts determine meaning.
4. When tempted to fight fire with fire, remember that the fire department usually uses water.
5. The two-valued orientation is the starter, not the steering apparatus.
6. Beware of definitions, which are merely words about words.

All in all, this is an insightful book on language in action.

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A/D and D/A Conversion—An Inexpensive Approach

Although there are many ways to achieve the conversion of data from analog to digital form, a converter that is simple, fast, inexpensive, and reasonably accurate is seldom available to the serious experimenter. Here I will describe a design that fulfills these characteristics.

To be of practical use, a converter should have at least 8 bits of resolution and be accurate to 0.4% (the value of the least significant bit). In most cases, the conversion should be complete in 10 to 20 µs; this is about as fast as most microprocessors can collect two measurements and do anything with them.

Theory

After ruling out V/F (voltage-to-frequency conversion), slope integration, and charge-balancing systems because of their slowness or complexity, I finally decided that the circuit should consist of a counter cycling continuously to drive a D/A (digital-to-analog) resistance ladder, commonly called an R/2R circuit. The ramp signal produced is used as a reference voltage which the analog input signal is compared with.

The output of a comparator may be used to strobe latches that sample the output of the counter. This means that a conversion is completed every 256 clock cycles—at 20 MHz, the conversion takes less than 13 µs.

The Circuit

The clock circuit is based on a K1100A packaged oscillator produced by Motorola, designated as IC1 in figure 1. This particular circuit was chosen primarily because one was on hand. There are a number of other circuits that would work as well, such as a 74123 multivibrator connected in an astable configuration, or an NE555 timer (if speed is not a consideration). For full-speed operation, the clock frequency can be in the range of 20 MHz and should have a clean square-wave output to drive the counter stage properly.

The counter stage consists of IC2 and IC3, both 74193 synchronous 4-bit up/down counters. These are designed to switch simultaneously and therefore do not produce the switching transients seen at the outputs of asynchronous ripple counters. Such “glitches” would result in erratic comparator operation.

A second advantage of these devices is that they may be loaded in parallel; this allows us to use the circuit in converting data both to and from digital form. The parallel output from these counters drives the 74173 quad-D latches (IC4 and IC5) as well as the resistance ladder.

The resistance ladder is a network of resistors designed to produce a voltage proportional to the binary number applied. The output voltage that appears at point A in figure 1 is described by equation 1. E0 thru E7 represent the voltages present on the eight counter-output lines. Since the counter output is nominally 5 V, voltages from 20 mV to almost 5 V can be generated in 20 mV increments.

The actual value of R in figure 1 is not too important, and can be anywhere in the range of 5000 to 50,000 ohms. It is important that all resistances in the ladder are closely matched because this will affect the accuracy of the circuit. A good method to ensure close tolerance is to

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**SOFTWARE FOR THE ATARI 800**

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Figure 1: This schematic diagram shows that a small number of parts (all easily obtainable) can be used for a fast, flexible converter. Operation is switch-selectable for A/D or D/A modes; conversion takes less than 13 µs in A/D mode, and is almost instantaneous in D/A mode. Speed of conversion is set by clock frequency and propagation delays in the integrated circuits used. The concept is easily expandable to 12 or 16 bits, if necessary.

Equation 1

Output Voltage = \( E_7 + E_6 + E_5 + E_4 + E_3 + E_2 + E_1 + E_0 \)

\[
\begin{align*}
\text{Number} & \quad \text{Type} & \quad +5V & \quad \text{GND} \\
& & & \\
IC1 & \quad K1100A & \quad 1 & \quad 2 \\
IC2 & \quad 74193 & \quad 16 & \quad 8 \\
IC3 & \quad 74193 & \quad 16 & \quad 8 \\
IC4 & \quad 74173 & \quad 16 & \quad 8 \\
IC5 & \quad 74173 & \quad 16 & \quad 8 \\
IC6 & \quad 7404 & \quad 14 & \quad 7 \\
IC7 & \quad LM311 & \quad 8 & \quad 1,4
\end{align*}
\]

buy twenty-five resistors of the same value from the same batch, then use two resistors in series for each 2R leg. In the D/A conversion mode, the output, which may be taken from point A, must be buffered, since the counter outputs are of the low-power type.

The voltage comparator (IC7) compares the analog input signal to the output voltage of the resistance ladder. Since the counter increments from zero, the ladder output should start out lower than the analog signal. When the ladder output level is greater than the analog signal, the comparator senses the change and provides a strobe to latch the counter values into IC4 and IC5. A 5 k-ohm potentiometer may be included to attenuate input signals greater than 5 V.

The comparator is an LM311, which was chosen because it requires only a single-ended power supply. This simplifies construction considerably.

The output latches (IC4 and IC5) are a pair of 74123 quad-D flip-flops. They were chosen because of their three-state outputs. The output pins may be connected to the parallel inputs of the counter circuit, and their three-state ability allows the use of one port for both input D/A and output A/D (analog-to-digital) operation.

Operation

A complete A/D conversion cycle goes as follows (refer to figure 2):

- The cycle starts as the counter goes through hexadecimal 00. The voltage at point A is at zero and the output latch contains the result of the last conversion cycle.
- The counter increments toward hexadecimal FF, and at some
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Figure 2: This timing diagram shows that, when the reference voltage (point A) has reached the level of the analog-input signal, the comparator toggles to strobe the 74173 latches. Data in the latches remains valid until the comparator toggles again. In the A/D mode, the data is applied to the counter inputs with the load pin (pin 11) grounded. This feeds the digital information directly to the resistance ladder, so conversion is immediate.

Construction
As long as component leads are kept short, no special construction practices are required. I believe that wire-wrap is the best way to build such projects. Due to the high speed of the circuit, it is important to bypass each integrated circuit with a 0.1 μF capacitor. I soldered the bypass capacitors directly to the back of the sockets. Any component failures in the bypass network will show up as erratic operation (due to noise).

Application
The A/D operation of the circuit is very simple. Connect the circuit to an 8-bit I/O (input/output) port; when you want a measurement, simply read the value that appears at the port. Operation is similar in the D/A mode; simply write data to the port (with the select switch set to D/A). The analog input signal may range from zero to about 4.5 V (or greater with the optional attenuator). Analog outputs have the same range, unless you take the trouble to install a buffer amplifier.

Of course, the concept is expandable; 12-bit and 16-bit converters are easily possible with a few more components, although conversion times will be longer.

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- Maximum # of physical and logical drives: 128
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**BYTE February 1981**

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Turn Your COSMAC VIP into a Frequency Counter

Andrew Modla
5 Derby Pl
Newtown PA 18940

Many electronic construction projects include a decade-frequency counter somewhere in their hardware. For example, I have seen decade-frequency counters in pH meters, digital voltmeters, capacitance meters, tachometers, digital thermometers, camera shutter-speed meters, event counters, etc. This article describes a frequency counter that is somewhere else—in software. This application is an example of the elimination of hardware by using software techniques. No additional hardware is required. Your microcomputer can replace decade-counter hardware in each of the construction projects named above.

I programmed my RCA COSMAC VIP microcomputer to perform as a general-purpose, audio-range decade-frequency counter. The program will count in the 1 to 11,004 Hz range. It checks the transitions of the COSMAC 1802 microprocessor EF4 input flag for one second. The binary count taken is then converted to a decimal value for display on the video monitor. After two seconds to show the count, the program begins to count again.

The program derives its accuracy from the crystal clock that runs the microprocessor. Timed program loops check the input line at precise intervals to obtain a count. Figure 1 shows the flowchart of the program. The program is shown in listing 1. It consists of a COSMAC VIP CHIP-8 interpretive-code main program for control and display, and an RCA CDP1802 machine-language subroutine to perform the counting function.

One of the parameters passed to the machine-language subroutine is a time parameter that, when incremented to zero, gives a precise 1-second interval used in counting. The COSMAC VIP has a 3.521280 MHz crystal. If you use a different crystal, the following formula will provide a number that, when subtracted from 65,536, will count for one second:

\[
T = \frac{\text{number of clock cycles in 1 second}}{\text{number of clock cycles to execute looping instructions}}
\]

\[
= \frac{F \times 10^6 \text{ clock cycles}}{2 \text{ second}} \times \frac{1 \text{ second}}{8 \text{ clock cycles} \times \frac{2 \text{ machine cycles}}{\text{machine cycle}} \times (5 \text{ instructions})}
\]

\[
= \frac{F \times 10^6}{160}
\]
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Listing 1: The main frequency-counter program for the RCA COSMARC VIP microcomputer. The program is written in CHIP-8 interpretive code.

where \( F \) is the crystal frequency in MHz. For \( F = 3.521280 \), \( T \) has the value 22,008. Since the program counts up to zero, the count used in the program is decimal \( 65,536 - 22,008 = 43,528 \), or hexadecimal AA08. Note that the VIP microcomputer halves \( F \) by using a flip-flop. The maximum frequency that can be counted by the program is \( T/2 \) or 11,004 Hz using the above crystal frequency. This assumes no half-cycle of the signal being measured is shorter than five instruction executions, or 45.438 \( \mu s \).

The counting subroutine uses a five-instruction loop for counting in both the high and low halves of a cycle. Every five instructions, the time-parameter count is incremented by 1. When the time parameter becomes zero

Figure 2: Flowchart for the frequency-counting program written for the CDP1802 microprocessor. The program can be adapted to work with almost any microprocessor.
### Listing 2: The counting subroutine for the frequency-counter program written for the RCA COSMAC VIP microcomputer. The subroutine is written in CDP1802 microprocessor code and corresponds to the flowcharts in figures 2 and 3.

<table>
<thead>
<tr>
<th>Hexadecimal Address</th>
<th>Hexadecimal Code</th>
<th>Label</th>
<th>Instruction Mnemonic</th>
<th>Operand</th>
<th>Comment</th>
</tr>
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<tbody>
<tr>
<td>0300</td>
<td>F800</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
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<tr>
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<tr>
<td>0322</td>
<td>9E</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Circle 241 on inquiry card.
Listing 2 continued:

0325 1E
0326 9E
0327 3A0B

*CONVERT BINARY TO DECIMAL
*FIVE-BYTE AREA FOR STORING DECIMAL NUMBER IN REGISTER A

0329 F805
032B A7
032E 8003
032F 686F
0331 AC
0332 9F
0334 1C
0335 8F
0336 5C
0337 1C
0338 EC
0339 F8 00
033B AD
033C 9F
033D BE
033E 6F
033F AE
0340 8E
0341 F7
0342 AE
0344 9E
0345 77
0346 8E
0347 2C
0348 3B 51
034A 1D
034C BE
034D BF
034E A0
034F 30 40
0351 8D
0352 5A
0353 1A
0354 1C
0355 1C
0356 27
0357 67
0358 3A 39
035A E2
035B 69
035C D4
0391

TABLE

| 1027 | E803 | 6400 | 0A00 | 0100 |

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Figure 3: Flowchart for the binary-to-decimal-conversion program. RA contains the address of the digit storage area.

Text continued from page 320:

(this 16-bit value will overflow to zero at 65,536), the binary-to-decimal-conversion portion of the subroutine gets control. This routine successively subtracts multiples of ten stored in a table from the binary number and stores decimal digits each time the frequency count underflows.

Once you have your frequency counter running, you might want to modify the program to check EF2 instead of EF4 input. With this change, sine waves on EF2 can be counted using the tape-input line of the VIP.

Other useful applications for the frequency-counter program are the alignment of a modem kit like the Pennystem 103 and the adjustment of cassette-tape clock interfaces.

Even if you don’t have a COSMAC VIP, you can program your microcomputer to perform frequency counts using the flowchart contained in this article. Happy counting!
IT'S REEALLY NEAT HOW THIS COMPUTER CAN GENERATE SPEECH.

WELL, HE'S WRITING A 4 VOICE SPEECH SYNTHESIS PROGRAM.

WE'LL NEED 4 DIFFERENT PEOPLE FOR THE VOICES.

WALK THIS WAY GENTLEMEN WHO TO GET.

OK MEN... WE'RE READY FOR A TEST.

ICE CREAM, ICE CREAM, ICE CREAM COFFEE, COFFEE, COFFEE...

ICE CREAM, ICE CREAM, ICE CREAM, ICE CREAM

I DON'T KNOW WHAT HAPPENED TO THE 4TH VOICE!

CRIPES! WHAT HAPPENED TO THE 4TH VOICE?

IT'S A BAD I.C.

IT COULD BE THIS BIG ONE.

IT COULD BE THIS BIG ONE.

WHAT'S WRONG WITH YOU?

HOLD YOUR PANTS ON!

HOW'S THAT?

COF... AH... BETTER!

I'LL PUT IT BACK AND TRY IT AGAIN.

MAYBE IT'LL WORK NOW.

MAYBE IT'LL WORK NOW.

WE'RE READY FOR THE REAL THING.

THIS IS NOT A TEST.

IT'S NICE WHEN YOUR COMPUTER RUNS PROPERLY.
I run MMSFORTH on my Radio Shack TRS-80 Model I. I wrote the KNIGHT program in listing 1 to compare the speed of FORTH with other languages. The program in listing 1 shows the trial-and-error solution of the Knight's Tour problem (i.e., to find a sequence of Knight moves such that each chessboard square is visited exactly once) displayed on the screen while the solution is being worked out. A modified version of this program that does not give a dynamic display of each move was compared in execution speed and relative program size to the same algorithm coded in TRS-80 Level II BASIC and in Z80 machine code. The results are given in Table 1.

Listing 1: The program KNIGHT, a Knight's Tour problem written in MMSFORTH. This listing was made on a European printer, which necessitates the American user to change all the percent signs (%) to exclamation points (!). The exclamation point is actually the familiar "store-value" variable in FORTH and is used in the words \[ I \] and \[ +1 \].

<table>
<thead>
<tr>
<th>Language</th>
<th>Execution Time</th>
<th>Relative Size of Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z80 machine language</td>
<td>1 min, 06 sec</td>
<td>1</td>
</tr>
<tr>
<td>MMSFORTH</td>
<td>30 min</td>
<td>27</td>
</tr>
<tr>
<td>Level II BASIC</td>
<td>9 hr, 52 min</td>
<td>539</td>
</tr>
</tbody>
</table>

Table 1: Comparative execution times and program sizes of three versions of the same program. The same algorithm was used to code each of the three versions of the Knight's Tour problem, one version each in Z80 machine language, MMSFORTH, and Level II BASIC. The machine used was a Radio Shack TRS-80 Model I.
This article describes a practical application for computer-automated management of your home's heating and cooling needs.

Let's review some simple facts about the home that will be helpful in planning a home heating and cooling management system. Of course, you may have a few of your own to add after reading the list:

- The kitchen is usually warmer than the rest of the house during cooking periods.
- The laundry room, while being used, is usually warmer than the rest of the house.
- During normal sleep periods, we care only about the temperature of the bedrooms.
- In a two-story house, the temperature upstairs is usually significantly warmer than downstairs.
- We do not care what the temperature is (within reasonable limits) in the house when we are away.

Now let's take a look at the basic weakness of most central heating (and air conditioning) units. There is only one thermostat and it is located in one room. Therefore, only the temperature of that room is really regulated, and the thermostat must be manually adjusted. Now let's examine a system that can be used to help manage the heating and cooling of a home. The components of the system are the computer, the central heating unit, a real-time clock, a switch that indicates whether anyone is at home, and an array of computer-compatible temperature sensors.

Designing the System

The first step is to determine how many of the temperature sensors you will need. For a week or so, measure the temperature in each room of your house about six or eight times a day. At least two of these times should be during cooking and washing periods. You will probably find that the temperatures in all the bedrooms are about equal. Several other rooms will probably be similar under most conditions. The number of sensors needed for your home will vary with your conditions, but you will probably not need a sensor in every room. You will want to place a temperature sensor outside, in the kitchen, in a bedroom, and in any room that shows a temperature difference of several degrees in a day's time.

To approximate the thermal capacity of each area, determine the number of cubic feet of space served by each sensor. This is necessary to compute the average temperature of the house. From this information, we will decide whether to turn on the heating (or cooling) system or to just balance the temperature throughout the house by turning on blower fans. Of course, when we do not care about the temperature balance (such as when we are sleeping or away from home), it will not be controlled as tightly.

The flowchart of figure 1 presents a possible control routine for the hardware described here. It is written for winter with the assumption that our main concern is keeping the house warm.
The flowchart is self-explanatory, but several notes are in order. When installing an interface to your heating system, be sure to leave the existing thermostat active for safety reasons. Also, if you are not familiar with the workings of your heating unit, ask for assistance from a professional.

**Hardware Description**

Figure 2 demonstrates two versions of the remote switch that tells the computer whether or not anyone is home. The version in figure 2a uses one wire from the computer connecting through the remote switch to a natural ground (for example, a water pipe). The software that samples the STATUS bit should do so several times in order to be sure of the remote switch's position.

Because the use of the home's ground may produce a false reading (due to the "noise" of household appliances, among other things), the more complex circuit of figure 2b provides a foolproof solution; its disadvantage is that it requires three extra remote lines. The 1 k-ohm resistor close to the 5 V supply limits the current coming from the source in case of an accidental short. The IC4a and IC4b pair form an RS latch that holds the most recent value of the remote switch (which is a momentary closure switch). This circuit has the advantage of requiring only a conventional electrical ground. The AT HOME OVERRIDE switch is located close to the computer so that the user can change the value of STATUS without throwing the switch at the remote location.

Figure 3 is a schematic of the temperature sensor, which is based on a National Semiconductor LX5700 temperature transducer. The circuit converts the analog output of the transducer to a pulse frequency via a timer circuit. We can later convert this in

Text continued on page 330
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Figure 2: Schematic diagram for the home/gone remote switch. The version of this switch given in figure 2a is simpler, using fewer components and wires, but it may be vulnerable to electrical “noise” in the natural (house) ground it makes use of. The version in figure 2b is more complex, but it uses a conventional (equipment) ground and two NAND gates wired as a set-reset (RS) latch that remembers the most recent switch position.
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REMOTE SENSOR

<table>
<thead>
<tr>
<th>Number</th>
<th>Type</th>
<th>+5 V</th>
<th>GND</th>
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<tbody>
<tr>
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<td>LX5700</td>
<td></td>
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</tr>
<tr>
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<td>LM3046N</td>
<td></td>
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<td>IC3</td>
<td>7404</td>
<td>14</td>
<td>7</td>
</tr>
<tr>
<td>IC4</td>
<td>7400</td>
<td>14</td>
<td>7</td>
</tr>
</tbody>
</table>

* = ±1% METAL FILM 1/2 W

Figure 3: Schematic diagram for the remote temperature sensor. IC1 is the temperature sensor, while IC2 is a transistor array that exhibits stability over a wide temperature range. The output bit CNEN must be high to allow the pulse train CN to appear. The frequency of the pulse train at CN is proportional to the temperature being sensed.

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Circle 245 on Inquiry card.

February 1981 ©BYTE Publications inc
Figure 4: Schematic diagram for a temperature-count accumulator. This circuit allows the computer to count the pulses from any one of the eight temperature sensors. After the count is finished, the circuit returns the count as an absolute 16-bit number delivered 1 byte at a time. IC5 is an 8-bit shift register that transfers the 8 bits coming from the computer (IB0 thru IB7) to the enable lines of the eight temperature sensors (CNENA thru CNENH) when the load-sensor-select-byte input line goes high. IC6 thru IC9 are three-state binary counters that are cascaded to form a 16-bit counter.

Text continued from page 327:

resistors forms a constant-current source. A constant-current source is an efficient way of sending power to a remote circuit because the impedance of the power line to the remote circuit is not critical. Also, a zener diode is present within IC1 to regulate its voltage.

To minimize the number of wires running to the multiple remote sen-
To figure the actual temperature:

\[
\text{Temperature (in Degrees)} = \frac{(\text{Number of Counts for Unknown Temperature}) - (\text{Counts at } 32^\circ F)}{(\text{Count Change per } 1^\circ F \text{ of Temperature Change})}
\]

Table 1: Equations for obtaining corrected temperature readings from the sensors.

sors that this design requires, I used a technique that allows the use of the same wire both to supply power to the integrated circuits and to return the pulse train from IC2. The pulse train from IC2 pulls the power line low enough to be recognized as a logical low by IC3. During the short periods that the power line is low, the capacitor C3, assisted by the constant current coming from the transistor-LED pair even when the power line is low, maintains power to the sensor.

The pulse train arriving at IC3 has a frequency that is proportional to the temperature being sensed by IC1. The NAND gate of IC4 allows the CNEN line to control the flow of the pulse train to the 'CN' line.

Figure 4 shows the temperature-count accumulator that receives the CN signal from any one of eight sensors. The circuits IC6 thru IC9 are each binary counters with three-state outputs (high, low, or disconnect). They will be used to count the number of pulses in a fixed time frame from each sensor in its turn. Figure 5 shows a timing diagram for the temperature accumulator and gives an explanation of its workings.

To calibrate the sensors, a large bucket of ice and a thermometer capable of measuring temperatures from about -5°F to 120°F are needed. The sensor to be calibrated should be hooked up to the computer in the same way that it will be for remote-temperature sensing. The real-time clock should allow the sensor to count for about 0.5 seconds before the computer reads its count value from the circuit in Figure 4. The count for the sensor should be in the range of 3000 to 15,000 counts; this tells us only that the sensor is functioning.

Take each sensor and dunk it in the bucket of ice. Pour in just enough water to cover the ice, stir, and stick the thermometer in. This is called an ice-point bath. The count from each sensor is the number of pulses equivalent to a temperature of 32°F. Confirm this reading with your thermometer, which should also read 32°F. If it does not, note the difference in the two readings—this number can be used as a correction factor in the next step.

Take the sensors out of the bucket and pour out the ice water. Rinse the bucket with hot tap water. Then fill the bucket with hot tap water, put the sensors back in the bucket along with the thermometer, and stir again. Read the thermometer and record the count for each sensor at the new temperature. If the reading at 32°F was off, you will have to adjust the new temperature by the same amount.

This gives us the corresponding count for each sensor for two temperature extremes. From this we can easily determine the temperature of a given sensor by using the equations in Table 1. Knowing the temperature from each sensor, you can proceed to write a program from the flowchart and start keeping track of your home heating system.

1. Lefferts, Peter, Linear Applications 2 (National Semiconductor, Santa Clara, California).
Modifying the SwTPC Computer

Thomas J Weaver
825 N Sherry Ave
Norman OK 73069

Changing to a newer 6809 microprocessor is a simple way to upgrade a 6800-based computer. In fact, Southwest Technical Products Corporation makes a conversion kit for its 6800 system that includes a 6809 processor board (see photo 1) and complete instructions. The kit can be built in one evening, but does require some modifications to the existing system.

Because of changes that I had already made to my computer, I was able to ignore the modifications suggested for the memory boards and disk controller. However, these changes are not complex, and should not require much time.

What I found most upsetting were the modifications that had to be made to the motherboard. These changes, if made, would not allow the use of the 6800 processor board. Because I have many large 6800 programs in binary form, without source code, it became necessary for me to fix the motherboards so that it would work with either processor board.

Although several of the bus lines are redefined for 6809 use, some of the changes do not affect 6800 operation. For example, the 6809 uses the UD2 line for the active-low FIRQ signal. All told, these are only five incompatible signals.

By installing a five-pole, two-position switch, it is a simple matter to change the configuration from 6800 to 6809. Most of the wiring attachments to the motherboard can be made in a small area, and a ribbon cable allows the switch to be mounted above the reset and power controls. Other connections must be made to the reset switch and the motherboard power-supply connector. These connection points on the bottom of the MP-B motherboard are shown in photo 2. Table 1 summarizes the jumpers and traces that must be cut. See figure 1 for the various switch connections.

When the modifications are complete, either processor board may be used by connecting or disconnecting the 6809 reset cable, changing pro-

<table>
<thead>
<tr>
<th>Connection Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 9U3 on I/O bus</td>
</tr>
<tr>
<td>B SELECT 5 on I/O bus</td>
</tr>
<tr>
<td>C 6 pin 7</td>
</tr>
<tr>
<td>D 6 pin 11</td>
</tr>
<tr>
<td>E 6 pin 6 (at R12)</td>
</tr>
<tr>
<td>F 12 line on S550 bus</td>
</tr>
<tr>
<td>G 5 pin 5, 6</td>
</tr>
<tr>
<td>H 4 pin 2 (on connector line)</td>
</tr>
<tr>
<td>I 4 pins 9, 10</td>
</tr>
<tr>
<td>J 4 pin 11</td>
</tr>
<tr>
<td>K 4 pin 12</td>
</tr>
<tr>
<td>L 3 pin 6 (at R11)</td>
</tr>
<tr>
<td>M master Reset line on S550 bus</td>
</tr>
<tr>
<td>N UD2 line on S550 bus</td>
</tr>
<tr>
<td>O +5 V (at R1, R2, R3, et al)</td>
</tr>
<tr>
<td>P reset switch</td>
</tr>
<tr>
<td>Q reset switch</td>
</tr>
<tr>
<td>R power supply connector pin 9</td>
</tr>
</tbody>
</table>

**jumper:**

**cut:**

Table 1: The five-pole, two-position switch of figure 1 is connected to the points specified in this table. Note that not all modifications are made directly to the switch; some are jumpers.

<table>
<thead>
<tr>
<th>Physical Address</th>
<th>Logical Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>0xxx</td>
<td>0xxx</td>
</tr>
<tr>
<td>1xxx</td>
<td>1xxx</td>
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<tr>
<td>2xxx</td>
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</tr>
<tr>
<td>9xxx</td>
<td>9xxx</td>
</tr>
<tr>
<td>Cxxx</td>
<td>Cxxx</td>
</tr>
<tr>
<td>Dxxx</td>
<td>Dxxx</td>
</tr>
</tbody>
</table>

Table 2: Physical and logical memory addresses are mapped in a slightly different manner.
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Processor boards, and resetting the five-pole switch. Eventually, I plan to disassemble my binary programs and reassemble them on the 6809; but this system is quite flexible, so there is no rush. This allows me to evaluate and disassemble newly acquired 6800 programs without having to borrow a friend's 6800 system.

The Monitor

The 6809 processor board includes space for four 2716-compatible 2 K-byte programmable-memory integrated circuits. The address locations for the first two circuits overlap I/O port addresses, while the third has addresses identical to the 8-inch floppy disk controller board (this presents no problem for those using 5-inch floppy disks). The last of the four sets of addresses is occupied by the SBUG-E monitor read-only-memory integrated circuit.

This monitor is slightly different from SwTPC's SWTBUG monitor, for the 6800 processor, but is also similar in many ways. This monitor allows all registers to be examined and set directly, using the Control key, in combination with the register name. For example, keying Control-D allows the user to examine or change the direct-page register. In the SBUG-E monitor:

- all registers may be displayed using the R command, and the system stack may be examined using the S command.
- There are separate commands to boot 8-inch (D) and 5-inch (U) floppy-disk units.

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Photo 1: To ensure proper operation of the 6809 processor board, in a modified system, resistor R20 should be installed on the solder side of the board, as shown. It is necessary to trim the leads flush with the top of the board, since they will be covered by the NMI/RESET connector.

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A memory-dump command (E) produces hexadecimal and ASCII dumps.

The familiar byte-examine and byte-change command (M) is still implemented.

A memory-test command (Q) checks a specified block of memory.

The go (G) command has been restructured to obtain the program execution address from the program control register, rather than hexadecimal location A048.

The go command also removes software interrupts created by the set breakpoint (B) command.

All breakpoints may be removed at once using the X command.

The MIKBUG tape load (L) and punch (P) commands are still present.

Commands which are conspicuous by their absence are J (execute program starting at specified location) and F (find locations containing a specified byte). I hope these commands are included in the next version of the monitor, since I use them frequently, especially while trying to discover why new binary programs refuse to run on my system.

Memory

One of the areas that must be mastered before using the memory check (Q) command is Dynamic Address Translation. Basically, memory may have different physical and logical addresses. When powered up, the monitor checks the amount of memory available, and then maps it in 4 K-byte segments, using the following hexadecimal hierarchy: Dxxx, Cxxx, 0xxx, 1xxx, 2xxx, 3xxx, 4xxx, 5xxx, 6xxx, 7xxx, 8xxx, 9xxx, Axxx, Bxxx. Up to 56 K bytes of programmable memory may be mapped in this manner. An example of the physical and logical addresses of 48 K bytes is shown in Table 2. Since the modifications mentioned do not permit user memory at physical addresses 8000 thru 8FFF for 6800 operation, the memory limit for systems with this modification is 52 K bytes.

The address table for the software interrupts (SWI, SWI2, and SWI3) and the interrupt requests (IRQ and FIRQ) is near the top of the user memory beginning at hexadecimal address DFC0. This table also includes the lower and upper limits for a supervisor-call address table, used in connection with the SWI3 instruction. When an SWI3 instruction is encountered, the following byte is examined. Assume this next byte contains the value \( n \). If the user has provided a supervisor-call address table containing at least \( n+1 \) addresses, the supervisor routine indicated by the \( (n+1) \)th address will be executed. If the supervisor-call address table is not present or does not contain enough entries, the regular SWI3 address will be used.

Extras

Several parts of the MP-09 processor board have obviously been designed for expansion. Simple, onboard connectors reconfigure the data rate lines for speeds from 110 to 38,400 bps (bit per seconds), or use the 110 bps line as a Bus Request line. These and other features suggest that SwTPC has specific enhancements in mind.

The FLEX2 (6800) and FLEX9 (6809) 5-inch floppy-disk operating systems from TSC (Technical Systems Consultants) further enhance the use of this modification. Text files, BASIC programs, and source code may be easily transferred from one system to the other since both use the same disk format. Now disks as well as hardware can be used interchangeably with a dual 6800/6809 system.
MTC brings you the ULTIMATE diskette storage system, at an affordable price. Storing 50 to 60 diskettes, this durable, smoke-colored acrylic unit provides easy access through the use of index dividers and adjustable tabs. Unique lid design provides dust-free protection and doubles as a carrying handle.

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What's New?

SOFTWARE

Stock Portfolio Package

APEX—Apple II Floppy-Disk Operating System

The APEX disk operating system features a command structure that is similar to CP/M’s. Twenty command words are contained within the system, and APEX has the ability to treat external programs as transient commands to the operating system. There is a scrolling editor that is compatible with the Videx 80 character card. APEX can handle both 5- and 8-inch floppy and hard disks on the same system, and it is fully functional on single-drive and multidevice systems. Backup files, a backup directory, read-after-write, and size limit checks are included. File allocation techniques make APEX’s file handling four times faster than CP/M’s. Automatic default structures set up command strings, file names, and extensions. A special device handler structure allows for interfacing nonstandard peripherals. The basic APEX package includes a two-pass resident assembler and a macro-editor. The assembler generates an alphabetized symbol table, a cross-reference table, and it is capable of assembling over 1900 lines per minute. The editor has 18 commands and 10 text buffers. APEX costs $99 from Apparat Inc., 4401 S Tamarac Pky, Denver CO 80237, (303) 741-1778.

TRS-80 Program Generator

The program Generate writes a three-program system (a selector, input/edit module, and print program) that will maintain a key file. The input/edit module allows the operator to add, delete, or change records and their keys in the file. The print program selects the fields to be printed, and it selects the range to appear on the listing. The program comes on a 5-inch floppy disk with instructions that include suggested applications. Generate requires a TRS-80 Model I Level II system with at least two disk drives and 32 K bytes of memory. A printer is optional, because the program can be user-adapted for a display screen. The program costs $100 from Paul Swanson, c/o DataWorks Inc, 97 Jackson St, Cambridge MA 02140, (617) 492-4305.

OSI Software

HEXDOS 2.3 is a disk operating system designed for use with OSI (Ohio Scientific) BASIC in ROM (read-only memory). It runs in 2 K bytes of memory. HEXDOS supports a real-time clock, named floppy-disk files, trace and single-stepping of programs, a tone generator, multiple data files, editing capabilities, chaining of programs, and an interactive disassembler. The price for a 5-inch floppy disk and manual is $27.50.

FOCAL-65 is DEC’s (Digital Equipment Corporation) powerful, high-level language adapted for the 6502. It constructs programs that are more compact than similar BASIC programs. All in 8 K bytes, FOCAL-65 features 9-digit floating-point arithmetic and string handling functions. This language is available on a 5-inch floppy disk or cassette with a manual for $49.50. Information on either software package can be obtained by writing The 6502 Program Exchange, 2920 W Moana, Reno NV 89509.

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.
Statistics Program

Microstat is a statistics package for CP/M systems using BASIC-80. The program is chiefly oriented towards files. It includes a data-management subsystem that allows users to list, edit, delete, augment, sort, rank order, lag, move, merge, and transform data into new data. Programs are provided for statistical analysis in descriptive statistics, hypothesis testing, analysis of variance, scatterplots, correlation analysis, simple and multiple regression, time series, and more. Microstat requires 48 K bytes of memory, a single-density 8-inch floppy-disk drive, and CP/M with BASIC-80. The program is available for the North Star disk operating system and BASIC. Two disk drives are recommended. The cost is $250. A manual is $15. For further information, contact Ecosoft, POB 68602, Indianapolis IN 46268. (317) 283-8883.

CP/M-86

Digital Research's CP/M-86 operating system is for any microcomputer that is based upon the Intel 8086/8088 microprocessors. CP/M-86 is a single-user operating system designed to take advantage of the 8086's address space and speed, while expanding upon the facilities of CP/M. For compatibility, the file format of CP/M 2 has been retained. CP/M-86 can function as a slave node in a CP/NET network. Logical and hardware-dependent portions of the operating system are modularized. For more information, write to Harold Elgie, c/o Digital Research, POB 579, 801 Lighthouse Ave. Pacific Grove CA 93950. (408) 649-3896.

muLISP/muSTAR-80

The muLISP-80 pseudocode LISP interpreter can provide the basis for AI (artificial intelligence) projects. muSTAR-80 provides a resident display-oriented editor and debugging facility. A pseudocode compiler in muLISP-80 produces extremely compact code. Dynamic allocation of data-space boundaries maximizes the use of programmable memory storage. Linkage to machine-language subroutines is easily performed. These two programs work on 8080-, 8085-, and Z80-based systems. The system includes a library file that contains utility functions which provide examples of muLISP function definitions. Supplied with the system are several games, including a muLISP implementation of the Eliza (Doctor) program. Microsoft and Lifeboat Associates are offering muLISP/muSTAR-80 for a variety of microcomputers including those using the TRSDOS and CP/M operating systems, or equivalent systems. For details, contact Microsoft, 10800 NE 8th, Suite 819, Bellevue WA 98004, or Lifeboat Associates, 1651 Third Ave, New York NY 10028.

Circle 404 on inquiry card

CP/M-Modem

Information Engineering has released CP/M-Modem. This package can send files between a CP/M computer and another computer, make a CP/M system function as a terminal to a remote computer, and allow users to operate, control, and perform diagnostics on remote CP/M systems. A high-level protocol supports error checking and automatic retries during file transfers. File transfer is block-oriented. CP/M modem has three operating modes: terminal, telememo, and datalink, plus a transitional state command mode. The program has a split-screen display, with status indicators for data rates, mode, parity, stop bits, word length, data type, and file name. The software supports data rates to 19.2 kbps and has full- and half-duplex modes. The CP/M Modem software package is distributed as object code on 5- and 8-inch floppy disks in CP/M format. A single microprocessor license is $300. The manual is $15. Mainframe support for Digital Equipment Corporation's DECSYSTEM-10 is $1500. For further information, contact Information Engineering, 8 Bay Rd, POB 305, Newmarket NH 03857. (603) 659-5891.

Circle 404 on inquiry card

CP/M/2.2 for OSI C3 Systems

Known as CP/M2, this version of CP/M 2.2 is compatible with the original OSI (Ohio Scientific) C3 computer's CP/M format. All software and data on current OSI CP/M disks can be retained. With CP/M2, disk read operations are four to five times faster, and disk write operations can be as much as fifty times faster. The C3 CP/M2 compensates for 2 or 4 MHz microprocessor operation. The system also includes a CP/M disk-to-disk copy routine, a memory test program for the Z80, and I/O [input/output] drivers for most OSI peripherals. CP/M2 is available for $200 from Lifeboat Associates, 1651 Third Ave, New York NY 10028. (212) 860-0300.

Circle 408 on inquiry card

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What's New?

SOFTWARE

VisiCalc Plus for the HP-85 Microcomputer

VisiCalc Plus is an enhancement of the calculating and bookkeeping VisiCalc program for the Hewlett-Packard HP-85 microcomputer. The program is useful for forecasting, budgeting, and other business and technical applications. The enhancements include a graphics program that lets users turn VisiCalc tables into four-color graphics. Line charts, bar charts, pie charts, and curve-fitting graphs are available along with graphics features, such as six styles of lines and hatchings. Twenty extra financial, statistical, and mathematics functions include internal rate of return, standard deviation, and length data file. Also included are Pascal demonstrations with listings on BASIC reports on customer orders can be run the program. For information, contact Circle 410 on inquiry card.

Pascal Express Utility Package

This package of utilities and other software for the Apple II is designed to help experienced BASIC users become acquainted with Pascal. Four sections simplify I/O (input/output) formatting; allow access and change in the disk directory from a Pascal program; perform integer, string, and real number conversions; and support files of variable-length records. Also included are Pascal demonstrations with listings on BASIC equivalents, a routine to view disk files in ASCII or hexadecimal code, a text formatter, a program to maintain a variable-length data file, and a Happy Birthday surprise. A manual, a disk, and the source-code files cost $145 from Software Express, POB 50453, Palo Alto CA 94303, [415] 856-9244.

Circle 412 on inquiry card

Multi-User, Multitasking Disk Operating System

The Cromix operating system supports Cromemco's floppy- and hard-disk drives. It includes multiple hierarchical directories and subdirectories; compatible I/O (input/output), which supports user redirection of I/O; a shell-sort program; a password security system; data and time support; file buffers; and swapping-free execution of tasks through bank selection. The Cromix operating system includes a CDOS Simulator that allows CDOS programs to be executed directly. Cromix requires a minimum memory of 128 K bytes. A single 64 K-byte memory card must be added for each additional user or task. Cromix is available on 5- or 8-inch floppy disks for $295. Inquiries can be addressed to Cromemco Inc., 280 Bernardo Ave., Mountain View CA 94043, [415] 964-7400.

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The Store Manager

High Technology Inc., 8001 N Classen Blvd., POB 14665, Oklahoma City OK 73113, [405] 840-9900, is distributing The Store Manager. This program is a point-of-sale and inventory-control system. It produces purchase orders, receiving reports, invoices, packing slips, and quotations. Sales totals and inventory-management reports are also handled. The program is useful for managing small businesses. The Store Manager runs on a 48 K-byte Apple II with at least two floppy-disk drives. The suggested retail price is $250.

Circle 411 on inquiry card

The Prisoner

The Prisoner was inspired by the television series of the 1960s. Consisting of twenty interlinked games, the program places the player on an island housing a psychological prison camp. The player's task is to escape both the island and its attempts to extract information from him. The Prisoner requires an Apple computer with 48 K bytes and a single disk drive. The program lists for $29.95. Contact Edu-Ware Services Inc., 22035 Burbank Blvd., #223, Woodland Hills CA 91367, [213] 346-6783.

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Track Orders Daily

CORP is a customer-order review program for a salesperson in any small-to-medium-sized business. Designed with the TRS-80 Models I and II in mind, CORP tracks the daily orders of individual salespersons. CORP allows management personnel to monitor a salesperson's performance and to know which customers have not placed an order since any particular date. Different criteria for selecting reports on customer orders can be specified. CORP contains updating facilities and diagnostics. It is available on a 5-inch floppy disk, including documentation, for $195 from B & B Software, POB 2090, Ann Arbor MI 48106.

Circle 415 on inquiry card

Apple II Word Processor

Computer Solutions, 6 Maize Pl., Mansfield, Queensland 4122, Australia, has announced its word-processor software for the Apple II. The software allows users to create simple control of devices, and implement tasks requiring monitoring and decision. Certain hardware modifications can be eliminated by using TFORTH to do digital logic or data reduction. TFORTH is designed for the TRS-80 with 16 K bytes of programmable memory and a single floppy-disk drive using either TRS-DOS or NEWDOS. It costs $129.95 or $136.95, depending on additions. Contact Sirius Systems, 7528 Oak Ridge Hwv, Knoxville TN 37921, (615) 693-6583.

Circle 416 on inquiry card

TFORTH

TFORTH is a procedural language that specifies process rather than desired result. It produces a compact code that can be executed at high speeds. TFORTH uses a stack for parameters and a dictionary for words that allows new words to be created in terms of predefined words. New data types and new processes can become part of the language. TFORTH can be used to develop new languages, provide simple control of devices, and implement tasks requiring monitoring and decision. Certain hardware modifications can be eliminated by using TFORTH to do digital logic or data reduction. TFORTH is a procedural language that specifies process rather than desired result. It produces a compact code that can be executed at high speeds. TFORTH uses a stack for parameters and a dictionary for words that allows new words to be created in terms of predefined words. New data types and new processes can become part of the language. TFORTH can be used to develop new languages, provide simple control of devices, and implement tasks requiring monitoring and decision. Certain hardware modifications can be eliminated by using TFORTH to do digital logic or data reduction. TFORTH is designed for the TRS-80 with 16 K bytes of programmable memory and a single floppy-disk drive using either TRS-DOS or NEWDOS. It costs $129.95 or $136.95, depending on additions. Contact Sirius Systems, 7528 Oak Ridge Hwv, Knoxville TN 37921, (615) 693-6583.

Circle 417 on inquiry card
What's New?

PUBLICATIONS and MISCELLANEOUS

Sinclair ZX80 Users Magazine
Sync is a bimonthly magazine for users of the Sinclair ZX80 microcomputer. The publication carries articles about how best to use the features of the ZX80. Sync also carries financial analysis, statistics, simulations, and games. Sync has published program listings for Acey Ducey, Hunkie, and the Nicomachus "boomerang" puzzle. Reviews of software, peripherals, and books related to the ZX80 are also provided. Subscriptions are $10 per year from Sync, 39 E Hanover Ave, Morris Plains NJ 07950, (201) 540-0445.

Design Aids for Electronics
This catalog has been designed for engineers and draftsmen in the electronics industry. It features templates containing the latest in logic and schematic symbols and component layout patterns. All symbols or patterns comply with ANSI, IEEE, IPC, and MIL-STD specifications. The catalog is available from Tangent Template Inc, POB 20704, San Diego CA 92120, (714) 292-0046.

Educational Catalog
The Micro Software Division of Charles Mann & Associates has compiled the Education Catalog. This catalog details educational programs for the Apple II, TRS-80, and TI 99/4A microcomputers. The programs can be used to develop customized teaching programs, to teach BASIC programming, and to reduce administrative tasks. Grade reporting, class scheduling, and record-keeping programs are also described. These and other programs have been designed by Charles Mann & Associates, which is located at 7594 San Remo Tr, Yucca Valley CA 92284, (714) 365-9718.

Educational Catalog
Marek publishes a free mail-order educational software catalog that has descriptions of hundreds of programs for small computers. Related products and articles are also included. Contact Marek, 280 Linden Ave, Branford CT 06405, (203) 481-3271.

Continuous Forms
Discount Data Forms Inc, 407 Eisenhower Ln S, Lombard IL 60148, (312) 629-6850, is marketing a line of continuous computer forms. The product line includes stock invoices, statements, bills of lading, purchase orders, and voucher, payroll, and personal checks. A brochure and samples are available from the company free of charge.

Speech Synthesis Evaluation Board
An assembled circuit board for evaluating the operation and application of the Digitalker speech synthesis integrated-circuit-set is available from National Semiconductor Corporation, 2900 Semiconductor Dr, Santa Clara CA 95051, (408) 737-5000. The DT1000 board requires a single 9 V power supply and a speaker for operation. It contains National Semiconductor's speech processor circuit, two speech ROMs (read-only memories), output filter, audio amplifier, keyboard, microphone, and an EPROM (erasable programmable read-only memory). The speech ROMs enable users to link words consisting of numbers and letters, nouns, verbs, and silence durations into phrases and sentences. National Semiconductor's Digitalker speech-synthesis systems utilize human speech and voice waveforms for digital encoding and storage.

PGI Wholesale Publishes Price Card
PGI Wholesale has published a quick-reference price list. The guide contains pricing information on microcomputer products from more than thirty-five manufacturers, including the Archives Business Computer. Contact PGI Wholesale, 1425 W 12th Pl, Tempe AZ 85281, (800) 528-1415 or (800) 528-6450.

Word Processing Report
The Small Systems Group has begun publication of a series of product evaluation reports. The first report "Word Processing on Personal Computers," is now available. This report introduces word processing with sections on software, hardware, and applications. It describes Auto Scribe, Electric Pencil, Magic Wand, and Wordstar word-processing programs. Single copies of the report are available for $10 from the Small Systems Group, POB 5429, Santa Monica CA 90405, (213) 392-1234.
MPI's Model 88G Printer

The Model 88G impact matrix printer features 100 cps (characters per second) bidirectional or unidirectional printing, with throughput rates of up to 150 lines per minute. A full uppercase and lowercase 96-character ASCII (American Standard Code for Information Interchange) set is printed in a 7 by 7 matrix, with print line formats of 80, 96, or 132 columns per line over an 8-inch print area. Double-width characters are software-selectable in any of the font styles or character densities. A high-resolution, dot-addressable graphics option can be added for plotting, printing of screen graphics, drawing of illustrations, or producing special characters and identification marks. Forms handling is carried out with a paper-feed system that can accept fanfold forms from 1 to 9½ inches in width. Sixteen selectable form lengths and a "skip-over-perf" feature are provided. The printer uses continuous-loop ribbon cartridges, and it has an RS-232C, and a parallel interface. It can also be interfaced to devices with an IEEE-488 bus output. A detachable roll paper holder, single-sheet feeder, and a 2-Kbyte buffer are available. The Model 88G with the graphics option lists for $799. Contact MPI, 2099 W 2200 South, Salt Lake City UT 84119, (801) 973-6053.

Circle 432 on inquiry card

Turn the TRS-80 into a Time-Sharing Terminal

TERMCOM is a hardware and software package that turns the TRS-80 into a time-sharing terminal. TERMCOM hardware allows Level II users to utilize time-sharing systems without acquiring the Expansion Interface and RS-232 board. The software includes full paging capabilities, making it possible to store several screens of data, which are accessible at any time. The TERMCOM program allows lines to be scrolled off the screen while still remaining accessible in memory. The wrap-on-blank capability breaks long lines into two lines between words. For tabular materials, automatic left- or right-justification may be specified. The TERMCOM package can lock information on the top or bottom of the screen, while keeping the other portion free for normal use. Other features include memory buffer-overflow protection, uploading and downloading of files from disk, and variable rates for file loading to match other systems used in time-sharing. It is compatible with all Radio Shack supplied products. The package costs $169.95 from Statcom Corporation, 5758 Balcones Dr, Suite 202, Austin TX 78731, (512) 451-0221.

Circle 435 on inquiry card
SYSTEMS

System Zero from Cromemco
Cromemco's System Zero computer, an S-100 bus microcomputer, includes a Z80A-based single-card computer, 1 K bytes of programmable memory, 3 K bytes of Control BASIC in ROM (read-only memory), and three extra slots on the S-100 bus. The system is designed for ROM programs, but it can be expanded by adding memory and I/O cards. The System Zero/D is available with floppy-disk drives, the Z80A board, 64 K bytes of programmable memory, and a disk-controller card. The controller contains RDIS-2, a disk operating system that reads and writes single- and double-sided and single- and double-density floppy disks, and also contains a systems diagnostic routine. Software for the System Zero includes RPG II, FORTRAN, COBOL, 16 and 32 K Structured BASIC, LISP, word-processing, database management, business software, and operating systems. The System Zero list price is $995, and the Zero/D has a list price of $2995. The Model DDF dual-disk drive is available for $1295. Contact Cromemco Inc., 280 Bernardo Ave., Mountain View CA 94043, (415) 964-7400.

Microcomputers with High-Resolution Graphics Options
The Dynamic Blackboard microcomputer systems use the S-100 bus and a Z80A microprocessor. The systems support either black-and-white, gray shades, or full-color graphics at a resolution of 640 by 512 pixels. CPM-compatible graphics software and Tektronix-emulation software are also available. Graphics printers are supported. Three Dynamic Blackboard systems are available: the Brilliant Terminal, the Standalone System, and the Network Configuration. The Brilliant Terminal is for larger mainframes, and it can be used as a stand-alone computer and color graphics terminal. The Standalone System has a graphics option, and the Network Configuration allows several microcomputers to share a disk subsystem and a printer. Prices for the single computers are in the $10,000 to $15,000 range. For more information, contact the Cambridge Development Laboratory, 36 Pleasant St. Watertown MA 02172, (617) 926-0869.

SSM’s Z80 Microprocessor Board
SSM Microcomputer Products, 2190 Paragon Dr., San Jose CA 95131, (408) 946-7400, has announced the CB2 Z80 microprocessor board. The CB2 is capable of operating at 2 or 4 MHz, and it includes sockets for two 2716 or 2732 EPROMs (erasable programmable read-only memories) or HM61162 K-byte programmable memories. The memory sockets can be enabled or disabled. Run/stop and single-step switches are also included on the board to permit system evaluation without the need for a front panel.

The CB2 also features a firmware-vector jump and an output port to control eight extended address lines. Memory can be expanded to more than 64 K bytes. Board jumpers can generate the proposed IEEE (Institute of Electrical and Electronics Engineers) S-100 signals. The board can emulate 8080 I/O (input/output) addressing, and it is provided with an 8-bit output port for extended addressing. The CB2 requires +8 V at 0.75 A.

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P.O. Box 721
Radio City Station
New York, New York 10101

Circle 429 on inquiry card

Circle 430 on inquiry card

Circle 431 on inquiry card
Ampex Corporation, 200 N Nash St, El Segundo CA 90245, (213) 640-0150, has entered the video-terminal market with the Ampex Dialogue 80, a buffered editing terminal that operates in conversational or block modes. The terminal features a detached keyboard, lowercase descenders, and a 25th display line that allows operators to determine the status of various operational modes and note errors. Dialogue 80 has an RS-232C asynchronous interface that operates at half- or full-duplex and a standard serial printer interface. Scrolling is a standard feature in the conversational mode. The display features 24 lines by 80 characters. The format is a 6 by 8 dot matrix in a 7 by 10 field. The terminal has reverse video, blink, blank, underline, and half-intensity features. Protected fields appear at half-intensity and cannot be changed when in the protect mode. Editing features include erase, insert, and delete character and line functions. The 128 symbols include 96 ASCII (American Standard Code for Information Interchange) characters, 21 control characters, and 11 characters to support line drawings. Constants, screen formats, or command sequences for the terminal and host computer are user-programmable. A 2 K-byte expansion memory is optional. The Dialogue 80 is $11,499 in single units.

Circle 436 on inquiry card

The Performer Systems are an entire line of business microcomputers offering word processing, billing, general accounting, data communications, and record-keeping functions. One model, the Standard Performer, uses 5-inch floppy-disk drives that store 400 K bytes of memory (about 200 typewritten pages). Another model, the Maxi Performer, uses 8-inch drives that can hold 1.25 megabytes (about 600 typewritten pages). As a word processor, either Performer can handle documents such as contracts, engineering reports, and ordinary business correspondence. Functions include true proportional spacing, underlining, boldface, justification, centering, indentation, and more. Typical applications include inventory, purchase or sales orders, court or appointment calendars, and customer or prospective customer lists. Additionally, mailing labels and envelopes can be prepared. Facilities include complex sort sequences and selection criteria, full-formula arithmetic, and multilevel subtotals and page breaks. Accounting capabilities include accounts receivable, accounts payable, general ledger, and financial statement preparation. A client-billing package for attorneys, accountants, consultants, and other professionals is available. The Performer also supports the WESTLAW automated legal-research system and the New York Times INFObANK services. The systems are priced between $12,000 and $18,000, or they may be leased for $400 to $600 per month. Contact Info 2000 Corporation, 20620 S Leapwood Ave, Carson CA 90746, (213) 532-1702.

Circle 438 on inquiry card

The Model 9400 bar-code reader is designed for in-house data collection. A bar-code alphanumeric keypad is provided for manual data entry. Bar-code labels up to 32 characters long may be scanned. The memory has a 20 K-byte capacity. The user may select between a belt clip and a shoulder strap to carry the unit. The 9400 may be operated on-line in the terminal mode without affecting data in its memory, and a real-time clock feature is available to store time and date information. Previously stored data can be reviewed and edited. The Model 9401 Charger/Interface unit provides two RS-232C connectors. Contact Wade T Nixdorf at Interface Mechanisms Inc, POB N, Lynnwood WA 98036, (206) 743-7036.

Circle 437 on inquiry card
PERIPHERALS

On-Board Screen Memory with the V-100 Video Controller

The V-100 video-controller board, with 2 K bytes of on-board screen memory, can reduce central-processor overhead. It is fully compatible with the IEEE's (Institute of Electrical and Electronics Engineers) S-100 bus standard. The V-100 can be I/O (input/output) mapped, so that the screen memory does not take up space in the user's system. Interfacing to the video monitor is handled by writing control information to the V-100's logic. The board can display 24 lines by 80 characters in 7 by 9 dot-matrix formats. Fonts are available for standard ASCII (American Standard Code for Information Interchange), or French, German, or Japanese characters. It also provides 16 user-programmable graphic characters. The board can accept data at 2 megabytes per second, allowing data to be transferred to the screen at the processor speed. A compatible software package, VEDIT, allows screen editing with full cursor control, block moves, file handling, and more. It requires a CP/M-compatible operating system. The V-100 is priced at $450 per board, and VEDIT is $110. Contact Piiceon Inc. OEM Division, 2350 Bering Dr., San Jose CA 95112.

Apple Plug-Compatible Floppy-Disk Drive

The A-70 and A-40 floppy-disk drives have a jumper-selectable boot PROM (programmable read-only memory) for 13- or 16-sector Integer BASIC- or Pascal-language cards as standard features. The A-40 drive provides 40 tracks of storage and track-to-track speeds of 5 ms for $495 for the first unit and $395 for additional units. The A-70 has the same features as the A-40, however, it provides 70 tracks of storage and is priced at $575 for the first unit and $575 for additional units. For more information, contact Micro-Sci, 1405 E. Chapman, Suite E, Orange CA 92666, (714) 997-9260.

Power Supply on a Card

An 8 W power supply has been introduced by Miller Technology, 16930 Sheldon Rd., Los Gatos CA 95030, (408) 395-2999. The PS-80 supplies +5 V at 800 mA, +12 V at 150 mA, and -5 and -12 V at 150 mA. The power supply card is 11.5 by 16.5 cm (4.5 by 6.5 inches), including the 22-pin edge connector. A standard fuse is supplied. A 115 V AC and a power-line switch can be connected with the supplied connectors. The PS-80 is available in kit form for $35 or assembled and tested for $60.

TRS-80 Printer and Memory Expansion Module

This printer/memory expansion module can add 16 K or 32 K bytes of dynamic programmable memory to a TRS-80 microcomputer. It can also drive Microtek's MT-80P dot-matrix printer or any Centronics-compatible printer. The module is housed in an aluminum case that sits under the video display. It is available in three configurations: the MT-32A, without memory for $99.50; the MT-32B, with 16 K bytes of programmable memory for $159.50; or the MT-32C with 32 K bytes of memory for $199.50. For further information, contact Microtek Inc., 9514 Chesapeake Dr., San Diego CA 92123, (800) 841-1081, in California (714) 278-0630.

High-Resolution H-8 Color Graphics

The Heathkit H-8 is now able to generate high-resolution color graphics with the addition of this color graphics board. The board is fully compatible with the H-8. It contains 8 K bytes of static programmable memory, which is address dip-switch selectable. On-board RF (radio frequency) modulation is included for output to color or black-and-white television. The board can generate eight graphic display modes, eight colors, and features a resolution of 256 by 192 pixels. It is available in kit form for $379, or assembled and tested for $479. Request complete details from Owen Phairis Computer Products, POB 3400, Big Bear Lake CA 92315, (714) 585-8354.

PS-8 Power Supply

Cromemco's PS-8 power supply is designed to power microcomputer systems configured with the Cromemco CC-8 eight-slot card cage and any combination of S-100 boards. The PS-8 provides one output of +7.5V/12A, +14.5V/2.5A, and -14.5V/10A. A system reset switch is built into the power supply. The supply is designed for 110 or 220 V operation. Ambient temperature operation is from 0 to 55° C. The power supply is available from Cromemco Inc., 280 Bernardo Ave., Mountain View CA 94043, (415) 964-7400.
Bar-Code Reader for the Apple

The ABT BarWand plugs into the Apple II or III and reads standard bar code. ABT has also developed a program to read UPC (Universal Product Code). Additional programs have also been created to print and read ABT's own LabelCode and Applesoft programs in Paperbyte Code. The latter two programs are forms of bar code that can be printed with a dot-matrix printer. When bar code is entered through the BarWand, a scan tone sounds indicating that the last line of data was correctly read. The suggested retail price of $195 includes the BarWand and a demonstration floppy disk of the UPC, LabelCode, and Paperbyte programs. A ROM (read-only memory) multiprotocol BarWand I/O (input/output) board is also available. For more information, contact Advanced Business Technology Inc., 12333 Saratoga-Sunnyvale Rd., Saratoga CA 95070, (408) 446-2013.

96 Tracks Per Inch 5-Inch Floppy-Disk Drives

The SA410 (single-sided) and the SA460 (double-sided) drives feature unformatted capacities of 500 K bytes and 1 megabyte, respectively, using double-density recording. For faster access time, the drives incorporate a helical cam v-groove lead screw for head positioning. The drives also use a DC spindle motor that allows the drive to be shut down when not in use. The drives can back up 5- to 10-megabyte hard disks, including Shugart's SA400 and 450 drives. Other features of the drives include a track-to-track access time of 6 ms, a tachometer that provides servo speed control, and an activity indicator. A maximum recording density of 5876 bits per inch is another feature. Mean time between failures is 8000 power-on hours. The SA410 costs $325 in OEM (original equipment manufacturer) quantities of 100; the SA460 is priced at $400 in the same quantities. For further details, contact Shugart Associates, 475 Oakmead Pky, Sunnyvale CA 94086, (408) 733-0100.

SSI Band Printer Has 900 Lines Per Minute

SSI's B-900 printer features several bands and a 48-, 64-, and 96-character set, plus specialized and foreign character sets. The print speed is 1100 lpm (lines per minute) at 48 characters, 900 lpm at 64 characters, and 600 lpm at 96 characters. Vertical spacing for multiple-form lengths, provisions for up to five copies, a diagnostic display, paper-out detect sensors, and print-to-bottom of the form capabilities are included. The B-900 is compatible with Digital Equipment Corporation's DECsystems 10 and 20, Hewlett-Packard, Data General, SEL, Texas Instruments, Burroughs, and other minicomputers and mainframes. Parallel interfacing is standard, and SSI also supplies serial synchronous and asynchronous interfaces. Contact Southern Systems Inc., 284 Cypress Creek Rd, Ft Lauderdale FL 33309, (800) 327-5602, in Florida (305) 979-1000.

Apple II Nine-Voice Music Synthesizer

You can turn your microcomputer into a nine-voice music synthesizer with the AM-II package from Peripherals Plus. The AM-II package consists of the software and a board that plugs into the Apple II. The $198 AM-II allows users to compose music with two game paddles. The music is displayed as notes on a music staff. From a menu at the bottom of the screen, users can select notes from a six-octave range, along with duration and other characteristics. The music is displayed with graphic animation during playback. Using the keyboard, the user has control of key, tempo, envelope values and duration, waveform, and length. The AM-II is available from Peripherals Plus, 119 Maple Ave., Morristown NJ 07960, (800) 631-8112, in New Jersey (201) 267-4558.

Link Winchester ST-506 Disk Drives to GPIB Computers

The MSC-9305 controller provides onboard interfacing to Seagate Technology's ST-506 disk drives, and incorporates the GPIB interface standard for attachment with computers using the GPIB standard bus. This will allow ST-506 drives to work with the PET, Xerox 1350, and the Hewlett-Packard HP-85 system. It can also be used with computers accommodating GPIB adapters, such as the Apple II, DEC (Digital Equipment Corporation) systems, Prolog, and with computers using Intel's Multibus. The controller employs an integrated data separator, automatic error correction, full-sector data buffer, and automatic position verification. The price of the MSC-9305 is $700 from Microcomputer Systems Corporation, 432 Lakeside Dr., Sunnyvale CA 94086, (408) 733-4200.

Circle 445 on inquiry card

Circle 446 on inquiry card

Circle 447 on inquiry card

Circle 448 on inquiry card

Circle 449 on inquiry card
Touch-Input Video Display

The VuePoint touch-input terminal is 7 cm (2 3/4 inches) thick and has a 12-line by 40-character flat-panel display. VuePoint's controller provides for up to fifty-one pages of information. A response is sent to the host computer by finger contact to any one of 240 discrete touch-sensitive locations of the display screen. Communication is selectable from 300 to 19,200 bps (bits per second) data rates via an RS-232 interface. The controller for the display can be placed up to ten feet from the screen. Prices begin at $3500. For more information, contact General Digital Corporation, 700 Burnside Ave, East Hartford CT 06108, (203) 289-7398.

The VuePoint touch-input terminal is 7 cm (2 3/4 inches) thick and has a 12-line by 40-character flat-panel display. VuePoint's controller provides for up to fifty-one pages of information. A response is sent to the host computer by finger contact to any one of 240 discrete touch-sensitive locations of the display screen. Communication is selectable from 300 to 19,200 bps (bits per second) data rates via an RS-232 interface. The controller for the display can be placed up to ten feet from the screen. Prices begin at $3500. For more information, contact General Digital Corporation, 700 Burnside Ave, East Hartford CT 06108, (203) 289-7398.

Atari Memory Expansion Kit Has Supporting Software

This memory expansion kit will upgrade Atari 8-K-byte programmable memory boards to 16 K bytes. The kit provides five times more program space in high-resolution graphics and allows access to higher resolution graphics. The $79.95 price includes all hardware and instructions. Software support includes graphics programs like Plot & Draw, which generates graphics quickly while saving data for incorporation into BASIC programs. For more information, contact Mosaic Electronics, POB 748, Oregon City OR 97045, (503) 655-9574.

The Model 460 Paper Tiger Printer

The Model 460 printer has throughput speeds of up to 160 cps (characters per second), can produce letter-quality print, and provides a variety of programmable print-control functions. The 460 employs a horizontal and vertical overlay dot-matrix character formation technique and a 9-wire bidirectional print head. Control functions include proportional spacing, bold text printing, and print densities of 10, 12, or 16.7 characters per inch. Automatic text justification, programmable horizontal and vertical tabbing, reverse paper feed, and positioning of characters to the right side of the page are other control features of the printer. It can print in 80-, 96-, and 132-column formats. Foreign or custom character sets can optionally be added to or replace the standard ASCII (American Standard Code for Information Interchange) character set; the printer allows uppercase and lowercase characters with descenders. Forms control features include programmable top and bottom of form, perforation skip, and vertical and horizontal tabs. A microprocessor provides an automatic memory, electronics, and print capability test. A 2-K-byte buffer and the ability to print graphics such as bar codes, block letters, and illustrations are included. The 460 has an RS-232C serial and a Centronics-compatible parallel interface. Data rates from 110 to 9600 bps are switch-selectable. The price for the Model 460 Paper Tiger printer is $1295 from Integral Data Systems Inc, Milford NH 03055, (603) 673-9100.

Three HP-85 Interfaces

The three HP-85 interfaces are a serial (RS-232C compatible) interface card, a general-purpose parallel I/O (input/output), and a BCD (binary-coded decimal) card. The serial interface card provides the HP-85 with bit-serial asynchronous data communication capability, with support for RS-232C and current loop operations. Features include: user-programmable data rates, parity, bits per character, and stop bits without changing physical switch settings. Other features include full-duplex with I/O buffers, and a 20 mA current loop. This card allows printers, modems, and other peripherals to be used with the HP-85.

The general-purpose interface card provides bit-parallel byte-by-byte and word-oriented interfacing. Two bidirectional ports and two output-only ports are on the card. The card can be configured as four separate 8-bit ports, two 16-bit ports, or two 8-bit and one 16-bit ports. Paper-tape readers, punchers, and card readers can be interfaced with this card.

The BCD card permits all data to be present simultaneously on a set of 48 wires. Instruments can output up to eleven BCD digits; two BCD instruments can be accommodated with the card. Typical applications for this card are in voltimeters, counters, medical equipment, and electronic scales. The serial-interface card is $395 and the other cards are $495. Contact the HP-85 Factories, Hewlett-Packard Company, 1507 Page Mill Rd, Palo Alto CA 94304, (415) 857-1501.

The Gimix 2-port serial I/O board has two independent RS-232C-compatible I/O ports, with handshaking, on a 30-pin board. It features programmable pinouts and independent data rate and interrupt jumpers for each port. The board is compatible with the SS-50 and SS-50C bus configurations. The 2-port board, less cables, is priced at $128.43.

Also available is an 8-port serial I/O board that boasts eight independent RS-232C-compatible I/O ports with handshaking—all on a 50-pin board. It features DIP-switch selectable data rates for each port, extended address decoding for the SS-50C bus, and selectable interrupts. An on-board data-rate generator permits rates of up to 38.4 k bps. This board costs $318.46, less cables. Complete details are available from Gimix Inc, 1337 W 37th Pl, Chicago IL 60609, (312) 927-5510.

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6800/6809 I/O Boards by Gimix

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Power Supplies

WP-29 Monitor Isotap
- Supply line: 105 to 130V, 48 to 500Hz. Isolated output: 0 to 130V 48 to 500Hz. Leakage: Less than 0.1mA. Power rating (resistive load): 400VA. Meter: Taut band 3½" ±2% . Size: 3½" x 8½" x 8½". Weight: 14½ lb. Comes with output cable.

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- Two 0-20 VDC supplies, 0-2A full load. May be used in series to provide 0-40 VDC, 0-2A. One 5 VDC (0.4A full load) fixed supply. Two digital voltmeters 0-99.9 VDC with separate inputs on the front panel.

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**RCA Cosmac 1802 Super ElF Computer $108.95**
- Compares features before you decide to buy any other computer. There is no other computer on the market that has all the desirable features of the Super Elf for so little money. The Super Elf is a single-board computer with many big things it can do. It is an excellent computer for training and for learning programming with its machine language and yet it is easily expandable with additional memory, Full ASCII Keyboard, video color terminal, etc.

**Super Expansion Board with Cassette Interface $63.95**
- This board has been designed to allow you do decide. It offers the Super Expansion Board plus all the features of the Super Elf. It is an excellent computer for training and learning programming with its machine language and yet it is easily expandable with additional memory, Full ASCII Keyboards, video color terminal, etc.

**Quest Super Basic V.5.0**
- 16K of new and improved Super Basic is now available. Quest was the first company worldwide to ship a full size Basic for 8032 systems. A complete function Super Basic by Ron Calkins.

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- 32 x 16 alpha/numeric graphics and text, 8 color graphics, 6520 based.

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- Plug into Elf providing Super Elf and 40 pin socket for $38.50.

**Super Color 5-Video Kit $129.95**
- Expandable to 56 x 192 high resolution color graphics, 6850 with all display matrix to control.

**Gremgo Video Kit $95.95**
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BYTE February 1981 351
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- **5101CA** One SA850 in cabinet w/power, 80C Controller, cable and manual
- **5202CA** Two SA850 in cabinet w/power, 80C Controller, cable and manual

### S-100 BASED COMPUTERS

<table>
<thead>
<tr>
<th>MODEL NO</th>
<th>DESCRIPTION</th>
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<tr>
<td>4101C</td>
<td>SA400 in cabinet w/power</td>
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<td>8101C</td>
<td>One SA810 in cabinet w/power for Mod. II</td>
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### GENERAL

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**TRS80**

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BYTE February 1981 355
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$1550.00 Two drive Expansion System
$2710.00 Three drive Expansion System
$2250.00 Additional drives alone

Vista's Add on Drives for Apple™
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- From 20 to 400% more capacity
- Twice as fast
- Compatible with Pascal
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160-Track $825.00
Controller $150.00

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Daisy wheel
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Base 2 Printer $575.00 (includes 2K Buffer, graphics high speed tractor feed)
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0 to 64 dots in half dot increments
100 cps - six densities
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Up to 16 character fonts
Vista Printer $745.00
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MPI B52 Dual Head, Double Density-408K $375.00
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Siemens FDD 100-8 8" Single Sided Drive $448.00
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MUSIC
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MPI B51 Add On Drives $275.00
Siemens FDD 100-8 8" Single Sided Drive $448.00
Shugart 801R Single Sided Drive $448.00

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1. VISTA Verbatim diskettes (hard or soft sector) Certified $149.95
2. NEW! Uses latest State of the Art LSI Technology. $38.95
3. Requires only one slot for 9 voices! 2. 16K RAM upgrade kits, guaranteed for 120 days. $59.95
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MULTIPLE PROGRAMS PER DISK

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All features described in the Osborne and Assoc. manuals are fully implemented. No additional features fully documented.

ON DISKETTES, YOU GET:
- Basic language "source code"
- Compiled programs with data files
- Operations manual
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- No source code changes allowed.
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Management Consultant
Route 3, Box 285
Sandpoint, ID 83864
(208) 263-3559

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Yes! We supply **IMSAI** compatible products...

NOTE: "Original" IMSAI parts were purchased at the closing business sale of IMSAI Manufacturing Corp. WW Components also distributes S-100 buss IMSAI compatible parts and boards. As supplies of "original" parts are exhausted, WW reserves the right to supply equivalent compatible parts not made by IMSAI. All items listed as "Assembled & Tested" have been assembled by WW Components and carry a 1 year warranty.

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Intelligent keyboard with full ASCII character set, both serial and parallel outputs, +5VDC operation, 8035 processor and fully programmable keyboard.  
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Disk Controller works with most 8" or 5 1/4" drives. NO LSI controller chip used! All operations/specifications firmware controlled. Works with IMOS or CP/M® 2.2  
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Ask about documentation, repair service, firmware and software for your system.

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1) PREPAID Send check or M.O. for merchandise amount only - we pay the shipping.  
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California Residents add 6.5% Sales Tax.

**POWER SUPPLY KITS**
(MOUNTING BRACKETS: OPEN FRAME WITH BASE PLATE, 3 HRS. ASSY. TIME)

<table>
<thead>
<tr>
<th>ITEM</th>
<th>USED IN</th>
<th>PRI. WINDING TAPS</th>
<th>SECONDARY WINDING OUTPUTS</th>
<th>SIZE W x D x H</th>
<th>UNIT PRICE</th>
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<tbody>
<tr>
<td>KIT 1</td>
<td>RAM III</td>
<td>0V, 110V, 120V</td>
<td>2 x 7.5A</td>
<td>2 x 2.5A</td>
<td>3 1/4&quot; x 3 1/4&quot; x 3 1/2&quot;</td>
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<td>KIT 2</td>
<td>RAM III</td>
<td>0V, 110V, 120V</td>
<td>2 x 7.5A</td>
<td>2 x 2.5A</td>
<td>3 1/4&quot; x 3 1/4&quot; x 3 1/2&quot;</td>
</tr>
<tr>
<td>KIT 3</td>
<td>RAM III</td>
<td>0V, 110V, 120V</td>
<td>2 x 7.5A</td>
<td>2 x 2.5A</td>
<td>3 1/4&quot; x 3 1/4&quot; x 3 1/2&quot;</td>
</tr>
</tbody>
</table>

**DISK SYSTEM PWR SUPPLY "S3"**
ASSY. & TESTED, OPEN FRAME, SIZE 10"(W) x 6"(D) x 4 1/8"(H)........................................ 62.95

**DISK DRIVE PWR SUPPLY "S3"**
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**POWER TRANSFORMERS**
(WITH MOUNTING BRACKETS)

<table>
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<tr>
<th>ITEM</th>
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<tr>
<td>KIT 1</td>
<td>+ 8 Vdc</td>
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<tr>
<td>KIT 2</td>
<td>- 9 Vdc</td>
</tr>
<tr>
<td>KIT 3</td>
<td>+ 16 Vdc</td>
</tr>
<tr>
<td>KIT 4</td>
<td>- 18 Vdc</td>
</tr>
<tr>
<td>KIT 5</td>
<td>+ 28 Vdc</td>
</tr>
</tbody>
</table>

**SHIPPING FOR EACH TRANSFORMER: $4.75 IN CALIF. $5.00 IN OTHER STATES. CALIF. RESIDENTS ADD 6% SALES TAX. OEM WELCOME**

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4 MHz Z80A CPU, dbl den Controller (5½" or 8" simultaneously), CP/M compatible, on-bd EPROM/RAM/ROM, two serial & two parallel ports, real time clock, std 2K monitor & disk routine on ROM, one year warranty.

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Controls up to 4 mini or 4 maxi drives simultaneously, 8M diskette format, works with sgl or dbl sided drives, 1K RAM data buffer, works with any CPU regardless of clock speed, CP/M, 2.2 furnished for 5¼" or 8", Oasiss compatible.

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DB25S • $4.50
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NOV-CAT • $149.00

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  - SSM-CB2AT A&T $299.95
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  - SDS-RAM248K 48K A&T $419.95
  - SDS-RAM264K 64K kit $459.95
  - SDS-RAM264AT 64K A&T $459.95
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  - CCS-2016BCK 16K 4 MHz A&T $309.95
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  - SDS-RAM81AT A&T $239.95
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  - SDS-PROM100AT A&T $275.00
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  - SDS-S104AT A&T $259.95
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  - Puts problem boards within easy reach
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  - SDS-PROM100AT A&T $275.00
- I/O-4 - S.S.M.
  - 2 serial I/O ports plus 2 parallel I/O ports
  - SDS-SIO4K kit $179.95
  - SDS-S104AT A&T $259.95
  - SDS-SIO4B Bare board $35.00
- S-100 Extender - Cal Comp Sys
  - Puts problem boards within easy reach
  - CCS-2520A A&T $24.95

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- SDS-RAM2232AT 32K A&T $379.95
- SDS-RAM248K 48K A&T $419.95
- SDS-RAM264K 64K kit $459.95

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**BARE BOARDS AVAILABLE ON MANY PRODUCTS**

- 2 or 4 MHz switchable CPU with RAM, ROM & I/O
  - SSM-CB2K Kit $239.95
  - SSM-CB2AT A&T $299.95

**S-100 PRODUCTS**

- 2810 Z-80 CPU - Cal Comp Sys
  - 2 or 4 MHz Z80 CPU w/serial I/O port
  - CCS-2810 A&T $275.00
- ExpandoRAM II - SD Systems
  - 2.5 MHz RAM board expandable from 16K to 64K
  - SDS-RAM16K 16K kit $269.95
  - SDS-RAM32K 32K kit $309.95
  - SDS-RAM48K 48K kit $349.95
  - SDS-RAM64K 64K kit $399.95
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### S-100 Boards

<table>
<thead>
<tr>
<th>Name</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>64K RAM Board - Cal Comp Sys</td>
<td>$494.95</td>
</tr>
<tr>
<td>MEM-6456A A &amp; T</td>
<td>$494.95</td>
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### Memory Bank - Jade

<table>
<thead>
<tr>
<th>Name</th>
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<tbody>
<tr>
<td>MEM-99730K Kit, no RAM</td>
<td>$219.95</td>
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<tr>
<td>MEM-16830K 16K kit</td>
<td>$289.95</td>
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<td>MEM-10360A 16K A &amp; T</td>
<td>$329.95</td>
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<tr>
<td>MEM-32371K 32K A &amp; T</td>
<td>$399.95</td>
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<td>MEM-32371A 32K A &amp; T</td>
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<td>MEM-48372K 48K kit</td>
<td>$324.95</td>
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<td>MEM-48372A 48K A &amp; T</td>
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<td>MEM-64373K 64K A &amp; T</td>
<td>$409.95</td>
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<tr>
<td>MEM-99970B Bare board</td>
<td>$55.00</td>
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### ExpandedRAM II - SD Systems

<table>
<thead>
<tr>
<th>Name</th>
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<tbody>
<tr>
<td>4 MHz RAM board expandable from 16K to 256K</td>
<td>$289.95</td>
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<tr>
<td>MEM-16630K 16K kit</td>
<td>$289.95</td>
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<tr>
<td>MEM-10630A 16K Jade A &amp; T</td>
<td>$329.95</td>
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<tr>
<td>MEM-32631K 32K kit</td>
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<td>MEM-48632K 48K kit</td>
<td>$369.95</td>
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<td>MEM-48632A 48K Jade A &amp; T</td>
<td>$419.95</td>
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<tr>
<td>MEM-64633K 64K kit</td>
<td>$409.95</td>
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<td>MEM-64633A 64K Jade A &amp; T</td>
<td>$459.95</td>
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### 32K STATIC RAM - Jade

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<thead>
<tr>
<th>Name</th>
<th>Price</th>
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<tr>
<td>2 or 4 MHz expandable static RAM board uses 2114E’s</td>
<td>$199.95</td>
</tr>
<tr>
<td>MEM-16151K 16K 4 MHz A &amp; T</td>
<td>$224.95</td>
</tr>
<tr>
<td>MEM-32151K 32K 4 MHz kit</td>
<td>$299.95</td>
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<tr>
<td>MEM-32151A 32K Jade A &amp; T</td>
<td>$349.95</td>
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### 16K STATIC RAM - Cal Comp Sys

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<th>Name</th>
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<tr>
<td>MEM-16160A 16K 2 MHz A &amp; T</td>
<td>$279.00</td>
</tr>
<tr>
<td>MEM-16162A 16K 4 MHz A &amp; T</td>
<td>$309.00</td>
</tr>
<tr>
<td>MEM-16160B Bare board</td>
<td>$29.95</td>
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### THE BIG Z* - Jade

<table>
<thead>
<tr>
<th>Name</th>
<th>Price</th>
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<tbody>
<tr>
<td>2 or 4 MHz switchable Z-80* CPU with serial I/O</td>
<td>$145.00</td>
</tr>
<tr>
<td>CPU-30201K Kit</td>
<td>$145.00</td>
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<tr>
<td>CPU-30201A A &amp; T</td>
<td>$199.00</td>
</tr>
<tr>
<td>CPU-30202B Bare board</td>
<td>$35.00</td>
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### SBC-100 - SD Systems

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<tbody>
<tr>
<td>2.5 MHz 2.5x8 CPU with serial &amp; parallel I/O ports</td>
<td>$295.95</td>
</tr>
<tr>
<td>CPC-30100K Kit</td>
<td>$295.95</td>
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<tr>
<td>CPC-30100A Jade A &amp; T</td>
<td>$369.95</td>
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### SBC-200 - SD Systems

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<tbody>
<tr>
<td>4 MHz 2.5x8 CPU with serial &amp; parallel I/O ports</td>
<td>$359.95</td>
</tr>
<tr>
<td>CPC-30200K Kit</td>
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<td>CPC-30200A Jade A &amp; T</td>
<td>$399.95</td>
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### CB2 - S.S.M.

<table>
<thead>
<tr>
<th>Name</th>
<th>Price</th>
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<tbody>
<tr>
<td>2 or 4 MHz switchable Z-80* CPU with RAM, ROM, &amp; I/O</td>
<td>$239.95</td>
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<td>CPU-30300K Kit</td>
<td>$239.95</td>
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<td>CPU-30300A A &amp; T</td>
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### 2810 Z-80* CPU - Cal Comp Sys

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<tr>
<td>2/4 MHz Z-80* CPU w/serial I/O port</td>
<td>$275.00</td>
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<td>CPU-30400A A &amp; T</td>
<td>$275.00</td>
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</tbody>
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### Single Board Computers

#### AIM-65 - Rockwell

6502 computer with printer, display, & keyboard

- CPK-5016S 1K AIM | $374.95 |
- CPK-5046S 4K AIM | $449.95 |
- SFRK-7400006E 8K BASIC ROM | $99.95 |
- SFRK-6400004E 4K assembler ROM | $84.95 |
- PSX-030A Power supply | $64.95 |
- ENX-000002 Enclosure | $49.95 |
- Special package price | $625.00 |

#### Z-80* STARTER KIT - SD Systems

Z-80* computer with RAM, ROM, I/O, & keyboard

- CPS-30010K Kit | $389.95 |
- CPS-30010A Jade A & T | $459.95 |

### Motherboards

#### ISO-BUS - Jade

Silent, simple, and on sale - a better motherboard

- MBS-061B Bare board | $19.95 |
- MBS-061K Kit | $39.95 |
- MBS-061A A & T | $49.95 |
- MBS-121B Bare board | $29.95 |
- MBS-121K Kit | $89.95 |
- MBS-121A A & T | $89.95 |
- MBS-181B Bare board | $49.95 |
- MBS-181K Kit | $99.95 |
- MBS-181A A & T | $139.95 |

### Mainframes

#### MAINFRAME - Cal Comp Sys

12 slot S-100 mainframe with 20 amp power supply

- ENC-112105 Kit | $309.95 |
- ENC-112106 A & T | $349.95 |

#### DISK MAINFRAME - NNC

Dual 8" drive cutouts with 8 slot motherboard

- ENS-112320 with 30 amp pps | $699.95 |

### Video Monitors

#### Video Monitors

- 9" B & W MONITOR - A.P.F.
  High quality, high resolution video monitor
  VDM-750900 9" monitor | $149.95 |
- 13" COLOR MONITOR - Zenith
  The hi res color you've been promising yourself
  VDC-201301 | $449.00 |
- 12" GREEN SCREEN - NEC
  20 MHz, P31 phosphor video monitor with audio
  VDM-651200 12" monitor | $249.95 |
- SUP'R'MOD II - M & R Assoc
  Color or B & W TV interface recommended for Apple
  IOR-5050A A & T | $29.95 |
peripherals, and software. All you have to do is ask for it. Just circle our inquiry number on the reader service card in the rear of this magazine and we will send you the best. It's free and it's easy.

Accessories for Apple

**16K MEMORY UPGRADE**
Add 16K of RAM to your TRS-80, Apple, or Exidy
MEX-16100K TRS-80 kit $39.95
MEX-16101K Apple kit $39.95
MEX-16102K Exidy kit $39.95

**DISK DRIVE for APPLE**
24" disk drive with controller for your Apple
MSM-12310C with controller $475.00
MSM-12310Y w/out controller $375.00

**8" DRIVES for APPLE**
Complete kit with controller, DOS, and two 8" drives
Special package price $1475.00

**AIO - S.S.M.**
Parallel & serial interface for your Apple
IOI-2050A Kit $159.00
IOI-2050A A & T $199.00

**PRINTER INTERFACE - Cal Comp Sys**
Centronics type I/0 card with firmware
IOI-2041A A & T $99.95

**APPLE CLOCK - Cal Comp Sys**
Real time clock w/battery backup
IOK-2030A A & T $119.95

**SUPERTALKER - Mtn Hardware**
Speech recognition/synthesizer w/speaker & mike
IOS-2015A A & T $275.00

**Z-80" CARD for APPLE**
Z80 CPU card with CP/M for your Apple
CPX-30800A A & T $279.95

**MICROMODEM - D.C. Hayes**
Auto answer/dial modem card for Apple or S-100
IOM-2010A Apple modem $349.95
IOM-2010A S-100 modem $375.00

**Micronet Modem - Micromate**
Direct connect modem with extra features
IOM-2020A Best Apple modem $275.00

**EPROM ERASERS**
XME-3100 Without timer $69.95
XME-3101 With timer $94.50
L.S. Engineering UV eraser for up to 48 EPROMs
XME-3200 A & T $39.95

**8" Disk Drive Sale**
JADE's new dual disk sub-assemblies include:
Handsome metal cabinet with proportionately balanced air flow system, rugged dual drive power supply, cooling fan, cable kit, lighted power switch, approved fuse assembly, line cord, Neupert-Mar rubber feet, and all necessary hardware to mount 28" disk drives - it's all American made, guaranteed for six months, and it's in stock!

**DISK DRIVE Sale**
8" Drive Sale
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**Spinwriter - NEC**
65 cps, bi-directional, letter quality with tractor
PRD-55101 with 16K buffer $2595.00

**CENTRONICS 737-1**
9 x 9 dot matrix, letter quality, proportional spacing
PRM-15737 Parallel $795.00
With interface for Apple $895.00

**MX-80 - Epson**
133 columns, 9 x 9 dot matrix, multiple fonts
PRM-27000 Sys $100.00
$545.00 Interface for Apple $110.00

**Printers**

**_DISKETTES - Jade**
Bargain prices on magnificent magnetic media
5 1/4" single sided, single density box of 10
MMD-5110103 $69.95
MMD-5110203 $79.95

**DISKETS**
Add 16K of RAM to your TRS-80, Apple, or Exidy
Z-80A $10.95
Z-80B $12.95
Z-80C $14.95
Z-80D $16.95

**DISKETTES**
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MMD-5111003 Soft sector $27.95
MMD-5111010 10 sector $27.95
MMD-5111016 16 sector $27.95

**8" DRIVES**
Highly reliable double density floppy disk drives
Shugart 8011 single sided, double density
MSF-10810R SA-801R $425.00
Special Sale Price $2 for $790.00

**JADE DISK PACKAGE**
Double-D controller kit, two 8" double density drives
CP/M 2.2, cabinet, power supply, & cables
Special package price $1935.00

**PRINTER INTERFACE - Cal Comp Sys**
Centronics type I/0 card with firmware
IOI-2041A A & T $99.95

**SUPERTALKER - Mtn Hardware**
Speech recognition/synthesizer w/speaker & mike
IOS-2015A A & T $275.00

**Z-80" CARD for APPLE**
Z80 CPU card with CP/M for your Apple
CPX-30800A A & T $279.95

**MICROMODEM - D.C. Hayes**
Auto answer/dial modem card for Apple or S-100
IOM-2010A Apple modem $349.95
IOM-2010A S-100 modem $375.00

**Micronet Modem - Micromate**
Direct connect modem with extra features
IOM-2020A Best Apple modem $275.00

**EPROM ERASERS**
XME-3100 Without timer $69.95
XME-3101 With timer $94.50
L.S. Engineering UV eraser for up to 48 EPROMs
XME-3200 A & T $39.95

Circle 313 on inquiry card.
Jameco Electronics

MAIL ORDER ELECTRONICS - WORLDWIDE
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PRICES SUBJECT TO CHANGE

Circle 314 on inquiry card.

BYE February 1981 369
NEW APPLE PRODUCTS

- **Apple II** - Carry around, plug into conversation with people
- **Apple III** - Can work on a table
- **Apple IIc** - Can work on an IBM or Macintosh

NEW SOFTWARE

1. **SYSTEM SPECIAL**
   - **COM-SUSPENSE** - Apple II - $19.95
   - **COM-EMERGENCY** - Apple II - $19.95
   - **COM-APPEARANCE** - Apple II - $19.95
   - **COM-CONTINENTAL SPECIALIES** - Apple II - $19.95
   - **COM-APPLI力气** - Apple II - $19.95
   - **COM-APPLE** - Apple II - $19.95

Circle 315 on inquiry card.
ATTENTION VIDEO HOBBYISTS!!!

A new concept in high performance video. A complete Video system for only $99.95...

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Price: $99.95

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For use with IBM personal Computers, the Eprom Eraser, model UV-1, now has 3 speeds... 0.99

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Price: $0.99

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**NEW, UNUSED COMPONENTS**

- 100 - 1N4148B Diodes (0.5A 100V 1/4W)
- 100 - 1N4001 Diodes (0.1A 600V 1W)
- 100 - 1N4002 Diodes (0.1A 600V 1W)
- 100 - 1N4007 Diodes (0.1A 600V 1W)
- 100 - 1N4004 Diodes (0.1A 600V 1W)
- 100 - 1N4148B Diodes (0.5A 100V 1/4W)
- 100 - 1N4001 Diodes (0.1A 600V 1W)
- 100 - 1N4002 Diodes (0.1A 600V 1W)
- 100 - 1N4007 Diodes (0.1A 600V 1W)
- 100 - 1N4004 Diodes (0.1A 600V 1W)

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Price: $7.95

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**LOW COST FLOPPY DISK SUBSYSTEM**

- IBM no. 1450 non-erasable Floppy Disk Subsystem, $11.95
- IBM no. 1460 erasable Floppy Disk Subsystem, $14.95
- IBM no. 2460 erasable Floppy Disk Subsystem, $19.95
- IBM no. 2470 erasable Floppy Disk Subsystem, $24.95

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Price: $11.95

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**EMAKO-20**, Reg. $77.00, NOW $25.00

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Price: $25.00

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**VISTA V-300 PRINTER**

**Model UV-W1** (W-cable included), $39.95

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Price: $39.95

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**BASE II PRINTER**

- IBM model 100 parallel printer, $49.95
- IBM model 100 parallel printer, $59.95
- IBM model 100 parallel printer, $69.95
- IBM model 100 parallel printer, $79.95
- IBM model 100 parallel printer, $89.95
- IBM model 100 parallel printer, $99.95

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Price: $49.95

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**2-60/2-60 1/2-800 CPU BOARD**

- IBM model 7080, $99.95
- IBM model 7080, $99.95
- IBM model 7080, $99.95
- IBM model 7080, $99.95
- IBM model 7080, $99.95
- IBM model 7080, $99.95

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Price: $99.95

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**S-100 MOTHERBOARD SPECIAL**

- IBM model 7080, $99.95
- IBM model 7080, $99.95
- IBM model 7080, $99.95
- IBM model 7080, $99.95
- IBM model 7080, $99.95
- IBM model 7080, $99.95

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Price: $99.95

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**SIEMENS' FLOPPY DRIVE**

- IBM model 7080, $99.95
- IBM model 7080, $99.95
- IBM model 7080, $99.95
- IBM model 7080, $99.95
- IBM model 7080, $99.95
- IBM model 7080, $99.95

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Price: $99.95

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**ACOUSTIC MODEM**

- IBM model 7080, $99.95
- IBM model 7080, $99.95
- IBM model 7080, $99.95
- IBM model 7080, $99.95
- IBM model 7080, $99.95
- IBM model 7080, $99.95

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Price: $99.95

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**VERBATIM DISKETTES**

- IBM model 7080, $99.95
- IBM model 7080, $99.95
- IBM model 7080, $99.95
- IBM model 7080, $99.95
- IBM model 7080, $99.95
- IBM model 7080, $99.95

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Price: $99.95

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**SOCKET SPECIALS**

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- IBM model 7080, $99.95
- IBM model 7080, $99.95
- IBM model 7080, $99.95
- IBM model 7080, $99.95
- IBM model 7080, $99.95

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Price: $99.95

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**DISCOUNTS**

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- IBM model 7080, $99.95
- IBM model 7080, $99.95
- IBM model 7080, $99.95
- IBM model 7080, $99.95
- IBM model 7080, $99.95

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Price: $99.95

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**RETAIL STORES OPEN MON-SAT**

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- 874-7920

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Price: Free

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**FOR INTERNATIONAL ORDERS:**

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- 874-7920

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Price: Free

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**BYTE February 1991 371**
This is ABSOLUTELY the LOWEST PRICE EVER for a Hi Speed (300 NS) LO-LO Power 32K RAM. 4K by 1 Chips are organized in Selectable Banks.

* Extended Address Lines A16 - A17
* Phantom Line  * 9 Regulators

---

### SCHOOLS

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### HOBBIEST

- **LM323K**: 5V, 3A. REGULATOR $5.50
- **TAB MOUNT**
  - Heat Sinks $1.25
  - Gold $2.50
  - S-100-CONNECTOR $3.25

### RESISTORS .02 ea.

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### WIRE WRAP WIRE

- Packed in 500 Lot Bundles
- Length includes 2" x 1" Strip

### DIP PLUGS

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### WIRE WRAP TOOL

- 6 Amps 125 VAC
- 7 Amps 30 VDC

### CONNECTORS

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### 74 LSXX

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| 74L02 | .33 |
| 74L03 | .33 |
| 74L04 | .39 |
| 74L05 | .39 |
| 74L06 | .39 |
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| 74L86 | .39 |
| 74L87 | .39 |
| 74L88 | .39 |
| 74L89 | .39 |
| 74L90 | .39 |
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| 74L92 | .39 |
| 74L93 | .39 |
| 74L94 | .39 |
| 74L95 | .39 |
| 74L96 | .39 |
| 74L97 | .39 |
| 74L98 | .39 |

### DEALS $299 (KIT)

- 4 MHZ Beastie with extra instructions!
- Z-80 SUPPORT
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  - SIO - $25.50
  - PIO - $6.50
  - DMA - $18.75

All 4 MHZ (who wants 2 MHZ?)

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Quantity Prices
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Soroc 10120 $675.00
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Also have 510C, SOROC, HAZELTINE, etc. What we don't have is room on 800 number for prices. Call Toll Free 800 number for prices.

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$12.50
(Gold Contacts)
As long as there is a price war, we will fight your battle. Compare at your local dealer and buy U.S. MICRO.

Memorex - Verbatum - Wabash
Basf Floppies

Box of 10 Only:

5 1/4" Soft $2.65 ea.
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5 1/4" Hard 15 $2.65 ea.
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These are brand new, in the box fans. Not noisy bearing pullouts. Never again at these low prices!

8" $810R $395.00
Manufacturer had too many, buys at 1000 piece rate, sales dropped, so we got 'em. Fantastic buy, get them while they last! Full warranty.

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Very Special Price on these BRAND NEW current production units. Add $10.00 for Extended 1 Year Warranty.

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Don't be misled by this LOW price. This is a rugged 100% Duty Cycle 7 by 7 Dot Matrix Printer. Brand new, factory warranty.

$3.45
200 NS

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MM-5257 $250 NS

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The other of the world's most popular static RAMs. This one is 4K by 1 organization. Don't buy Gold, buy these, the price won't last!

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Remember when 2716s were $50.00 and hard to get? These units are so beautiful it's hard to part with them. But we will, for a small price. Guaranteed.

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Write for full catalog!
NEW
from
Shugart Technology

5
Megabyte
Hard Disk Drive

Packaged in the same physical size at the industry standard 5 1/4 inch floppy drive, the new Winderstor models three times as much data (160 megabytes unformatted, 6 less than 110 megabytes formatted) in about twenty times faster than 1200 revolutions per second.

The ST500 is factory sealed to protect the media from environmental conditions. The California Digital 5 1/4 inch load disk drive and power supply.

Shugart Associates SA-400 removable diskette drive for use with the Apple II and $100 Apple controller scheduled for April release.

SURPLUS
IBM 2980
SELECTIVE
BINARY TERMINAL
$250

The IBM 2980 model 200 terminal, designed to be operated at terminals for small business, church, or school, has been used in computer installations since the early sixties. It has a built-in electronic light pen, a built-in printer, and a built-in keyboard. The IBM 2980 has a built-in keyboard and printer, and is designed for use in schools, churches, and small businesses.

The IBM 2980 was designed for use in schools, churches, and small businesses. It has a built-in electronic light pen, a built-in printer, and a built-in keyboard. The IBM 2980 has been used in computer installations since the early sixties.
Introducing the
ANAACOM 150
DOT MATRIX PRINTER
Mfg. suggested list $1350
California Digital Introductory Price
$995

NEW
from INTEGRAL DATA
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AA $1058
18 columns
AA $1192
12 columns
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CENTRONICS
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737 $595

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MODEM
Your Choice
$169

IBm 3101 DISPLAY TERMINAL

IBM direct price $1295
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ACCESSORIES FOR THE
APPLE COMPUTER

S-100 BOARDS
Assembled • Tested • Burned-in

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SINGLE BOARD COMPUTER
FLOPPY DISK CONTROLLER

TOLL FREE ORDER LINE
800-421-5041
TECHNICAL & CALIFORNIA
213-679-9001
### Modem Sale

**$129.00**

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Description</th>
<th>Price</th>
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<tr>
<td>CN0-00508</td>
<td>50 PIN FEMALE S</td>
<td>$8.32/each + $3.00 100 pieces + $4.25</td>
</tr>
<tr>
<td>CN0-0825P</td>
<td>25 PIN MALE S</td>
<td>$8.80/each or 8.54/each or 10.25/each</td>
</tr>
<tr>
<td>CN0-DE9P</td>
<td>9 PIN MALE S</td>
<td>$11.85/each</td>
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<tr>
<td>CND-DD50P</td>
<td>50 PIN MALE S</td>
<td>$8.75/each</td>
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<tr>
<td>CND-OC37C</td>
<td>37 PIN COVER S</td>
<td>$17.95/each</td>
</tr>
<tr>
<td>CND-OC37S</td>
<td>37 PIN FEMALE S</td>
<td>$16.80/each</td>
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<tr>
<td>CND-OC37P</td>
<td>37 PIN MALE S</td>
<td>$17.80/each</td>
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<tr>
<td>CN0-OE9S</td>
<td>9 PIN FEMALE S</td>
<td>$2.70/each</td>
</tr>
<tr>
<td>CN0-RS232F</td>
<td>25 PIN MALE S</td>
<td>$4.60/each</td>
</tr>
<tr>
<td>CND-020418</td>
<td>HARDWARE SET 2 PR.</td>
<td>$1.00/each</td>
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### Hardware Sale

**$450.00**

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<thead>
<tr>
<th>Part No.</th>
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<th>Price</th>
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<tbody>
<tr>
<td>GBT164A16</td>
<td>16K RAM A&amp;T</td>
<td>$399.00</td>
</tr>
<tr>
<td>GBT164A24</td>
<td>24K RAM A&amp;T</td>
<td>$379.00</td>
</tr>
<tr>
<td>GBT164A32</td>
<td>32K RAM A&amp;T</td>
<td>$459.00</td>
</tr>
<tr>
<td>GBT143U</td>
<td>Unkit A&amp;T</td>
<td>$79.00</td>
</tr>
<tr>
<td>GBT144A</td>
<td>Unkit A&amp;T</td>
<td>$399.00</td>
</tr>
<tr>
<td>GBT2D</td>
<td>SUBLOGIC UNIVERSAL GRAPHICS INTERPRETER SOFTWARE</td>
<td>$35.00</td>
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### Spectrum 100 Color Graphics Board

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Description</th>
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<tbody>
<tr>
<td>GBT144U</td>
<td>Unkit</td>
<td>$235.00</td>
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<tr>
<td>GBT145A</td>
<td>Assmbled &amp; Tested</td>
<td>$425.00</td>
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### IO Boards

**$239.00**

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<thead>
<tr>
<th>Part No.</th>
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<tbody>
<tr>
<td>GBT133U</td>
<td>Unkit</td>
<td>$249.00</td>
</tr>
<tr>
<td>GBT133A</td>
<td>A&amp;T</td>
<td>$249.00</td>
</tr>
<tr>
<td>GBT153U</td>
<td>3 PARALLEL</td>
<td>$249.00</td>
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### Econoram XA 32K RAM

<table>
<thead>
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<th>Part No.</th>
<th>Description</th>
<th>Regular Price</th>
<th>Sale Price</th>
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<tbody>
<tr>
<td>GBT129A32</td>
<td>4MHz with Z80</td>
<td>$450.00</td>
<td>$89.00</td>
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<tr>
<td>GBT133U</td>
<td>4MHz with 8085</td>
<td>$219.00</td>
<td>$99.00</td>
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<tr>
<td>GBT134A</td>
<td>A&amp;T 6 Slot</td>
<td>$279.00</td>
<td>$199.00</td>
</tr>
<tr>
<td>GBT145U</td>
<td>12 Slot Rackmount</td>
<td>$569.00</td>
<td>$449.00</td>
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<tr>
<td>GBT164A24</td>
<td>20 Slot</td>
<td>$579.00</td>
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<tr>
<td>GBT164A32</td>
<td>32 Slot</td>
<td>$699.00</td>
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### S-100 Mainframes

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<thead>
<tr>
<th>Part No.</th>
<th>Description</th>
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<tbody>
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<td>GBT164A24</td>
<td>24K RAM A&amp;T</td>
<td>$399.00</td>
</tr>
<tr>
<td>GBT164A32</td>
<td>32K RAM A&amp;T</td>
<td>$459.00</td>
</tr>
<tr>
<td>GBT1612A</td>
<td>Assembled &amp; Tested</td>
<td>$425.00</td>
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### Motherboards

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<thead>
<tr>
<th>Part No.</th>
<th>Description</th>
<th>Price</th>
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<tbody>
<tr>
<td>GBT190A</td>
<td>A&amp;T</td>
<td>$249.00</td>
</tr>
<tr>
<td>GBT190A</td>
<td>A&amp;T</td>
<td>$249.00</td>
</tr>
<tr>
<td>GBT190A</td>
<td>A&amp;T</td>
<td>$249.00</td>
</tr>
<tr>
<td>GBT190A</td>
<td>A&amp;T</td>
<td>$249.00</td>
</tr>
</tbody>
</table>

### Memory Expansion Kits

**$8 for $29.00 Guaranteed!**

**ADD $2.00 FOR PROGRAMMING JUMPERS FOR TRS-80 KEYBOARD**

### Dual 8" Disk Cabinets

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Description</th>
<th>Price</th>
</tr>
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<tbody>
<tr>
<td>TEIRFDO</td>
<td>Desk Cabinet</td>
<td>$199.00</td>
</tr>
<tr>
<td>TEIRFDO</td>
<td>Rack Mount</td>
<td>$279.00</td>
</tr>
</tbody>
</table>

### Color Cables

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Description</th>
<th>Price</th>
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<tbody>
<tr>
<td>CND-RS232F</td>
<td>ECONORAM XA 32K RAM</td>
<td>$11.95/each + $7.50/each</td>
</tr>
<tr>
<td>CND-RS232F</td>
<td>ECONORAM XA 32K RAM</td>
<td>$17.95/each + $15.85/each</td>
</tr>
</tbody>
</table>

### PRIORITY ONE ELECTRONICS

**16723 B ROSECO BLVD. • SEPELVADA, CA. 91343**

Terms: Visa, MC, BAC, Check, Money Order, U.S. Funds Only. CA residents add 8% sales tax.

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*A Socket and Connector prices based on Gold, not exceeding $700 per oz.

*Saw Prices for prepaid orders only credit card orders will be charged appropriate freight.
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**DISCUS M10**

10MB 8" HARD DISK DRIVE & S-100 CONTROLLER WITH CP/M 2.2

**Specifications**:
- Full-size, single-density disk memory system
- 10MB capacity
- CP/M 2.2 standard
- Plug compatible with Shugart, Remington and Siemens single- or double-sided drives
- Doubles as an expandable microcomputer capable of utilizing MFM and FM data formats
- Western Digital 119L floppy disk controller chip
- Uses 2K of S-100 address space
- TK PROM with built-in disk drive and I/O utility programs, monitoring memory mapped I/O
- TK-714-In/300 ns access time RAM for disk data offering and general purpose use
- Starting address of memory space is 340,000 (E000 hex) for compatibility with other popular ROM based systems
- Phase-locked data separator and crystal controlled datawrite precompensation capability to insure the highest standards of data integrity in double density mode
- Compatible with all 2 MHz and 4 MHz systems which conform with the proposed IEEE standard for the S-100 bus
- 1602 UART with crystal-controlled baud rate generator
- 4 MHz selectable baud rates from 60 to 120,000 bits/second
- 17 pin serial loop and industry standard RS232C serial interface
- Power-on jump circuitry for automatic bootstrap loading from the disk drive
- Power supply requirements: 8V @ 1200 mA; 16V @ 150 mA

**Price**
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- Sale Price: $195

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OSCILLOSCOPE

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(4MHz)
• Sweep-time magnifier
• Z-axis modulation
• DUAL, ADD, DIFF.
• Vertical Detection Modes
• X, Y operation
• Trace Rotation

HITYL302B DUAL TRACE 15MHZ (no delay)
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SALE $650.00

LP-1 LOGIC PROBE—Hand-held logic probe provides
problems instantly, solves problems—on your system—
with logic “O” keeps LED off. A power seeking gate
or level detection. Pulse Memory: Pulse or level transition
detected and stored.

GSC DUAL DIGITAL PULSER

The ultimate in speed and ease of operation. Simply con-
nect clip leads to positive and negative power, then touch
DP-1’s probe to a circuit node; automatic polarity sensor
detects circuit’s high or low condition. Depress the push-
button and trigger an opposite polarity pulse into the cir-
cuit. Fast, troubleshooting includes injecting signals at key
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control pushbutton selects single shot or continuous
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put signals, and memory analysis. Same as Model LG-1.

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Minimum MDT $5.00. Excess refunded. Just in case... please include your phone no. Prices subject to
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TRS-80 ADD ON 5¼” DISK

FROM MICROPOLIS THE WORLDS LARGEST
MANUFACTURER OF HIGH DENSITY 5¼”
FLOPPY DISK DRIVES

Now at an incredibly low price, you can add the Micropolis MCP1027M1 floppy disk drive to your TRS-80® computer. The MCP1027M1 is fully plug compatible with the TRS-80® expansion interface floppy disk output.

SIMPLE INSTALLATION
Simply plug the MCP1027M1 into your data cable and your on-line. There is no need to worry about format compatibility. Your TRS-80® 30-track 5¼” floppy disk programs will operate identically on the MCP1027M1. Compatibility doesn’t end here. Micropolis has even matched the colors of the MCP1027M1 to the TRS-80®.

WHAT’S A LITTLE TECHNICAL SUPERIORITY AMONG FRIENDS?
Anyone can cut price by cutting out capacity or valuable features. But there’s no long term advantage in it. Not for the user. Or the builder.
Micropolis takes a better approach, even though it’s harder. Using advanced design to provide more capability while also lowering cost.
For example, most 5¼-inch floppy disks cut costs by using a cheap, less accurate plastic cam or cam follower to position the read/write head. Most 8-inch floppy disks use a better approach, with a rolled steel lead screw for this function.

We go them one better and use an all-steel system, with a precision-ground steel lead screw and steel follower. It costs more but gives us greater storage capacity with lower cost per thousand bytes. Not so incidentally, our steel construction (compared to plastic) significantly increases reliability, too. There’s even a built-in File Protect feature that prevents accidental loss of valuable data. (A file protected diskette cannot be written on.)

Heat can cause numerous read and write errors that can become hazardous to your data. The major heat producing power supply components are mounted to a large heat sink, external to the cabinet, by the power switch and fuse (located at the rear of the cabinet). This design is to assure that the drive components are kept as cool as possible to assure reliable data recovery.

MICROPOLIS BUILDS ‘EM RIGHT
Reliability just can’t happen, and it can’t be pasted on later. Micropolis knew you had to have it, so they designed it in. Micropolis builds it in every day. Just because Micropolis drives are economical doesn’t mean they’re cheap.

To save unnecessary wear and tear on the diskette, Micropolis included an automatic deselection feature which relieves head pressure on the recording surface when the disk isn’t in use. This produces longer life, more than 100,000 units; Micropolis is able to design and build a drive of superior performance.

This total integration means Micropolis controls everything from beginning to end. The result is a better drive for you, backed by a full 120 day factory guarantee.

YOU’RE IN GOOD COMPANY
As an individual, you can’t help but wonder when you spend your hard earned money. Have you made the proper choice? With so many drives in the marketplace, and so few hard facts available to the individual, how can you make an intelligent decision?
One way is to see which drives the large system manufacturers and OEM’s rely on. Companies like Commodore, Eddy, Harris, and Vector Graphics depend on Micropolis for years of reliable performance. That is one reason why International Computer, Ltd., has recently signed a $20 million dollar contract for Micropolis disk drives.

For example, most 5¼-inch floppy disks cut costs by using a cheap, less accurate plastic cam or cam follower to position the read/write head. Most 8-inch floppy disks use a better approach, with a rolled steel lead screw for this function.

Purchasing Power

Priority One Electronics, the worlds largest stocking distributor of Micropolis disk drives was able to negotiate a special price for the MCP1027M1 when we committed to buy an entire production run. The MCP1027M1 is a good buy at the list price of $545.00.

The MCP1027M1 is an excellent buy at our sale price of $279.00. Now all that remains is for you to take advantage of this truly incredible buy, while the supply lasts.

Credit card buyer call toll free
(800) 423-5633 except CA, AK, HI. call (213) 894-8171

Priority One Electronics
16723 Roscoe Blvd. • Sepulveda, CA 91343

Please send me the following items:

<table>
<thead>
<tr>
<th>Item Number</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCP1027-1</td>
<td>Micropolis TRS-80™ Ad on drive.</td>
<td>$279.00</td>
</tr>
<tr>
<td>APF395</td>
<td>New DOS 80 operating system.</td>
<td>$149.00</td>
</tr>
<tr>
<td>VRRM025-01</td>
<td>Box of 10 Verbatim diskettes</td>
<td>$29.95</td>
</tr>
<tr>
<td>MMM744-0</td>
<td>Box of 10 Scotch diskettes</td>
<td>$39.95</td>
</tr>
<tr>
<td>VRBF0S</td>
<td>Head Cleaning Kit.</td>
<td>$29.95</td>
</tr>
<tr>
<td>PR134CCEE-2</td>
<td>2 drive data cable.</td>
<td>$29.95</td>
</tr>
<tr>
<td>PR134CCEE-4</td>
<td>4 drive data cable.</td>
<td>$39.95</td>
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I have enclosed a check or money order

<table>
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<tr>
<th>Sub-Total</th>
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*These sale prices are for PREPAID U.S. orders only. Credit card orders will be charged appropriate freight. On approval, purchase orders for the MCP1027-1 will be accepted at $379.00, FOB Sepulveda, CA, (6% CA only). Tax

Visa Mastercharge

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Circle 319 on inquiry card.
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- Two RS232C ports
- Complete with CP M 2.2 and BASIC
- 64K Memory, List $3345
- Self-contained computer with disk drives
- 2.2 Barracuda
- 64K MultiMicroMart upgrade to quad density

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- 10149, List $1650
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- HAZELTEK 1410, List $900
- 1430, List $1225
- 1500, List $1395
- 1520, List $1650
- ADDS R 20, List $925
- LEAR SIEGEL ADMMA, List $849
- TELEVIDEO 912C, List $950

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- DP-9500, List $1650
- DP-9501, List $1650
- PAPE TIGER 8400, List $995
- 16x64, Call for Price
- NORTH STAR HORIZON

- HORIZON 1 ASSEMBLED & TESTED
  - 32K, Double Density, List $2695
  - 2279
  - 32K, Quad Density, List $3259
  - 2279

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  - Discus 20, List $1199
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  - Discus 2 - 2, A&T, List $1549
  - $1319
  - Dual Discus 2 - 2, A&T, List $2748
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  - *New includes CP M 2.2

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  - ASCOMP, List $470
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- SSM 2B Z/0, Kit, List $199
  - Assembled & Tested, List $269
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  - Assembled & Tested, List $242
- SSM VB2, 80 Char, 4 MHz, Kit, List $481
  - Call 4 MHz, A&T, List $565
- MULTIMORPHE, 16x84, A&T, List $165

PRINTERs

- ANADEX DP-8000, List $849
- DP-9500, List $1650
- DP-9501, List $1650
- PAPE TIGER 8400, List $995
- 16x64, Call for Price

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- 720 1 parallel interface, NEW LOW $649
- 737 parallel interface, SUPER VALUE $829
- 779 w/Tractor, List $350
- 702 w/Tractor, List $280
- 703 w/Tractor, List $295
- PRICEs
- TI 810 Basic, List $1895
- 810 bare & Centronics-style parallel interface, List $1540
- 810 w/Full ASCII, List $1695
- 714 w/Full ASCII, List $1695
- COMPRINT 912 w/parallel interface, List $599
- 912 w/serial interface, List $699
- AXIOM IMP I, List $699
- MICROTEK, List $750
- OKIDATA Microline 80, List $949
- 649
- Traffic Option
- RS232 Serial Interface

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- 280 CPU Boards, List $259
- DISK CONTROLLER 282, List $39
- Kit, List $229
- CASE STATIC, List $710
- 64 DYNAMIC BOARD, List $695

CPU BOARDS

- NORTH STAR 280A 12PB A1, List $299
- CROMEMCO 4 MHz, List $395
- SSF W4, List $450
- SYSTECHS formerly Ithaca Audios
- NIXOS Series II, List $395
- SSM CB12100 A1, List $212
- CB1A Kit, List $183
- CB2 Z 80 A/T, List $344
- CB2 Kit, List $263
- DELL 2 20, List $289
- SD SOO, List $350
- SBC 200, List $400
- SBC 200 Kit, List $320

MEMORY BOARDS

- 32K SD ExpandDB Board
  - ONLY $289
  - Only $7599 without RAM chips

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- List $595
  - OUR PRICE $505

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**HAZELTINE**

**1500**

**ONLY** $879

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**NEC SPINWRITER™**

1410 w/numeric keypad, List $900 ... $749
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1510, List $1395 ... $1089
1520, List $1650 ... $1389

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parallel, friction, tractor ... $649
779-2 w/tractor (same as TRS-80 Line Printer II), List $1350 ... $649
703 185 cps, bi-direct., tractor, VFU ... $209
704 RS232 serial version of 703, $2350

**NEW 702**
1201 cps, bi-direct., tractor, VFU ...
703 185 cps, bi-direct., tractor, VFU ...
704 RS232 serial version of 703, $2350

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ONLY $649
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**Digital Harmony**

by John Whitney

BYTE BOOKS is pleased to offer DIGITAL HARMONY, a major new work by John Whitney, a pioneer of the special effects industry, who is best known for his work in STAR WARS and 2001: A SPACE ODYSSEY. His book explores the special union of music and computer graphics, and expands the frontier between sight and sound, synthesizing the two to create a new art form. Whitney tells how it’s done, provides a thorough theoretical background, and includes listings and programs for those interested in joining in the discovery of this new art form. DIGITAL HARMONY lays the foundation for audio-visual art made possible by microcomputers. It is must reading for all art, music and home computer enthusiasts. Illustrated in Color.


FOR SALE: 3K Eikio Sorcerer computer, $655, SD VR024 video board; $295. S-100 mainframe, $28 A power supply; $245. IBM 821B video board, $100. Hank, (716) 245-0024 weekdays or evenings after 9 PM.


FOR SALE: IMSAI 8080A mainframe, fully loaded with North Star 280 processor and MDS single-density minicassette. 44 K of programmable memory, Crossencom TV-Dazzler color graphics. ProcessorTech VDM-1 video VR8024 video board; $295. S-100 mainframe. 28 A power supply, $489. IMSAI 3 A, 5 V power supply for $484. IMSAI single-board computer never used for $75. IMSAI programmable memory (kit form) for $110, or will trade for a video terminal. George Kimble, 213617th St, San Diego CA 43164, (419) 855-7743 days, (419) 655-6602 evenings.

WANTED: Would like to exchange TRS-80 newsletters with other users. I want to exchange the data on disks so I will not need to rekey info. If you know of a group that does newsletters exchange on disk, please let me have their mailing address so I can contact them. Also, give them my address so they can contact me. S80 userNEWSLETTER, POB 20855, Columbus OH 43228.

FOR SALE: Apple II+ (48 K), DOS 3.3, disk with controller, all manuals, Sanyo A G 12-Inch Monitor, Vexx 80-column board, Hayes micromodem, Qume 4/5 rtr printer, serial I/F card, RF modulator, EasyWriter professional word processing system, Apple Dow Jones Evaluator, Data Capture software. All purchased new in 1978/79. $6000 or best offer. Whitley Strieber, 300 E 85th St, New York NY 10021, (212) 746-1650.


FOR SALE: Printer: 165 cps, excellent condition, variable character size, double-width characters, graphics can be added, same mechanism as the IDS printers. $295. S Levine, 1802 Melville St, Ocean NJ 07712, (201) 531-8305 after 6 PM.

WANTED: $5000 micro cross assembler program that runs on 8600 or 8600 machines. Must have good documentation. J L Peterson, 7150 N Terra Vista #704, Peoria IL 61523.

FOR SALE: IBM Selectric II (Micro Computer Devices, Selecterm, system 976) interfaced for the SCL-20. This Selectric is loaded with all the options. It has tractor feed, dual pitch, 1/2 spaced, set correction, and software for a North Star drive, Bell Windows Language, 1931 Cedar Ridge Dr #18, St. Paul MN 55102, (206) 957-7108.

FOR SALE: Intersil IM-801 programmable interface element. Compatible with the IM-8000 microcomputer, the IM-801 provides control signals to peripheral devices for reading or writing on the DX bus by activating the write and read control lines with input/output timer instructions. Excellent like new condition. Asking $1500. Glenn Cardinal, (914) 471-9500.

FOR SALE OR TRADE: IMSAI single-board 8048 EROM computer (kit) for $395, cost $499; IMSAI A 3, 5 V power supply for $484. IMSAI single-board computer never used for $75, cost $95; IMSAI programmable memory (kit form) for $110, or will trade for a video terminal. George Kimble, 213617th St, San Diego CA 43164, (419) 855-7743 days, (419) 655-6502 evenings.

FOR SALE: TRS-80 Utility Program (26 K), dual: Pdi-Decks, Printer B, extra I/O board, lots of software (including Manuscript by MicroWorks and Sergon); $150 or will trade for Apple. Mark Weber, 6515 Weydton, Box 3812, Clayton MO 63103, (314) 863-7026.


FOR SALE: TEL-I message and inventory computer system. ZBD-based terminal with 16-character readout (no CRT); built-in R/W tape, real-time clock. Will interface to IBM 3270 or other. Cost $3900, asking $500. Bob Loveless, (714) 860-7800.

FOR SALE: IBM 1980 Buffered Terminal Model (Model 9) and IBM 7441 Control Unit. Used less than one year by credit company in perfect working order. terminal has Selectric-type ball and could be converted into printer. Has transmit and receive abilities compatible with Bell terminals. $600 plus shipping. Doug Arnold, Rte 1 Box 276, Hancockville AL 35707, (205) 734-0390.

FOR SALE OR SWAP: 1159, condition and fully operational with Master Library Module. No case or manuals. Will sell for $100 or swap for functional PC-100C printer. Robin Haynes, 352A Washington Rd, West Point NY 10996.

FOR SALE: Brand-new Heath H-8 microcomputer with 4 K memory board, serial interface basic, BASIC tape, all assembly and operating manuals. Fully assembled and tested. Total value $614 (assembled) or $489 (kit); you get them assembled for only $250 and shiping. Robert James, 1201 Cabana Ln, Austin TX 78759, (512) 837-4749.

FOR SALE: Intel System 8010 computer with 19-inch chassis: SBC-953 power supply, fans, four-slot card cage, SBC-60/10 (single-board computer), SBC-916 (16 K programmable memory, $489); SBC-918 (16 K programmable read-only memory), SBC-108 (8 K programmable memory, 4 K programmable read-only memory, six parallel, one serial ports). Also, have extra four-slot card cage with SBC-416, SBC-104 (like 108 but 4 K programmable memory), MCS-80 (SBC card unpopulated). Twenty-six 2703 erasable programmable read-only memories included. Will sell for about 25% of list price or swap for S-100 bus system. John Gill, Rte 5, Box 370, Blountville TN 37617, (615) 783-2453.

November BOMB Results

Steve Ciarcia found the mark with "Home in on the Range: An Ultrasonic Rang ing System" (page 32), which came in first in the voting. Steve receives the $100 first-place prize.

Second place was won by one of the articles on the issue theme of high-resolution graphics, "Micrograph, Part 1: Developing an Instruction Set for a Raster-Scan Display," by E Grady Booch (page 64). He gets the $50 second-place prize.


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